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

राष्ट्रीय हरित पोत-परिवहन नीति

NATIONAL GREEN SHIPPING POLICY

Minister's Message
Minister of State Message
Secretary - MoPSW Message
Preface

These sections will be populated following the final approval of the policy..

Table of Contents

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 & Industry
- **GCF:** Green Climate Fund
- **GCI:** Green Compliance Index
- **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 & 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
- **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
- **IMU:** Indian Maritime University
- **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
- **MAITRI:** Marine Aids to Navigation & Training for Responsible Indian shipping
- **MAKV 2047:** Maritime Amrit Kaal Vision 2047
- **MBM:** Market-Based Measure
- **MEPC:** Marine Environment Protection Committee
- **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 & 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 & Shipping
- **NDCs:** Nationally Determined Contributions
- **NGSCC:** 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 & Coasts
- **OECD:** Organisation for Economic Co-operation and Development
- **OPS:** Onshore Power Supply
- **PEMS**: Portable Emissions Measurement System
- **PIB:** Press Information Bureau
- **PPE:** Personal Protective Equipment
- **PPP:** Public Private Partnership
- **PPPs:** Public-Private Partnerships
- **R&D:** Research & 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
- **VOC Port:** V. O. Chidambaranar Port
- **VOCPA:** V. O. Chidambaranar Port Authority
- **ZEPZ:** Zero Emission Port Zones

Chapter 1: Charting India's Green Maritime Destiny

Why India Needs a National Green Shipping Policy — Now

1.1 India's Maritime Backbone: A Strategic, Economic and Ecological Force

India's maritime sector is more than an economic driver — it serves as a vital lifeline of the nation's growth, connectivity, and integration with the global economy. With a **coastline spanning 11,098 km**[1], supported by **12 major ports**, **217+ non-major ports**[2], and an **inland waterways network of (about 14,500 km of navigable waterways)** [3] **111 National Waterways**[4], India handles **95% of its trade by volume** and **68% by value**[5] through seaborne transport. This massive ecosystem underpins not just commerce, but also regional equity, coastal development energy resilience — all these factors contributing to India's growing maritime prowess.

In **FY 2023–24**, India achieved a **record cargo throughput of 1,540.34 MMT**[6], with major ports handling **621.76 MMT**[7] between April and December 2024. **Inland Water Transport (IWT)**, too, surged — with **133.03 MMT**[8] of cargo moved, supported by reforms like **Jal Marg Vikas**, **Arth Ganga**, and **Jal Vahak Yojana**. Mega projects such as **VOC Port's Outer Harbour**, **Vizhinjam port, Vadhavan port,** Galathea **Bay Port etc.**,–are reinforcing India's ambition to become a regional logistics hub.

Aligned with the Maritime Amrit Kaal Vision 2047, six port clusters have been identified for development into Mega Ports by 2047. These include four port clusters — Cochin–Vizhinjam, Galathea South Bay, Chennai–Kamarajar–Cuddalore, and Paradip and other Non-Major Ports cluster — each with a planned capacity exceeding 300 Million Tonnes Per Annum (MTPA). Additionally, two high-capacity clusters — Deendayal–Tuna Tekra and Jawaharlal Nehru–Vadhavan — are projected to reach capacities exceeding 500 MTPA. Infrastructure

[1] Ministry of Ports, Shipping and Waterways. *Annual Report 2024–25*. New Delhi: Ministry of Ports, Shipping and Waterways, Government of India, 2025. https://shipmin.gov.in
[2] ibid
[3] Inland Waterways Authority of India, Ministry of Ports, Shipping and Waterways, Government of India https://iwai.nic.in/about-us
[4] Ministry of Ports, Shipping and Waterways. *Annual Report 2024–25*. New Delhi: Ministry of Ports, Shipping and Waterways, Government of India, 2025. https://shipmin.gov.in
[5] ibid
[6] ibid
[7] ibid
[8] ibid

augmentation and capacity enhancement works at major ports are already underway, leveraging Public Private Partnership (PPP) models and internal resources.[9]

India's green credentials are rising:

- **Harit Sagar Guidelines** (2023) and **the Green Tug Transition Programme (GTTP)** provide early pathways,
- **Cochin Shipyard and GRSE are** pioneering electric and hydrogen-hybrid vessels,
- Paradip, Deendayal, and VOCPA ports are developing **green hydrogen hubs,**
- And digital systems like **NLP-Marine** reflect India's intent to build a modern, clean, and tech-enabled maritime sector.

These are just a few of the many ongoing initiatives that illustrate the country's accelerating transition toward low-carbon, circular, and innovation-driven maritime solutions, in alignment with its global and national sustainability goals.

1.2 Rising Global Expectations, Fragmented Domestic Action

While India's ambitions are bold, the path to a green maritime transition is challenged by **fragmented policy landscapes**, **regulatory silos**, and **limited integration of green metrics**. India's current maritime ecosystem is in dire need of:

- Operational definitions for **green ports**, **green ships**, or **green fuels**;
- **Baseline emissions** inventory across ports, vessels, coastal and IWT;
- Sector-wide **Monitoring, Reporting & Verification (MRV)** systems;
- Robust **carbon pricing frameworks**;
- Clear **performance-linked financial incentives** for decarbonisation.

Concurrently, with intensification of **global commitments are intensifying**, India's shipping sector faces growing climate and regulatory pressures:

- The **IMO's Revised GHG Strategy (2023)** aims for net-zero emissions from international shipping **by or around 2050**,
- Whereas, India's **Panchamrit declarations** and **Long-Term Low Emission Development Strategy (LT-LEDS)** commit to net-zero by **2070**.

This **20-year gap** poses both a **technical and geopolitical alignment challenge** that India must now address with clarity, realism, and agility.

To complement programs like **Harit Sagar, Project Unnati, Maritime India Vision 2030 (MIV 2030)**, and the **Amrit Kaal Vision 2047 (MAKV 2047)** — India needs a **unified, regulatory**, and forward-looking framework that can coherently guide this green transition.

[9] Master Plan to Develop Mega Ports, PIB Delhi, Ministry of Ports, Shipping and Waterways, Government of India, 01 April 2025 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2117248

1.3 Why the National Green Shipping Policy (NGSP) 2025 Is Imperative?

NGSP 2025 is envisioned as a **national transition framework** to anchor India's maritime decarbonisation across **ports, vessels, fuels, supply chains and the entire maritime ecosystem**.

It is not just another policy — it is:

- A **strategic mandate** to deliver India's **net-zero by 2070** goal in the shipping sector;
- A **compliance roadmap** for IMO-aligned emission targets (2030, 2040, 2050);
- A **market enabler** for **green finance**, **clean technologies**, and **global competitiveness**;
- A **people-centered policy** to mainstream coastal communities, workers, and MSMEs into the green economy.

The NGSP will:

- Define **"green" in measurable terms**—to guide regulations, tenders, and port/ship classifications;
- Institutionalize MRV systems, emission baselines, and green certification;
- Launch a **Maritime Green Transition Fund** and unlock sustainability-linked finance;
- Drive skill transformation with a **National Green Maritime Training Mission**.

The NGSP will unify environmental goals, financing frameworks, and sectoral action into one coherent mission, enabling India to become a global green shipping leader while ensuring local development.

1.4 Where India Stands Globally: Maritime Scale, Strength and Green Potential

India has emerged as a maritime power with rising global relevance in sustainability, industrial ambition, and renewable integration. While advanced maritime nations have historically dominated green innovation, India is rapidly closing the gap—leveraging its demographic scale, policy innovation, and sectoral transformation. Its green maritime leadership is evident in five critical domains:

1.4.1 Renewable Energy Surge: Powering Maritime Transition

India's decarbonisation roadmap is reinforced by its clean energy momentum:

- **Total RE Capacity**: As of June 2025, Non-fossil fuel sources now contribute **235.7 GW** (49%) of total capacity, including 226.9 GW renewable and 8.8 GW nuclear.[10]
- **Annual Gains**: In 2024 alone, India added **24.5 GW of solar** and **3.4 GW of wind capacity**[11].

[10] India's Energy Landscape, Powering Growth with Sustainable Energy, Government of India, 22 June 2025 https://www.pib.gov.in/PressNoteDetails.aspx?id=154717&NoteId=154717&ModuleId=3

[11] India's Renewable Energy Revolution, 2024 Achievements & 2025 Roadmap, PIB Delhi, 22 Jan 2025 https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2094992

- **Global Ambition**: With a **500 GW non-fossil fuel target by 2030**[12], India is among the fastest-scaling clean energy economies—essential for powering future-ready ports and green fuel hubs.

1.4.2 Port-Led Industrialization and Green Infrastructure

India's Sagarmala and **Maritime India Vision (MIV) 2030** lays the groundwork for large-scale transformation:

- **Investments & Jobs**: ₹3 lakh crore planned investment[13]; 2 million jobs; over **29 port-led industrial clusters across 14 coastal economic zones**[14].
- **Export Ambition**: MIV 2030 calls for aggressive export growth, with an aim of ~5% global share[15]
- **Green Port Goals**: India is targeting **>60% renewable energy use in ports by 2030**[16] **and other green metrics** enabled by the **Harit Sagar Guidelines**.

1.4.3 Ship Recycling Leadership

India is among the **top three ship recycling nations globally**, holding **33% of global gross tonnage dismantled in 2023**[17], second only to Bangladesh (leading at 46%). At times, India's share has exceeded 40%[18], reaffirming its leadership.

- **Projected Growth**: The ship recycling sector is expected to reach **3.8–4.2 million GT by 2025**, up from 2.3–2.6 million GT in 2024, with a **10% CAGR projected till 2028**[19].
- **Competitive Edge**: Indian ship recycling yards benefit from established infrastructure, increasing supply of ageing ships, and improving environmental compliance—making them more competitive than counterparts in Pakistan or Bangladesh.

1.4.4 Shipbuilding Aspirations and Industrial Scale

India aims to become a **top 10 shipbuilding nation by 2030**, and **top 5 by 2047**, supported by public–private cluster development and global investments.

- **Market Outlook**: The Indian shipbuilding sector, valued at **$90 million in 2022**, is expected to reach **$8.1 billion by 2033**[20], and grow into a **$62 billion opportunity by 2047.**[21]
- **Key Players**: Defence PSU shipyards, CSL and Larsen & Toubro etc., are leading in building eco-friendly vessels.

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[12] Ministry of Ports, Shipping and Waterways. *Annual Report 2024–25*. New Delhi: Ministry of Ports, Shipping and Waterways, Government of India, 2025. https://shipmin.gov.in
[13] ibid
[14] ibid
[15] Maritime India Vision 2030, Ministry of Port, Shipping and Waterways, Government of India https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/Maritime%20India%20vision%202030.pdf
[16] Harit Sagar-Green Port Guidelines, Ministry of Port, Shipping and Waterways, Government of India https://shipmin.gov.in/sites/default/files/Harit%20Sagar%20-%20Green%20Port%20Guidelines%20.pdf
[17] CareEdge Ratings. *Anchored in Change: Alang-Gujarat's Ship Recycling Industry Poised for Major Growth in CY25, Eyes 10% CAGR by CY28*. Mumbai: CARE Ratings Ltd., October 8, 2024. https://www.careedge.in/.
[18] ibid
[19] ibid
[20] Press Information Bureau. "India's Renewable Energy Capacity Hits New Milestone." *PIB*, November 2024.
[21] ibid

1.4.5 Green Shipping and Global Climate Leadership

India is stepping forward as a leading voice in green shipping through innovation and international engagement:

- **Green Tug Transition Programme**: Targets transitioning all tugs at major ports to green tugs by 2040, with select ports procuring at least two green tugs each between 2024 and 2027; the program also aims for a 30% reduction in greenhouse gas emissions from port vessels by 2030.[22]
- **Hydrogen Hubs**: Paradip Port (Odisha), Deendayal Port (Gujarat), and V O Chidambaranar Port (Tamil Nadu) are being developed as clean fuel ports.
- **IMO Pilot Country**: India is the **first nation selected under the IMO Green Voyage 2050** to pilot green shipping transition efforts.[23]
- **Policy Infrastructure**: NGSP 2025 will bridge the gap between fragmented domestic programs and international climate goals.

1.4.6 The Global Gap: India and Advanced Maritime Economies

India's baseline emissions, MRV systems, and sector-wide green certification mechanisms need further development to be compared to leading nations. Moreover, there is a **strategic mismatch between India's net-zero target (2070)** and the **IMO's 2050 decarbonisation timeline**.

Bridging this gap will require: Reconciling India's shipping emissions targets with the 2050 net-zero goal, thereby providing a glorious opportunity to occupy pole position in our national endeavour to achieve net-zero.

- Accelerated development of emissions inventories for ships, ports, and fuels,
- Investment in carbon-neutral infrastructure and MRV protocols,
- A proactive stance on green finance, retrofits, and digital systems.

India is not just keeping pace—it is **setting direction**. With scale, momentum, and now a unified policy, the country is poised to become a global model for sustainable maritime development.

NGSP 2025 will consolidate this position—transforming India's ports, ships, fuels, finance, and human capital systems to meet 21st-century climate and trade realities.

1.5 Climate Justice and India's Just Transition Imperative

India's green transition must be guided by **climate justice**—recognizing its historically low gross national contribution and current per capita emissions which are much lower than

[22] Press Information Bureau, Government of India. "India's Cumulative Installed Renewable Energy Capacity Reaches 179.57 GW." *PIB*, March 28, 2024. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2045946.

[23] India has been selected as pioneer lead country for International Maritime Organization (IMO) Green Voyage2050 Project: Shri Sarbananda Sonowal, PIB Delhi, 8 december 2023 https://www.pib.gov.in/PressReleasePage.aspx?PRID=1983989

developed and some developing economies, developmental needs, and socio-economic disparities across its coastal and riverine populations, with approximately 18 percent of India's population living in the 72 coastal districts.[24]
A maritime transition that is **clean and just** must include ship recyclers, small inland vessel operators, informal repair yards, and low-income workers, to deliver the desired long-term impact.

Therefore, NGSP 2025 will embed **inclusive transition principles**, including:

- Support to small ports, shipyards, and informal operators,
- Green skilling for underrepresented groups and women,
- Affordable access to green technologies for MSMEs,
- Decentralised infrastructure models that do not centralize green benefits.

Climate action will be designed to uplift livelihoods and regional economies—anchoring ecological responsibility within **social and economic equity**.

1.6 Defining "Green": From Ambition to Action

The policy will formally define:

- **Green Port**: Based on energy mix, air/water quality, modal shift capacity, digitalization, and zero-discharge systems.
- **Green Ship**: Based on energy efficiency (EEDI/EEXI), fuel type, emissions per nautical mile, and operational practices.
- **Green Fuel**: Based on lifecycle GHG emissions, calculated on well-to-wake basis, feedstock sustainability, and other IMO-aligned standards and stipulations (e.g. e-methanol, ammonia, hydrogen, bio-LNG, etc.)

These definitions will be operationalized through **standards, audit mechanisms, and certification protocols** detailed in later chapters of this policy.

1.7 Anchoring the Future

NGSP 2025 aims to transform India into a **climate-resilient maritime nation**, designed to:

- Unite fragmented schemes and visions into a whole-of-nation action plan,
- Build **emissions baselines**, MRV systems, and institutional coordination,
- Mobilize green capital, including through India-led initiatives like the **Green Credit Framework**,
- Create a workforce equipped for decarbonisation, circularity, and digitalisation,
- And position India as a **sustainable maritime powerhouse** by 2047.

[24] Coastal Community Development, SagarMala https://sagarmala.gov.in/project/coastal-community-development

With this policy, India sets sail not only to meet and exceed international expectations — but to **lead them**.

Chapter 2: Vision, Objectives & Guiding Principles

2.1 Vision

The **National Green Shipping Policy (NGSP) 2025** envisions **India as a global leader in sustainable maritime development**—one that harmonizes economic growth with environmental integrity, fosters climate-resilient infrastructure, promotes clean technology, and ensures equity in the green transition for all maritime stakeholders, including coastal communities.

Vision Statement:
"To be a global maritime leader by 2047 by developing a climate-resilient, technology-enabled, resource-efficient, low-emission, and innovation-driven maritime sector that ensures environmental sustainability, global competitiveness, and inclusive prosperity."

2.2 Scope of the Policy

The NGSP 2025 applies across the entire spectrum of the Indian maritime ecosystem, including both coastal and inland waterways operations, and acts as the overarching policy framework for sustainable maritime planning, investment–implementation and regulatory alignment. It covers:

- **Ports**: All major, non-major, and private ports; port-based SEZs and terminals.
- **Shipping**: Indian-flagged operating in Indian waters; coastal and inland vessels.
- **Shipbuilding, Repair and Recycling**: Public and private yards including clusters at emerging sites in different coastal states.
- **IWT & Coastal Shipping**: Infrastructure under IWAI, Jal Marg Vikas, Arth Ganga, and Jal Vahak.
- **Green Fuel Infrastructure**: Facilities for production, transportation, bunkering, storage, and refueling of methanol, hydrogen, ammonia, biofuels, e-LNG etc.
- **Digital and Skill Infrastructure**: NLP-Marine, Port Community System (PCS 1x), green skill centres, Centre of Excellence campuses, and training programs.
- **Ancillary and Community-Linked Services**: Dredging, coastal tourism, marine clusters, fisheries harbours, and climate-resilient community development.
- **Green Technologies**: Promotion of green technologies for domestic and international markets.

2.3 Policy Rationale

While India has initiated progressive programs such as the **Harit Sagar Guidelines**, **Green Tug Transition Programme**, and the **Ship Recycling Act (2019)**, these are fragmented or scheme-based. A **comprehensive national policy** is required to:

- Define "**green port**", "**green ship**", and "**green fuel**" in clear and operable terms.
- Codify national **emissions reduction targets** for domestic maritime activities.
- Establish **emission baselines**, waste management metrics, and MRV frameworks.
- Integrate **climate finance** tools, such as **green bonds**, **ESG-linked lending**, and **blended finance**.
- Align India's domestic efforts with global decarbonisation trajectories—especially with the IMO GHG Strategy (net-zero ~2050)[25] and India's LT-LEDS (net-zero by 2070)[26].

Without such a policy, India risks competitive disadvantage, non-compliance with emerging international frameworks (e.g. **FuelEU Maritime Regulation**, **carbon border adjustments, UK ETS**), and under-utilisation of global climate finance mechanisms.

The NGSP will also support:

- **Green fuel adoption and retrofitting** at scale.
- **Development of Green Corridors and ZEPZs (Zero Emission Port Zones)**.
- **Investor confidence** through standardised metrics, governance mechanisms, and climate-aligned procurement.

Importantly, it will promote **climate justice** by incorporating MSMEs, informal workers, small shipyards, and local communities into the green transition through targeted capacity building and inclusive policy design.

2.4 Guiding Principles

The NGSP 2025 is underpinned by the following principles:

1. **Sustainability**: Environmental integrity, emissions reduction, and responsible resource use are embedded across the value chain.
2. **Technology Neutrality**: The policy supports multiple technological pathways (eg., fuel-agnostic) to achieve GHG targets.
3. **Lifecycle Thinking**: Lifecycle emissions, from vessel construction to recycling, guide all interventions.

[25] International Maritime Organization. *2023 IMO Strategy on Reduction of GHG Emissions from Ships*. Resolution MEPC.377(80), adopted July 7, 2023. MEPC 80/17/Add.1, Annex 15. London: IMO, 2023.
[26] Government of India. *India's Long-Term Low-Carbon Development Strategy (LT-LEDS)*. New Delhi: Ministry of Environment, Forest and Climate Change, 2022.

4. **Equity and Just Transition**: Special support for MSMEs, informal sectors, and vulnerable communities.
5. **Coherence and Convergence**: Alignment with **Harit Sagar**, **GTTP**, **MIV 2030**, **MAKV 2047**, and sectoral development goals.
6. **Data-Driven Governance**: Baseline development, digital MRV systems, and performance-based incentives.
7. **Stakeholder Partnership**: Collaboration with industry, academia, civil society, and international bodies for robust implementation.

2.5 Stakeholder Consultations: Foundation of NGSP 2025

The NGSP has been developed through an extensive and structured **multi-stage consultation process**:

- A **consultative document** was developed by **Lloyd's Register (LR)** at the behest of the **Directorate General of Shipping (DGS)**[27].
- As tasked by the MoPSW, a comprehensive **Gap Analysis** of the above consultative document was undertaken by the **National Centre of Excellence for Green Ports and Shipping (NCoEGPS)**[28] to identify systemic, institutional, and regulatory shortfalls.
- This informed the **First Multi-Stakeholder Consultation**, held on **11 June 2025**, with participation from over **130 stakeholders in the Indian maritime ecosystem**, including major ports, shipyards, shipowners, industry associations, academic institutions, green technology developers, and civil society.

To deepen technical inputs, **Seven Specific Sectoral Consultations** were conducted from **23–27 June 2025**, on:

1. **Green Shipping (including Shipbuilding and Ship Repair)**
2. **Green Ports**
3. **Green Shipping (including Shipbuilding and Ship Repair)**
4. **Green Finance**
5. **Capacity Building (Green Skill Development)**
6. **Sustainable Ship Recycling**
7. **Green Technology**
8. **Green Fuels**

Each session was guided by a thematic background note and stakeholder questionnaire. Inputs were received in the form of:

- Real-time video conference comments during the online interaction,

[27] Ministry of Ports, Shipping and Waterways. *Draft Consultative Report: National Green Shipping Policy*. New Delhi: Ministry of Ports, Shipping and Waterways, Government of India, 2023.

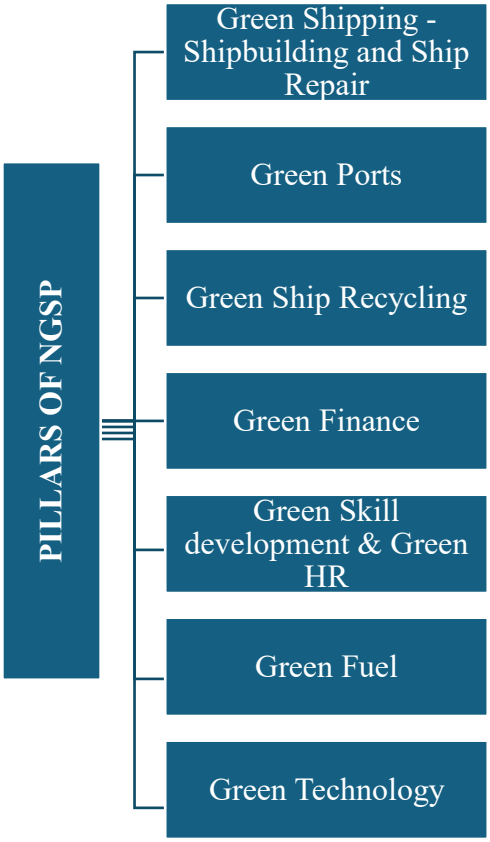
[28] National Centre of Excellence for Green Ports and Shipping (NCoEGPS). *Gap Assessment of NGSP 2025: Section-wise Analysis, Recommendations, and Drafting Plan for India's Green Shipping Policy*. New Delhi: NCoEGPS, June 2, 2025.

- Written emails,
- Feedback forms (Microsoft Forms),
- And filled **Stakeholder Interaction Forms**.

Key stakeholder contributions—including from **IITs**, **IMU**, **IRS**, **IWAI**, **JNPA**, **GH2 India**, **Indian National Shipowners' Association**, **Anglo-Eastern Ship Management (India)**, **VOCPA, NIOT, GMB, CSL, FICCI**, **SCI**, **GRSE, NYK Line** and others—have been incorporated throughout the policy.

Chapter 3: India's Green Maritime Pillars

In the spirit of the ancient *Saptasagara* (Seven Seas) that symbolized India's historic maritime reach, the NGSP 2025 anchors its strategy on seven interlinked foundational pillars critical to achieving a green maritime future. These definitions and national targets aim to unify standards, guide investment, and align India's efforts with international and domestic goals.



3.1 Green Shipping - Shipbuilding and Ship Repair

Green Shipping as a strategic pillar of the National Green Shipping Policy (NGSP) 2025 encompasses the adoption of zero- and low-emission vessels, integration of alternative fuels such as bio-diesel, green methanol, ammonia, hydrogen, and electrification, as well as the digitisation of fleet operations to enhance energy efficiency. The policy also promotes climate-resilient ship design, green retrofitting, and the modernisation of ship repair and shipbuilding yards—including key public assets such as Cochin Shipyard Ltd., Ms MDL. Ms GRSE, Goa Shipyard Ltd., HSL and other private yards including Ms L&T, Ms Swan Energy—under Make in India and Atmanirbhar Bharat. With India emerging as a design and manufacturing hub for hybrid and fuel-cell vessels, pilot deployments such as the hydrogen fuel cell powered

inland ferries by CSL and electric powered vessels by Ms GRSE [29] demonstrate early leadership[30].

India's green shipbuilding and ship repair ecosystem is gaining strategic momentum under initiatives such as the **Green Tug Transition Programme (GTTP)** and the Ministry of Ports, Shipping and Waterways' (MoPSW) vision to make India a **global hub for green shipbuilding by 2047**. Cochin Shipyard Ltd. (CSL), Garden Reach Shipbuilders and Engineers (GRSE), Mazagon Dock Shipbuilders (MDL), Goa Shipyard Ltd. (GSL), Hindustan Shipyard Ltd. (HSL), along with private players such as L&T and Swan Energy, are being modernised to adopt **energy-efficient design tools, advanced materials, and digital twin technologies** to meet International Maritime Organization (IMO) standards on EEXI, CII, and emerging GHG Fuel Intensity (GFI) metrics. The establishment of India's first **National Centre of Excellence in Green Port and Shipping (NCoEGPS)** and R&D-driven programmes on **hydrogen fuel cells, green methanol, ammonia, and electrification** are enabling next-generation vessel prototypes, including inland hydrogen ferries and battery-electric tugs. On the ship repair front, the **Ship Building and Repair Policy (SBRP) 2023–24** emphasizes eco-friendly retrofitting, energy efficiency upgrades, lifecycle emissions reduction, and improved waste and wastewater management at repair facilities—positioning India not only as a shipbuilding nation but also as a sustainable ship repair hub for the region. Together, these measures anchor the shift towards a **circular and climate-resilient maritime manufacturing ecosystem** in line with *Make in India*, *Atmanirbhar Bharat*, and India's net-zero 2070 commitments.[31]

The concept of a *green ship* has emerged as a cornerstone of maritime decarbonization and sustainability. Although not uniformly defined across jurisdictions, several widely accepted definitions converge on key environmental performance criteria:

- **General understanding of a green ship[32]:**

A green ship is a vessel designed, built, and operated to minimize environmental impact by reducing greenhouse gas (GHG) emissions, air and water pollution, and resource

[29] New Generation Electric Ferry, GRSE https://grse.in/ship-building/files/NGEFerry.pdf

[30] Ministry of Ports, Shipping and Waterways. *Annual Report 2024–25*. New Delhi: Ministry of Ports, Shipping and Waterways, Government of India, 2025. https://shipmin.gov.in

[31] Shri Sonowal inaugurates India's First National Centre of Excellence in Green Port & Shipping, MoPSW, PIB Delhi, 22 March 2023
https://www.pib.gov.in/PressReleasePage.aspx?PRID=1909599#:~:text=Country's%20first%20National%20Centre%20of,building%20Green%20Ships'%20by%202030
Also See: Standing Committee Report,
https://prsindia.org/files/policy/policy_committee_reports/SCR_Summary-Ship_Building.pdf
Also See: Infrastructure Development in Shipbuilding Clusters, PIB Delhi, 1 April 2025 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2117250

consumption. This is achieved through cleaner fuels, advanced propulsion systems, energy efficiency technologies, and optimized operational practices.

- **Regulatory Definition (South Korea):**

As per the *Act on the Development and Popularization of Green Ships* (Republic of Korea)[33], a green ship is:

  - A vessel that uses eco-friendly energy sources (e.g., e-LNG, electricity, fuel cells etc.), and/or
  - A ship incorporating pollution-reduction and energy-efficiency technologies certified by the government.
  - Types include electric, hybrid, and fuel cell propulsion ships.

- **IMO Perspective:**

The International Maritime Organization (IMO) defines the role of green ships within its GHG Strategy (2018, revised 2023)[34], targeting net-zero emissions by 2050. Green ships contribute to compliance with key instruments such as:

  - EEDI (Energy Efficiency Design Index)
  - EEXI (Energy Efficiency Existing Ship Index)
  - CII (Carbon Intensity Indicator)
  - GFI (GHG Fuel Intensity – *it is appreciated that the MEPC Extra Ordinary Session in October 2025 will adopt revised MARPOL Annex VI which incorporates this new benchmarking standard for GHG emission.*)

Key Features of Green Ships

Aspect	Description
Energy Source	Alternative/low-emission fuels: Bio-diesel, LNG, green methanol, ammonia, hydrogen, batteries etc.
Propulsion	IC Engines, Nuclear, Electric, hybrid, solar, wind-assisted, or fuel-cell propulsion systems
Efficiency Systems	Optimized hull designs, energy-saving devices, advanced propellers, digital routing etc.
Pollution Control	Ballast-free systems, exhaust gas scrubbers, onboard waste and water management, onboard carbon capture etc.
Digitalization	Real-time performance monitoring, Just-In-Time (JIT) arrivals, AI route optimization etc.
Regulatory Alignment	IMO, MARPOL Annex VI, ISO 50001

Global Examples of Green Ships

Vessel	Technology/Features	Owner/Region	Remarks

[33] Republic of Korea – Toward Green Shipping by 2050
[34] KLIMA–IMO – Green Transition of Shipping in Developing Countries

Laura Maersk[35]	Green methanol propulsion	Maersk (Denmark)	World's first large container ship powered by green methanol (2023)
China Zorrilla[36]	Battery-electric propulsion (>40 MWh)	Buquebus/Incat (Uruguay)	Largest battery-electric ferry (2025), fully zero-emission
Tûranor PlanetSolar[37]	100% solar-powered catamaran	Switzerland	First solar ship to circumnavigate the globe
Pyxis Ocean[38]	Wind-assisted propulsion (WindWings) + diesel	Cargill/BAR Technologies	Reduces fuel use and GHG emissions through rigid sail technology
Green Ships AS Fleet[39]	Hybrid electric/diesel, hydrogen, biofuels	Norway	Offshore vessels with modular green technology configurations

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."

Policy Rationale

India's **Green Ship** definition under the National Green Shipping Policy (NGSP) 2025 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.

[35] A.P. Moller - Maersk. "EU Commission President Names Landmark Methanol Vessel 'Laura Mærsk'." Maersk, September 14, 2023. https://www.maersk.com/news/articles/2023/09/14/eu-commission-president-names-landmark-methanol-vessel-as-laura-maersk

[36] Incat. "096 – INCAT." Incat, accessed July 18, 2025. https://incat.com.au/incat-vessels/096/

[37] PlanetSolar. "World Premiere: Boat." PlanetSolar, accessed July 18, 2025. https://www.planetsolar.org/en/world-premiere/boat/

[38] Cargill. "The World's First Wind-Powered Ocean Vessel's Maiden Voyage." Cargill, March 13, 2024. https://www.cargill.com/2024/first-wind-powered-ocean-vessel-maiden-voyage

[39] Hellenic Shipping News. "Green Shipping Fleet Growing as More Newbuilding Orders Were Placed in 2024." Hellenic Shipping News, July 3, 2024. https://www.hellenicshippingnews.com/green-shipping-fleet-growing-as-more-newbuilding-orders-were-placed-in-2024/

- **Guide regulatory recognition** through a **National Green Ship Certification Framework** that is harmonized with global standards, enabling acceptance by foreign ports and 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 or around 2050.
- **Enable access to Green Finance** from national and international sources, including **Sustainability-Linked Loans (SLLs)**, **Green Bonds**, and **multilateral climate funds**.

The NGSP will facilitate:

- Establishment of a **National Green Ship Certification System** to standardize environmental performance benchmarks across vessel categories.
- Deployment of **performance-linked incentives**, tax benefits, and accelerated depreciation for green-compliant vessels.
- Integration of global compliance metrics such as **EEDI (Energy Efficiency Design Index)**, **EEXI (Energy Efficiency Existing Ship Index)**, **CII (Carbon Intensity Indicator)**, and the upcoming **GFI (GHG Fuel Intensity)** metric into the certification process.

Incorporating the GFI (GHG Fuel Intensity) Index

To provide a measurable and transparent benchmark for green vessel classification, NGSP 2025 will incorporate the **GFI Index** — 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**.

This benchmark will:

- Enable a **quantifiable threshold** for "Green Ship" status — for example, vessels achieving a **GFI ≤ XX g CO_2e/MJ** will qualify for Green Certification.
- Facilitate **objective evaluation** by regulators, port authorities, classification societies, and financial institutions.
- Provide an **investment screening tool** for green finance eligibility.
- Align Indian shipping with **future IMO mid-term measures** and the anticipated global fuel lifecycle carbon standards.

Beyond Propulsion: Operational Efficiency Measures

Green shipping under NGSP 2025 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**.

3.2 Green Ports

Green Port pillar promotes **shore power infrastructure (Onshore Power supply - OPS), Just-In-Time (JIT) arrivals, electrified cargo handling, on-site renewable energy, port-level carbon accounting, smart water and waste systems, and ecosystem safeguards. It also endorses the creation of Zero Emission Port Zones (ZEPZ)** at major ports by 2030 and extension to non-major ports by 2040.

This section operationalises the Harit Sagar vision by defining what constitutes a **Green Port in the Indian context**—not just as a compliance-driven infrastructure, but as a dynamic and evolving, performance-based ecosystem that balances trade growth with ecological stewardship. The definition that follows will guide the development of a Green Port Ranking Framework, Inclusion of Green Port Index in the annual reports, inform MRV protocols under NLP-Marine, and serve as a basis for ESG-aligned investments in port infrastructure.

The term *green port* refers to ports that systematically minimize environmental impacts through integrated, multi-dimensional strategies. While there is no universally binding definition, several globally recognized interpretations highlight the operational, environmental, technological, and governance dimensions of green ports.

Prominent Global Definitions

Source/Author	Definition Highlights
Dom Magli (2024)[40]	A green port invests in long-term environmentally sustainable operations—emphasizing reduced pollution, energy optimization, and sustainable transport.
Ben Thompson [41]**(2025)**	Focuses on emission reduction, cleaner energy usage, and waste minimization across port functions.
Mark Buzinkay (2023)[42]	Defines green ports as those integrating ecological protection, human health, energy efficiency, and low-carbon technologies into their core operations.

[40] Magli, Dom. "What Is a Green Port?" *Port Technology*, March 7, 2024. https://www.porttechnology.org/news/what-is-a-green-port 2/#:~:text=By%20Dom%20Magli,the%20port%20and%20marine%20sector.

[41] IncoDocs. "Green Port Initiatives Explained." *IncoDocs Blog*, January 28, 2025. https://incodocs.com/blog/green-port-initiatives/#google_vignette

[42] Buzinkay, Mark. "The Green Port Concept." *Identec Solutions*, updated January 25, 2025 https://www.identecsolutions.com/news/the-green-port-concept

Source/Author	Definition Highlights
Multidisciplinary Digital Publishing Institute (MDPI) (2023)[43]	Positions green ports as institutions proactively preserving marine and ecological systems through robust governance.
World Economic Forum (2024)[44]	Green ports optimize digital tools, renewable energy, and circular systems to reduce their ecological footprint—highlighting convergence between operational efficiency and sustainability.
EU Preparedness for Operational Monitoring and Prediction of contaminant Transport in the Sea (PROMPT) Initiative[45]	Seaports that lower emissions, improve energy use, manage waste effectively, and align with circular economy and environmental compliance goals.

Key Elements of Green Ports

Dimension	Description
Energy Efficiency	Electrification of port operations; transition to renewable energy sources (solar, wind etc.).
Emission Reduction	Onshore power supply (OPS), zero-emission cargo handling, clean fuel bunkering.
Digital Optimization	Real-time monitoring, Just-in-Time (JIT) arrivals, smart energy management.
Waste and Water Management	MARPOL-compliant reception facilities, recycling, oil/waste segregation.
Ecosystem and Community Integration	Measures to protect marine biodiversity, air quality, and community health.
Certification and Standards	Compliance with ISO 14001, PERS (EcoPorts), Green Marine, Blue Flag.

Examples of Leading Green Ports

Port	Country	Key Initiatives
Port of Rotterdam[46]	Netherlands	CO_2 reduction by 50% (by 2025), onshore power supply, renewable energy hubs
Port of Los Angeles[47]	USA	Clean Air Action Plan, solar energy, electric trucks, OPS for cruise terminals

[43] "A Systematic Review of Green Port Evaluation: Methods, Subjects, and Indicators." *Journal of Marine Science and Engineering* 13, no. 3 (2025): 604 https://www.mdpi.com/2077-1312/13/3/604

[44] World Economic Forum. "These Are the World's 10 Most Efficient Ports – But Which Ones Are the Greenest?" *World Economic Forum*, July 9, 2025 https://www.weforum.org/stories/2024/07/best-world-ports-sustainable-shipping/

[45] PROMPT - Civil Protection Knowledge Network, European Union. "Preparedness for Operational Monitoring and Prediction of contaminant Transport in the Sea." UCPM-2022-PP, European Commission, 2024. https://civil-protection-knowledge-network.europa.eu/projects/prompt

[46] Port of Rotterdam Authority. "Storage and Use of CO2." *Port of Rotterdam*, last updated February 1, 2025 https://www.portofrotterdam.com/en/port-future/energy-transition/ongoing-projects/storage-and-use-co2#:~:text=The%20Port%20of%20Rotterdam%20Authority,based%20on%20carbon%20and%20hydrogen.

[47] Port of Los Angeles. "Sustainability Reports." https://www.portoflosangeles.org/environment/sustainability/sustainability-reports

Port	Country	Key Initiatives
Port of Yokohama[48]	Japan	Methanol bunkering, electric vehicle terminals, efficiency optimization
Port of Antwerp-Bruges[49]	Belgium	Hydrogen fueling, modal shift to rail/barge, circular economy infrastructure
Port of Gothenburg[50]	Sweden	LNG bunkering, cold ironing, electric cranes and vehicles

Standards and Certification Programs

Framework	Description
ISO 14001[51]	Environmental management system standard—used globally by ports for compliance and performance measurement.
EcoPorts[52]**(PERS)**	Environmental review and self-diagnosis method adopted widely across Europe; includes independent audits.
Green Marine	North American program requiring self-assessment and third-party verification of sustainability indicators.
Blue Flag for Ports	International recognition for clean water, biodiversity protection, and environmental education.

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."

Policy Rationale

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

- Anchoring regulatory reforms under 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 & guidelines, MARPOL Annex VI, and the SDG framework (especially SDG 9, 11, 13, and 14).

[48] City of Yokohama. "Carbon-Neutral Port Initiatives." *City of Yokohama*, last updated July 9, 2025.https://www.city.yokohama.lg.jp/lang/overseas/port/kankyo/cnp/initiatives.html
[49] Port of Antwerp-Bruges. "Green Energy Hub." *Port of Antwerp-Bruges*, https://www.portofantwerpbruges.com/en/green-energy-hub
[50] ort of Gothenburg. "The Port of Gothenburg – The Port of the Future." *Port of Gothenburg* https://www.portofgothenburg.com/about/future/
[51] International Organization for Standardization. "ISO 14001:2015 Environmental Management Systems — Requirements with Guidance for Use." *ISO* https://www.iso.org/standard/60857.html
[52] EcoPorts. "Home." *EcoPorts* https://www.ecoports.com

- Establishing eligibility for green finance, public investment, and ESG-linked incentives.

Green ports are not simply eco-efficient infrastructures—they represent a **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.

3.3 Green Ship Recycling

The Sustainable Ship Recycling pillar of NGSP 2025 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), 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 systems** 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.).

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.**

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 by also 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 monetise avoided emissions through **material recovery** (e.g. ~85–90% steel reuse per vessel).

3.4 Green Finance

Green finance refers to a structured set of financial instruments, mechanisms, and capital flows that are specifically directed towards environmentally beneficial activities. It is central to global sustainability goals and maritime decarbonization strategies, supporting investment in renewable energy, low-emission transport, pollution control, energy efficiency, and circular economy solutions.

Key Global Definitions

Source	Definition
UN Environment Programme (UNEP)[53]	Green finance is the increase in financial flows—banking, investment, insurance, and microfinance—towards sustainable development priorities while managing environmental and social risks.
International Finance Corporation (IFC)[54]	Financing through instruments such as green bonds and loans that align with recognized international principles (e.g., Green Bond Principles), aimed at advancing the UN Sustainable Development Goals (SDGs).
ISO (International Organization for Standardization)[55]	Green finance relates to the interface between financial activity and environmental impact, providing a framework for credible and transparent investment in sustainability.
OECD[56]	Green finance supports "green growth," which involves achieving economic progress while reducing pollution, emissions, and waste, and improving resource efficiency.
General Definition	Any form of capital allocation or financial incentive designed to promote sustainability, reduce environmental harm, and accelerate the green transition in key sectors.

Examples of Green Finance Instruments and Mechanisms

Instrument	Description	Example
Green Bonds	Debt instruments to raise funds exclusively for green projects	The World Bank's green bonds have financed energy efficiency and

[53] University of North Carolina Institute for the Environment. "What Is Green Finance and Why It Matters." *UNC Institute for the Environment*, https://ie.unc.edu/cleantech-story/what-is-green-finance-and-why-it-matters/
[54] International Finance Corporation (IFC). "Green Finance." *IFC*, January 1, 2024. https://www.ifc.org/en/what-we-do/sector-expertise/financial-institutions/climate-finance/green-finance
[55] International Organization for Standardization (ISO). *Green Bonds – Environmental Performance Evaluation – Guidance on Metrics*, ISO/PAS 22910:2022. Geneva: ISO, 2022. https://www.iso.org/publication/PUB100458.html
[56] Organisation for Economic Co-operation and Development (OECD). *Developing Sustainable Finance Definitions and Taxonomies*. Paris: OECD Publishing, 2023. https://www.oecd.org/en/publications/developing-sustainable-finance-definitions-and-taxonomies_134a2dbe-en.html

Instrument	Description	Example
		renewable energy projects in 60+ countries.
Green Loans	Loans with defined environmental objectives and outcomes	Commercial banks lending to port operators for solar rooftop installation or onshore power supply infrastructure.
ESG Investments	Investment funds that prioritize firms with strong environmental, social, and governance performance	ESG-screened equity investments in green shipbuilding companies.
Public-Private Partnerships (PPPs)	Joint financing arrangements between government and private sector to scale sustainable infrastructure	UNEP-supported PPPs for green ports, such as shore power infrastructure or alternative fuel bunkering stations.
Regulatory Taxonomies	Classification systems that define eligible green investments	The European Union's Sustainable Finance Taxonomy used to guide green finance flows.

Working Definition for the Indian Maritime Context

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

"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. 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."[57]

Policy Rationale and Alignment

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.

[57] Climate Policy Initiative. *Landscape of Green Finance in India 2024* https://www.climatepolicyinitiative.org/publication/landscape-of-green-finance-in-india-2024/

- **Institutional Anchoring:** Development of a **National Maritime Green Finance Framework** to define eligibility, verification, and impact monitoring protocols.

3.5 Green Skill development & Green HR

Green skill development refers to the process of building competencies that enable individuals and institutions to support the **transition to an environmentally sustainable, resource-efficient, and low-carbon economy**. These skills span **technical, cognitive, and social domains**, ensuring a workforce that is **future-ready**, environmentally responsible, and aligned with global climate goals. The following are some of the definitions and explanations green skills:

1. **United Nations Industrial Development Organization (UNIDO)**[58]

Green skills are the **knowledge, abilities, values, and attitudes** required to live in, develop, and support a sustainable society. They encompass **technical and transversal skills**, enabling environmental decision-making in all spheres.

2. United Nations Educational, Scientific and Cultural Organization - International Centre for Technical and Vocational Education and Training (UNESCO-UNEVOC)[59]

Green skills are **sector-agnostic**, essential at all levels of employment. They support the **adaptation of services and production systems** in response to climate change and environmental regulations.

3. International Organisation of Employers (IOE)[60]

Green skills include:

- **Job-specific technical capacities** in sustainable industries,
- **Human/social skills** like adaptability and critical thinking,
- **Transformational skills** such as entrepreneurship, essential for innovation in the green transition.

4. Greenly & UNDP[61]

Green skills are also embedded in **education systems**, **corporate upskilling**, and **national workforce planning**, ensuring alignment of talent with sustainability and green economy goals.

[58] Arthur, Charles. "What Are Green Skills?" *UNIDO*, August 8, 2022. https://www.unido.org/stories/what-are-green-skills

[59] UNESCO-UNEVOC. "Green Skills." *TVETipedia Glossary*. https://unevoc.unesco.org/home/TVETipedia+Glossary/lang=en/show=term/term=Green+skills

[60] International Organisation of Employers. *Green Skills for a Just Transition*. https://www.ioe-emp.org/index.php?eID=dumpFile&t=f&f=160853&token=1e1f9a7272398f2eef150f4f6c7b1155c6a32faa

[61] Greenly. "What Are Green Skills?" *Greenly Blog*. https://greenly.earth/en-us/blog/industries/what-are-green-skills

Examples of Green Skill Development Initiatives

Area	Skill Focus
Renewable Energy	Installation of solar panels, maintenance of wind turbines, grid integration
Sustainable Construction	Energy audits, green building design, use of eco-materials
Transport and Shipping	Operation of electric/hybrid vehicles, fuel efficiency, alternative fuel handling
Digital and Circular Economy	Digital optimization of energy, waste analytics, lifecycle design
Curriculum Integration	Sustainability modules in school, college, and ITI-level programs
Industry Upskilling	Green job apprenticeships and continuous learning in port, logistics, and shipbuilding

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 Green Skill Development Programme (GSDP),** and is implemented through institutions such as **NSDC, Skill Council for Green Jobs (SCGJ), NCoEGPS, IMU, ITIs, and port training institutes.**

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 green job demand-supply gap** with focused training in emerging technologies like hydrogen, biofuels, and carbon capture.

3.6 Green Fuel

Green fuels are increasingly recognized as essential enablers of the global energy transition. They are **low-carbon or carbon-neutral alternatives** to conventional fossil fuels and are produced using **renewable energy sources** or sustainable biomass. Green fuels are crucial for decarbonizing hard-to-abate/electrify sectors such as shipping, aviation, and heavy industry, and are actively promoted under the International Maritime Organization's (IMO) GHG reduction strategy.

1. General Understanding

A **Green Fuel** is any fuel intended for maritime propulsion or auxiliary power generation that is derived from **renewable energy sources** or **sustainable feedstocks**, and produced using processes that result in **significantly reduced or near-zero greenhouse gas (GHG) emissions** over its entire lifecycle.

This understanding includes, but is not limited to:

- **Biofuels** (e.g., advanced biodiesel such as FAME, hydrotreated vegetable oil, ethanol blends, etc.,) produced from **sustainable feedstocks** such as agricultural residues, waste cooking oil, waste animal fats, and algae.
- **Synthetic fuels (e-fuels)**, such as green methanol, green ammonia, and synthetic hydrocarbons, produced using **green hydrogen** (from renewable electricity) combined with captured CO_2 or nitrogen.
- **Renewable LPG** and **Fischer–Tropsch (FT) diesel**, subject to lifecycle sustainability verification.

Key Sustainability Principles:

Green Fuels must not only meet GHG intensity thresholds but also be produced using methods that preclude negative environmental and social impacts. Production should:

- Comply with **sustainable feedstock** criteria (broader than "sustainable biomass") to include non-biomass renewable sources and waste-derived inputs.
- Avoid adverse impacts on **local ecosystems, water resources, and soil quality**.
- Ensure traceability through recognized certification schemes (e.g., ISCC, RSB, BIS national standards).

Applicability:
While the **IMO GHG Strategy** targets **international seagoing ships above 5,000 GT**, India's NGSP 2025 may extend green fuel definitions and incentives to **domestic, coastal, and inland vessels** to accelerate the decarbonization of the wider maritime sector.

2. Major Categories

Fuel Type	Definition & Source	Examples
Biofuels	Derived from biological material (plants, waste, animal fat)	Biodiesel, Bioethanol, Biogas
Synthetic/E-fuels	Made by combining green hydrogen with CO_2 or nitrogen	Green Methanol, Green Ammonia, SNG
Green Hydrogen	Produced via electrolysis powered by 100% renewable energy	Used directly or as base for e-fuels

3. Certification and Standards

Standard	Highlights
Green Hydrogen Standard[62]	Requires ≤1 kg CO_2e/kg H_2, ESG safeguards, 100% RE-powered electrolysis
Renewable Fuel Standard (USA)[63]	Mandates biofuels reduce GHGs compared to petroleum-based fuels
EU RED II / Taxonomy[64]	Defines sustainable fuels and incentivizes production aligned with EU climate goals

4. Real-World Applications in Maritime and Industry

Project/Region	Fuel Type	Use Case
Maersk (Denmark)[65]	Green Methanol	First methanol-powered container ships
Yara (Norway)[66]	Green Ammonia	Pilot plant for fertilizer and maritime fuel
GH2 Projects (EU)[67]	Green Hydrogen	Certified hydrogen for e-fuel synthesis
Brazil (Proálcool)[68]	Bioethanol	Large-scale ethanol blending with gasoline
Sweden (Transit)[69]	Biogas	Public transport powered by anaerobically digested waste
Audi (Germany)[70]	Synthetic Natural Gas	E-gas project using renewable hydrogen and CO_2 for methane production

Types of Fuels: Green, Brown, and Other Classifications

This section clarifies fuel types by source, process, and emissions profile, aiding in technology prioritization, infrastructure planning, and policy alignment.

[62] Green Hydrogen Organisation. *The GH2 Green Hydrogen Standard*. Launched May 2022. https://gh2.org/our-initiatives/gh2-green-hydrogen-standard
[63] U.S. Department of Energy. *Renewable Fuel Standard (RFS)*. https://afdc.energy.gov/laws/RFS
[64] Joint Research Centre (European Commission). *Renewable Energy Recast 2030 (RED II)*. https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en
[65] Maersk. "EU Commission President Names Landmark Methanol Vessel 'Laura Mærsk'." *Maersk Newsroom*, September 14, 2023. https://www.maersk.com/news/articles/2023/09/14/eu-commission-president-names-landmark-methanol-vessel-as-laura-maersk
[66] Yara International. *Yara Clean Ammonia*. https://www.yara.com/yara-clean-ammonia/
[67] Green Hydrogen Organisation. *The GH2 Green Hydrogen Standard*. Launched May 2022. https://gh2.org/our-initiatives/gh2-green-hydrogen-standard
[68] Cortez, Luiz A. B., Amabile Passarella, Paulo Costa, and Silvio M. J. de Avila. "Perspectives for Development of Advanced Biofuels in Brazil and LAC." Paper presented at the 21st International Symposium on Alcohol Fuels (ISAF), Gwangju, Korea, 2016. https://bioenfapesp.org/gsb/lacaf/documents/papers/05_ISAF_2016_Cortez_et_al.pdf
[69] Sustainable Conservation. *Biomethane Sourcebook: Chapter 4 – Legal and Regulatory Considerations*. https://suscon.org/pdfs/cowpower/biomethaneSourcebook/Chapter_4.pdf
[70] Audi AG. "Audi Steps Up Research into Synthetic Fuels." *Audi MediaCenter*, October 13, 2017. https://www.audi-mediacenter.com/en/press-releases/audi-steps-up-research-into-synthetic-fuels-9546

A. Primary Classification by Carbon Impact

Fuel Category	Definition	Examples	Environmental Impact
Green Fuels	Produced from renewable sources, resulting in zero or low GHG emissions	Biodiesel, Bioethanol, Green Hydrogen, Green Methanol	Low
Brown Fuels	Fossil-based with high GHG emissions; minimal or no carbon mitigation	Lignite, Crude Oil, Brown Hydrogen	High
Black Fuels	Similar to brown, derived from high-grade coal	Black Coal, Black Hydrogen	High
Grey Fuels	Hydrogen from natural gas without CCS	Grey Hydrogen	High
Blue Fuels	Fossil-derived hydrogen with carbon capture and storage (CCS)	Blue Hydrogen	Medium
Pink/Red Hydrogen	Hydrogen via electrolysis powered by nuclear energy	Nuclear-based Hydrogen	Low (depending on source)
Turquoise Hydrogen	Hydrogen from methane pyrolysis with solid carbon as byproduct	Methane-based Hydrogen	Low (if RE powered)
White Hydrogen	Naturally occurring geological hydrogen	Not yet scaled	Unknown

B. Secondary Classification by State and Origin

Classification	Examples
Solid Fuels	Coal, Wood, Biomass
Liquid Fuels	Diesel, Bioethanol, Biodiesel
Gaseous Fuels	Biogas, Hydrogen, Synthetic Natural Gas
Natural Fuels	Found in nature: crude oil, wood, coal
Artificial Fuels	Manufactured: e-fuels, coal gas, SNG

Working Definition for the Indian Maritime Context

"**Green fuels** are alternative marine energy sources—such as **biofuels, green hydrogen, green ammonia, e-methanol, ethanol, renewable LNG, renewable LPG, FT diesel, Dimethyl ether etc.**—produced from **renewable energy or sustainable biomass using acceptable sustainable practices**. Their adoption in the maritime sector supports the **replacement of fossil-based marine fuels** and contributes directly to India's commitments under the **proposed Harit Nauka**, **Harit Sagar Guidelines, Panchamrit**, **Nationally Determined Contributions (NDCs),** and the **2023 Revised IMO GHG Strategy (as applicable).**"

3.7 Green Technology

NGSP 2025 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 indigenisation programs**.

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**.

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 MIV 2030, MAKV 2047, and Harit Sagar Guidelines)

Technology Cluster	Description / Use Case
Onshore Power Supply (OPS) / Cold Ironing	Providing clean shore-side electricity to reduce emissions from ships at berth
Hybrid and Electric Vessel Propulsion	Battery-powered or hybrid vessels for inland/coastal operations
Green Hydrogen and Fuel Cell Technology	Zero-emission marine propulsion via green hydrogen, including pilot projects at Cochin Shipyard
LNG, Methanol, and Ammonia Bunkering Infra	Development of alternate fuel storage, handling, and refueling infrastructure
Wind- and Solar-Assisted Propulsion Systems	Use of sails, rotors, solar panels to assist propulsion
Exhaust Gas Cleaning Systems (Scrubbers)	For SOx/NOx removal on conventional vessels
Port Electrification and Renewable Integration	Rooftop solar, wind turbines, RE-based microgrids in port clusters

Technology Cluster	Description / Use Case
Smart Cargo Handling and Electrified Equipment	Use of Electric RTGCs, e-cranes, e-trucks, and automated guided vehicles (AGVs)
Real-Time Emissions Monitoring & Control	Sensor-based emissions tracking across vessels, ports, and bunkering stations
AI-Based Operational Optimization	Route optimization, voyage planning, fuel consumption forecasting, predictive maintenance
Digital Twin and Simulation Technologies	Port and vessel-level energy efficiency simulations for design and performance testing
Maritime Digital Infrastructure (NLP-Marine, PCS 1x)	Tech-enabled planning, visibility, and GHG data integration
Advanced Ballast Water Treatment Systems	Reducing marine invasive species and compliance with IMO Ballast Water Convention
Automated and AI-Driven Waste Management	MARPOL-compliant reception facilities with digital logbooks and AI-based segregation
Smart Stormwater and Oil-Water Separation	Pollution containment at ports through smart drainage and runoff management systems
Energy Storage Systems (ESS)	Port-based battery systems to balance RE generation and peak load
Biofouling and Anti-Corrosion Hull Coatings	Low-friction, eco-friendly hull coatings that reduce drag and fuel use
Carbon Capture, Utilization, and Storage (CCUS)	Emerging onboard or land-based systems for CO_2 capture and reuse
Autonomous or Semi-Autonomous Vessels	For improved energy efficiency and route precision on coastal/inland operations
Green Tug Transition Technologies	Battery-electric or hybrid tugs under India's Green Tug Transition Programme
Eco-Dredging Equipment	Electrified or low-emission dredgers, with silt containment and biodiversity safeguards
Sustainable Building Materials in Port Infra	Green-certified cement, recycled steel, fly ash bricks in port and terminal infrastructure
Smart Street Lighting and HVAC	LED lighting, motion-sensor systems, and energy-efficient HVAC in port buildings
National Ship Design Centre & R&D Platforms	Innovation hubs for green vessel prototypes and marine tech localisation
Carbon Accounting & Emission Forecasting Tools	Software for MRV reporting, voyage emissions profiling, carbon credit quantification

Chapter 4: Policy Framework and Pillar-Wise Strategy

India's maritime decarbonisation journey must reconcile domestic sustainability goals with fast-evolving international regulatory expectations. The National Green Shipping Policy (NGSP) 2025 responds to this dual imperative through a structured policy framework that prioritizes emissions reduction, resilience-building, and technological transition across the maritime value chain.

At the **IMO's MEPC-83 session held from 07-11 April 2025**, India played a pivotal role in shaping a consensus on Market-Based Measures (MBM) framework, highlighting the country's rising influence in global climate diplomacy. The approved model—a hybrid GHG Fuel Standard jointly developed by Singapore and India—sets a precedent for integrating environmental ambition with equity and energy security concerns.

Internationally, countries like **Norway**, **South Korea**, and **China** have adopted forward-looking maritime greening strategies that combine regulation, fleet renewal, and financial support:

Norway's Green Shipping Programme (GSP)[71] has supported over **100 pilot projects** with collaborative risk-sharing models and a dedicated **GSP Service Centre** to aid green fleet conversion. The **Enova fund** provides up to **80% of incremental cost support** for hydrogen and ammonia vessels, catalyzing first-mover transitions.

South Korea's Green Ship-K Strategy[72] targets a **70% reduction in shipping GHG emissions by 2030**, involving the conversion of **528 vessels** and creating over **40,000 green maritime jobs**, backed by targeted tax and port fee incentives.

China's Green Vessel Financing Scheme[73] provides low-interest loans to support eco-friendly shipbuilding, including electric, LNG, and hydrogen-powered vessels, complementing its national carbon neutrality targets.

India's policy design is informed by these global benchmarks but tailored to national realities—balancing maritime trade competitiveness, port-led development ambitions, and Just Transition imperatives. Moreover, stakeholder consultations highlighted India's

[71] https://greenshippingprogramme.com/
[72] Republic of Korea – Toward Green Shipping by 2050
[73] Green Shipping Case Study: Norway, U.S., and China – Abhimanyu Dasgupta, ESCP

comparative advantage in circular ship recycling, the **potential for green hydrogen exports**, and the **need for harmonised, end-to-end green governance mechanisms** from ports to offshore logistics.

Against this backdrop, the NGSP 2025 introduces a layered policy framework, integrating regulatory reforms, financial innovation, and public-private partnerships. The framework builds institutional capacity while mainstreaming sustainability across ship design, port infrastructure, fuel ecosystems, and human resource development. This chapter presents a high-level strategic overview of each core focus area, which is then elaborated in depth in subsequent chapters.

4.1 Green Shipping: Transforming India's Vessel Ecosystem

India's merchant fleet (~1,530 vessels in 2023)[74] is at a critical inflection point. The **Maritime India Vision (MIV) 2030** [75] and **Maritime Amrit Kaal Vision (MAKV) 2047** [76] both acknowledge the need for large-scale retrofitting and the construction of green newbuilds. However, they need a comprehensive vessel-level decarbonization strategy and do not yet specify technology pathways or compliance trajectories. The NGSP addresses this gap through a structured framework encompassing certification, propulsion, fuel transition, operational efficiency, and MRV mechanisms.

Strategic Context: What's at Stake?

- **Indian Flagged Fleet** (2023)[77]: ~1,530 vessels including bulk carriers, container ships, coastal vessels, tugs, and IWT barges.
- **Global Regulatory Trends**: IMO's **GFS (GHG Fuel Standard)** [78] proposal—co-developed by India and Singapore—is expected to introduce **tiered GHG fuel thresholds**, gradually restricting high-emission fuels.
- **Fuel Cost Exposure**[79]: Under new market-based measures (MBMs) adopted globally, India's logistics and international shipping costs are projected to increase by an

[74] Ministry of Ports, Shipping and Waterways, *Annual Report 2023–24* (New Delhi: Government of India, 2024), https://shipmin.gov.in/publication/annual-reports.
[75] 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.
[76] 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.
[77] Ministry of Ports, Shipping and Waterways, *Annual Report 2023–24* (New Delhi: Government of India, 2024), https://shipmin.gov.in/publication/annual-reports.
[78] 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.
[79] 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.

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 & Repair Infrastructure:[80] 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.
- **Equipment Transport:** Logistics emissions from moving equipment to shipyards.
- **Assembly & Sea Trials:** On-site construction, outfitting, painting, testing, and commissioning activities.

Existing Efforts and Opportunities

India has launched several foundational programs:

- **Proposed Harit Nauka Scheme** encourages the use of battery-electric and hybrid propulsion on inland waterways.
- **SBFA (Shipbuilding Financial Assistance) Scheme** is under revision to incorporate green retrofits and dual-fuel systems.
- **Just-in-Time (JIT) Berthing pilots** and **Weather Routing Platforms** are being tested at Jawaharlal Nehru Port and VOCPA for operational decarbonization.
- **NLP-Marine architecture** is being leveraged to integrate fuel consumption, emission reporting, and voyage performance data into a centralized digital backbone.

However, the adoption of clean propulsion systems and green fuels remains limited due to high capital costs, regulatory fragmentation, and technology availability. India currently has

[80] 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.

no national certification framework for green ships, no lifecycle GHG accounting system, and minimal uptake of onshore power usage or alternative fuels.

4.1.1 Pillar-Level Policy Focus Areas

1. **Green Ship Certification & Compliance (for domestic vessels)**
   - Establish a **National Green Ship Certification Framework**, aligned with global benchmarks (EEDI, EEXI, CII).

     - **NGSCC** oversees policy, thresholds and reviews; **DGS** administers ship-level compliance; **IRS** certifies; **BIS/BEE** maintain factors and handbooks.
     - Penalties escalate from corrective action plans to **tender ineligibility** for repeat non-compliance; **bonus tariff rebates** for outperformers at major ports.

   - Include **tiered compliance thresholds** modeled on GFI/GFS for fuel carbon intensity.

Tiered Compliance Thresholds – GFI/GFS Model for India

1. 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 (NGSCC)**, whose formation and agenda is discussed in **Chapter 5**.

2. Suggested Lead Body for Development

Establish a **National Maritime GHG Standards Committee (NMGSC)** under **NGSCC** to technically design and pilot the GFI/GFS framework, with inputs from:

- **Directorate General of Shipping (DGS)** – regulatory oversight for vessels.
- **NCoEGPS** – technical modeling, benchmarking, and MRV integration.
- **Bureau of Energy Efficiency (BEE)** – fuel performance and lifecycle analysis.
- **Bureau of Indian Standards (BIS)** – formal standard-setting (fuel quality & sustainability criteria).
- **Ministry of Petroleum & Natural Gas (MoPNG)** – alignment with refineries, fuel suppliers, and alternative fuel blending mandates.
- **Ministry of New and Renewable Energy (MNRE)** – promotion of renewable energy integration in maritime fuel value chains, including green hydrogen, ammonia, methanol, biofuels, etc. and support for pilot projects and scale-up through policy and incentives.
- **Central Pollution Control Board (CPCB)** – environmental compliance and monitoring.

3. **Timeframe for Development & Implementation**

Phase	Period	Key Activities
Phase 1: Research & Consultation	2025–2026	Establish NMGSC under MoPSW, with NGSCC oversight.

- Conduct **national LCA studies** for all candidate fuels.
- Draft Indian GFI methodology aligned with IMO guidelines.

Consult with shipowners, ports, fuel suppliers, financiers.

Phase	Period	Key Activities
Phase 2: Pilot & MRV Integration	2026–2028	Deploy GFI monitoring on domestic vessel /volunteer vessels (domestic & international routes)

- Integrate fuel data reporting into **NLP-Marine & PCS 1x**.
- Develop compliance verification protocols.

Phase	Period	Key Activities
Phase 3: Tier 1 Implementation	2028–2030	Introduction of **Tier 1 GFI threshold** (≤ 75 gCO_2e/MJ) applicable to all vessels >400 GT* operating in Indian waters.[1]

*Applying standards to vessels above 400 gross tonnage (GT) aligns India with international norms under IMO's MARPOL Annex VI, ensuring consistency and facilitating global trade compliance. This threshold also matches existing Indian regulations (EEXI, CII, Statement of Compliance), providing regulatory continuity and

leveraging established compliance systems. As ships above 400GT contribute the bulk of maritime emissions and are already subject to mandatory surveys and reporting, focusing on this category enables efficient monitoring, enforcement, and maximum impact on national decarbonization goals.

- Link compliance to **green port incentives**, including reduced port dues, priority berthing, and access to green finance instruments.
- Mandate **annual GFI reporting** for all eligible vessels; voluntary reporting encouraged for smaller craft.

Phase	Period	Key Activities
Phase 4: Tier 2 & Beyond	2031 onwards	Introduce subsequent tiers (Tier 2: ≤ 50 gCO_2e/MJ by 2035, Tier 3: ≤ 30 gCO_2e/MJ by 2045, Tier 4: ≤ 10 gCO_2e/MJ by 2050)[1]

- Expand scope to include lifecycle GHG emissions (well to wake) from fuel production, transport, and bunkering infrastructure.
- Integrate GFI compliance into the **National Green Ship Certification Framework** and link with **international MRV and CII/EEXI requirements**.
- Conduct periodic reviews every **five years** to align with technological advancements, global regulatory changes, and India's decarbonization trajectory.

Key Governance Note:

The **NGSCC** will ensure cross-ministerial coordination, monitor compliance, publish periodic GFI performance reports, and recommend policy adjustments. The **NMGSC** will serve as the technical arm, responsible for data analysis, methodological updates, and stakeholder engagement.

- Define retrofitting guidelines and emission thresholds for existing ships across segments (cargo, cruise, coastal).
- Embed compliance into the proposed **Merchant Shipping Bill** and link to vessel registry updates.
- Link compliance to registry upgrades, incentives under SBFA, and eligibility for green finance.

2. **Technology Pathways and Propulsion Systems**
   - 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.
- Pilot **wind-assisted propulsion** and **air lubrication** technologies in collaboration with private operators.

Proposed Phased Decarbonization of Vessel Classes

- **Short-Term (2025–30)**:
  - Promote drop-in fuel, hybrid-electric and dual-fuel (LNG-methanol) retrofits/ New-builds for coastal and IWT vessels.
  - Enable **JIT arrival**, weather routing, and performance tracking via NLP-Marine.
  - Enforce SEEMP and CII compliance for vessels >5,000 GT.
- **Medium-Term (2030–40)**:
  - Roll out **green corridors** with onshore/off-shore refuelling for methanol and biofuels.
  - Mandate green certification for new builds.
  - Support **ammonia-ready ship** designs in strategic trade lanes.
- **Long-Term (2040–70)**:
  - Transition to **hydrogen and ammonia-fuelled vessels** for high-volume routes.
  - Enable **zero-emission inland vessels** across national waterways.

3. Shipbuilding & Ship Repair Modernization

- Prioritize **Green Shipbuilding Clusters** in Tamil Nadu (Kattupalli), Goa, Gujarat (Hazira/Dahej), and Cochin.[81]

- Update the **SBFA Scheme** to include:
  - Emission targets for new builds,
  - Grants for electric/hybrid propulsion integration,
  - Co-funding for cold ironing and lightweight material R&D.
- Mandate **Green Design Protocols** for all public sector vessel procurements by 2027.
- Develop **modular repair stations** along National Waterways for green tugs and ferries.

[81] Ministry of Ports, Shipping and Waterways. *Maritime India Vision 2030*. New Delhi: Government of India, 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

Prioritize Green Shipbuilding Clusters in Tamil Nadu (Kattupalli), Goa, Gujarat (Hazira/Dahej), and Cochin for several interlinked economic, strategic, and environmental reasons:

- **Strategic Coastal Locations**: These sites offer deep-draft access, proximity to global shipping lanes, and connectivity to major industrial zones, making them ideal for large-scale shipbuilding and repair operations.
- **Integrated Ecosystem Potential:** Planned clusters include not just shipyards but also equipment manufacturing, ancillary services, training centres, and R&D, enabling a competitive ecosystem similar to global leaders like South Korea, Singapore, and Japan. This integration supports local supply chains and innovation, while the government's blueprint earmarks these states for both greenfield (new) and brownfield (expanded) investment.
- **Economic Growth and Job Creation:** The clusters are projected to generate 1.1 million direct and indirect jobs across the maritime value chain, with a steep rise in India's shipbuilding market share from under 1% currently to potentially 7% by 2030 and 69% by 2047. Fiscal incentives—including rent holidays, infrastructure funding, and financial support (e.g., the ₹6,100 crore cluster outlay and ₹25,000 crore Maritime Development Fund)—will boost local economies and industrial growth.
- **Green and Sustainable Shipbuilding:** Government policy requires that new clusters adopt eco-friendly construction practices, facilitate green hydrogen/ammonia bunkering, and support green tug deployment, directly advancing India's decarbonization and blue economy targets. Ports in these states are already pioneering green hydrogen infrastructure and renewable energy use, reinforcing their suitability for green shipbuilding.
- **Global Competitiveness and Resilience:** By expanding world-class facilities and incentivizing modernization and automation, the clusters will help Indian shipyards compete with global giants, diversify export potential, and reduce reliance on foreign-owned fleets—a key lesson from recent global trade disruptions.
- **Skill and Technology Upgradation:** Initiatives specifically include maritime-specific skilling, tie-ups with foreign players (such as Cochin Shipyard's MoUs with leading international firms), and a holistic push for R&D in sustainable technologies and retrofitting for green propulsion.

Prioritizing these states thus aligns with India's vision to become a top-5 global shipbuilding hub by 2047, fostering sustainable economic, technological, and environmental leadership in maritime industries.

4. Operational Optimization & Fuel Efficiency

- Promote **JIT arrival, speed optimization**, and **voyage planning protocols** under NLP-Marine.
- Institutionalize:
  - Hull maintenance cycles 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 other similar platform.
- Pilot real-time CO_2 intensity dashboards for major Indian-flagged fleets.

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

6. **Maritime Clusters and Knowledge Hubs**
   - Establish green shipping clusters in **Cochin** (smart vessels), **Kolkata** (electric ferries), and **Gujarat** (green law and finance), modeled on Norway's cluster-based GSP.
   - Anchor each cluster with R&D centers (e.g., IMU, NTCPWC) and incentivize academia–industry–start-up collaboration.

7. **Global Benchmarks and Adaptation**
   - Emulate **Norway's Green Shipping Programme**, which uses tiered targets, co-financing, and performance-linked retrofitting.
   - Engage with the **Maersk Mc-Kinney Møller Center** and **Global Centre for Maritime Decarbonisation** to accelerate hydrogen and methanol pathways.

8. **Fleet Modernization and Investment Planning**
   - Adapt Korean initiatives under the "Green Ship-K"[82] 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 [83]under the GFS by 2027.
   - Implement **Green Retrofitting Guidelines** under SBFA and provide risk-sharing finance for emission control systems.

[82] 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.
[83] International Maritime Organization. "Fuel Life Cycle GHG Analysis for Maritime Fuels." https://www.imo.org/en/OurWork/Environment/Pages/Life-Cycle-GHG-Analysis.aspx

9. **Embedded-Carbon Accounting (materials, equipment, construction)**
    - **Life-cycle carbon disclosure** for every newbuild/major retrofit ≥400 GT for Indian flagged vessel:
        - Material stage **(steel, aluminum, composites),** equipment stage **(engines, motors, batteries),** shipyard processes **(cutting/welding/painting/sea trials).**
    - **Require** Environmental Product Declarations (EPDs) **or** ISO 14067 **carbon footprints for steel, major OEM equipment, and paints/coatings used.**
    - **Create a** National Maritime Embedded Carbon Registry **within the National Maritime Emissions Registry, tied to MRV and Green Ship certification tiers.** NMGSC and NGSCC will coordinate for the formulation and functioning of National Maritime Embedded Carbon Registry.

Proposed Implementation Plan:

- Standards & methods: **BIS to issue a** Maritime LCA Code **(harmonised with ISO 14040/44, ISO 14067, EN 15804) within 12 months; BEE to publish** default emission factors**; MoPSW/IRS to publish** ship-level LCA templates**.**
- Verification: **Use** NABL-accredited labs **and** IRS/class **as approved verifiers.**
- Data flow: **Suppliers upload EPDs to the Registry; shipyards compile a** Bill of Carbon (BoC) **for each vessel at delivery.**
- Phasing: **Voluntary disclosure FY26–27; mandatory for public procurement FY27; mandatory for all ≥400 GT FY29.**

10. **Material-Efficiency & Low-Carbon Design Standards**
    - **Material-efficiency targets** for newbuilds (e.g., steel intensity per dwt) and **light-weighting** where safe.
    - **Design for Disassembly/Reuse** (DfD/R) requirements for selected systems to enable future retrofits and recycling.
    - Minimum **recycled content** targets for steel/aluminum where quality permits (e.g., 20% by FY30, 40% by FY35—segment-specific).

Proposed Implementation Plan:

- Rules & class: **IRS to issue** Green Design Notations **incorporating material-efficiency KPIs; DG Shipping to accept them as compliance pathways.**
- Tooling: **NTCPWC-IIT Madras, Cochin Shipyard R&D, GRSE, and academia to develop** light-weighting toolkits **and** digital twins **for structural optimisation.**
- Safety first: **Align with** DGS statutory **and** IMO **safety codes; any weight reduction must pass class approval.**

11. **Green Procurement for Public Orders**
    - All **PSU orders** (SCI, CSL, GRSE, GSL, MDL, IWAI) to apply **Green Public Procurement** (GPP) criteria:
        - **Embedded-carbon score** as a **≥20% weight** in tenders by FY27 (rising to 30–40% by FY30).
        - Preference margins for **green steel** and **low-carbon equipment** (with EPDs).
        - Bonus points for shipyards with **ISO 50001 energy management** and **≥50% renewable electricity**.

Proposed Implementation Plan:

- **Model bid clauses** issued jointly by MoPSW + DPIIT within 6 months.
- **e-Procurement hooks:** GeM/GEM-Maritime to include **green filters** and **EPD fields**.
- **Audits:** CAG-compatible audit trail; IRS verifies embedded-carbon claims at delivery.

12. **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, fume extraction with heat recovery, low-VOC paints.**

Proposed Implementation Plan:

- PLIs & CCfDs: **Extend/align** PLI-Steel **(or create a maritime window) and pilot** Carbon Contracts for Difference **for green-steel offtake to yards.**
- Capex support: **20–30%** 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.**

4.1.2 Inland Waterways, Coastal and Cruise Tourism Shipping

A. Inland Waterways Transport (IWT)

1. **Fuel & Propulsion Prioritisation**

- Mandate a *battery-electric first* approach for short-route ferries (<50 km) and hybrid-electric for longer routes.
- Introduce **low-draft hydrogen fuel cell pilot vessels** for shallow waterways by 2028.
- Encourage retrofits of existing diesel-powered barges with LNG–biofuel dual fuel kits as a transitional measure.

2. **Operational Efficiency**

- Require integration of **river condition and depth forecasting systems** into voyage planning for fuel efficiency.
- 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-km** as primary cargo metric and **gCO_2e/passenger-km** for ferries. (detailed in chapter 6)
- Require data logbooks adapted to smaller vessels with seasonal operational variability.

B. Cruise Ships

1. **Fuel & Energy Systems**

- Mandatory shore power connection capability (OPS) 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 & Passenger-Focused Metrics**

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

3. **Regulatory Hooks**

- Include cruise-specific retrofitting guidelines under SBFA.

- Apply **stricter sulphur and NO_x standards** for cruise vessels operating in designated heritage or ecologically sensitive areas (e.g., Lakshadweep, Andaman).

C. Coastal Shipping

1. **Fuel Transition**

   - Mandate at least **20% green fuel blending** (bio-LNG, biomethanol) for all coastal vessels above 400 GT by 2030.
   - Prioritise wind-assisted propulsion pilots on short-sea coastal bulk carriers.

2. **Operational Optimisation**

   - Apply Just-in-Time (JIT) arrival protocols at all Indian major ports for coastal vessels by 2027.
   - Introduce **slow steaming incentive schemes** for voyages under 500 nautical miles.

3. **Infrastructure Support**

   - Develop **coastal green bunkering hubs** at Chennai, Kandla, Kochi, and Paradip with multi-fuel capability.
   - Provide cold ironing facilities for RoPax and coastal passenger ferries at high-traffic ports.

4. **MRV Specifics**
   - Track both **cargo emission intensity** (gCO_2e/tonne-nautical-mile) and **port turnaround emissions** for frequent-calling coastal vessels. (detailed in chapter 6)

4.2 Green Ports: Towards Zero-Emission Maritime Gateways

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.

4.2.1 Strategic Priorities:

1. Regulatory Alignment and Green Certification

- Introduce a **National Green Port Certification and Indexing Framework** with multi-tier benchmarks covering GHG emissions, waste recycling, renewable energy share, carbon capture infrastructure, and ecosystem impact.
- 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** to assess and disclose infrastructure readiness for alternative fuels (LNG, methanol, ammonia, hydrogen, renewable LPG, biofuels).

2. Emission Standards and Onshore Power Supply (OPS)

- Implement phased **Onshore Power Supply** at **50% of berths by 2030**, targeting a reduction of **500,000 tonnes CO_2 annually**, with full coverage at major ports by 2040.
- Enforce **emission limits** on cargo handling equipment, dredging operations, and vessels at berth, aligned with **NAPCC**, **MARPOL Annex VI**, and evolving IMO GHG regulations.
- Develop port guidelines for **low-emission dredging technologies** and electric/hybrid equipment.

3. Environmental Monitoring & Reporting Systems

- Phase-in **IoT- and GIS-enabled monitoring systems** for emissions, ambient air quality, water quality, and waste discharges — with an initial focus on high-traffic major ports before scaling nationwide.
- Require periodic (quarterly/annual) **environmental audits**, verified by third parties, with summary results disclosed on the **Swachh Sagar Portal**.
- Pilot **continuous emissions monitoring systems (CEMS)** for ships at berth and critical port areas, subject to a feasibility study on cost-effectiveness and data reliability.

4. Sustainable Infrastructure and Green Building Codes

- Enforce **green building standards** across all new and upgraded port terminals, including use of **low-carbon concrete, smart HVAC, daylighting systems, and LED retrofits**.
- Adopt **eco-dredging** methods and biodiversity-safe port design, including **artificial reefs, mangrove buffers, and sediment control systems**.
- Encourage **nature-based solutions** in coastal protection and port landscaping.

5. Waste and Water Circularity Systems

- Mandate **MARPOL-compliant waste reception facilities** for oily waste, sewage, garbage, and cargo residues, along with **stormwater management** and **oil–water separation systems**.

- Promote **closed-loop water reuse** and enforce the **5R framework** (Refuse, Reduce, Reuse, Repurpose, Recycle) as codified in **Harit Sagar Guidelines**.
- 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).

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**.
- Require **minimum 60% renewable energy share in port operations by 2030**, scaling to **100% for major ports by 2047**.
- Deploy **battery energy storage systems (BESS)** for grid stability and OPS integration.

7. Digitalization and Smart Port Systems

- Deploy **AI-driven port optimization**, **digital twins** for terminal planning, and **smart logistics platforms** (PCS 1x, NLP-Marine) to cut turnaround times and energy wastage.
- Enable **predictive maintenance** of port assets using IoT sensors to reduce downtime and operational emissions.
- Promote inclusion of Just in Time Arrival (JIT)

8. Public-Private and International Collaborations

- Facilitate **PPP models** for OPS, LNG/methanol/hydrogen bunkering, and carbon capture infrastructure.
- Align with global programs such as **IMO GreenVoyage2050**, **ASEAN Smart Port Network**, and **Clean Energy Marine Hubs (CEM-Hubs)**.
- Participate in **green shipping corridors** with strategic trade partners.

9. Port-Level Targets, Skills & Community Integration

- Set **annual GHG reduction targets** per port based on cargo mix, operational scale, and location, and report them in annual sustainability reports.
- Create and publicly disclose a **Fuel Readiness Index** for each port.
- Establish **Green Skills Training** in partnership with IMU, IITs, SCGJ, and global maritime academies for electric cranes, OPS, waste systems, and digital tools.
- Engage coastal communities through **CSR-led green livelihood programs, eco-tourism integration, and participatory environmental planning**.

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 Safety Recommendations** and Small Modular Reactor (SMR) standards.
- Ensure workforce and infrastructure preparedness for emerging technologies like **autonomous shipping**, **offshore wind servicing**, and **ocean-based carbon removal platforms**.

This aligns with the definition of a *Green Port* adopted in Chapter 3, where a port is an environmentally integrated node in the maritime chain, contributing to decarbonization, digitalization, and socio-economic development. **The Strategic Priorities mentioned above would be overseen and periodically reviewed by the National Green Shipping Coordination Cell (NGSCC), whose formation and agenda is discussed in Chapter 5.**

4.2.2 Terminals: Cruise Tourism, Coastal & 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 sensitivities, 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 & 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 Shipping Coordination Cell (NGSCC)/ MoPSW, whose formation and agenda are discussed in Chapter 5.

Priority Areas:

1. **Low-Emission Vessel Integration**
    - Encourage shift from diesel-powered ferries and cargo vessels to **battery-electric, hybrid, CNG, or green hydrogen-fuelled vessels** for inland and coastal transport.
    - Mandate Tier II/III or equivalent **IMO emission compliance** for all newbuilds operating on National Waterways.
2. **Onshore Renewable Energy Systems**
    - Install ground-mounted/**floating solar plants**, rooftop PV, or small-scale wind turbines at terminals to power operations, lighting, and OPS for vessels.
    - Integrate **battery storage** for energy resilience.
3. **Sustainable Terminal Infrastructure**
    - Enforce **green building codes** for passenger terminals with natural ventilation, rainwater harvesting, and LED systems.
    - Use **low-carbon materials** in jetties, pontoons, and storage facilities.

4. **Waste and Water Management**
    - Set up **MARPOL Annex-compliant reception facilities** for sewage and bilge water from inland vessels.
    - Implement **oil–water separators** and prevent discharge into sensitive freshwater ecosystems.
5. **Digital Operations & Smart Scheduling**
    - Introduce **GPS and AIS tracking** for vessel movements to minimize idle time and improve efficiency.
    - Develop integrated **Passenger and Cargo Terminal Management Systems** for smooth multi-modal connectivity.
6. **Biodiversity Protection**
    - 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.
    - Pilot 3–5 **fully electric ferry corridors** (e.g., Kolkata–Haldia, Kochi waterways, etc.).
- **Medium-term (2027–2035):**
    - Deploy OPS at 50% of high-traffic IWT terminals.
    - Achieve 50% renewable energy share in operations.
- **Long-term (2035–2047):**
    - 100% renewable-powered and zero-emission fleet for inland/coastal terminals.
    - Fully digitized 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), Indian Ports Association (IPA), State Tourism Departments, Inland Waterways Authority of India (IWAI), National Centre of Excellence in Green Ports and Shipping (NCoEGPS), Indian Maritime 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 Shipping Coordination Cell (NGSCC), as detailed in Chapter 5.

Priority Areas:

1. **Passenger-Centric Green Infrastructure**

    - Build **GRIHA**, **LEED or IGBC-certified terminal buildings** with optimized HVAC systems, natural lighting, and low-carbon construction materials.
    - Provide **onshore power supply** to docked cruise vessels to reduce auxiliary engine emissions.
2. **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.
3. **Waste & Sewage Management**
    - Install advanced **solid waste segregation** and **waste-to-energy plants** at major cruise hubs.
    - Provide **Annex IV sewage reception** facilities with tertiary treatment before discharge.
4. **Passenger Flow Optimization & Digitalization**
    - Implement **AI-based passenger scheduling systems** to reduce congestion and energy use in terminal operations.
    - Offer **paperless ticketing and digital customs/immigration processing**.
5. **Local Economic Integration**
    - Link cruise tourism with **green-certified local transport** (EV buses, bicycles, pedestrian pathways).
    - Ensure local shore excursions comply with **eco-tourism and cultural heritage preservation standards**.
6. **Carbon Capture & 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 OPS, waste reception, and passenger flow management systems.
    - Pilot carbon capture reception at one cruise port.
- **Medium-term (2027–2035):**
    - Achieve **60% renewable energy share** in terminal operations.
    - 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 Certification Framework**. 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 **tiered performance criteria** for:

- **Energy efficiency and renewable energy adoption** 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:

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, OPS (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 & 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 (NGSCC)**, in collaboration with sector-specific bodies such as the **Cruise Tourism Green Transition Committee (CTGTC)**, relevant **State Maritime Boards and IWAI**.

4.3 Sustainable Ship Recycling: From Compliance to Circularity

The **NGSP 2025** 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 need of digital reporting protocols.

4.3.1 Strategic Priorities:

1 **Tiered Green Compliance Framework:**

NGSP will institutionalize a tier-based Green Ship Recycling Compliance Framework, 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.

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 & SRP system - Verified CO_2 avoidance metrics	- Highest access to green finance instruments (green bonds, ESG loans) - FSDF eligibility for advanced automation - National "Green Yard" certification

Tier	Compliance Criteria	Key Features	Support and Benefits
		- Worker health/safety certifications - Certified downstream waste processing	- Priority in 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 & effluent systems - Segregated waste zones	- Targeted grant/loan access under FSDF - Technical support for Tier 1 transition - Training and digital onboarding 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 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: DG Shipping and MoPSW, in partnership with State Maritime Boards.
- Verification: Third-party audits (biennial) + online self-reporting dashboard.
- Upgradation Support: Access to tools under Harit Sagar, FSDF, and SENSREC partnership.

2. **Ship Recycling Transparency and Reporting System (SRTRS):** A **mandatory reporting platform** to be introduced to track hazardous waste flows, worker 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. The methodology 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 via **a national Ship Recycling Carbon Accounting Methodology (SRCAM)** developed by MoPSW, GMB, and technical partners such as TERI and NIOT, in alignment with ISO 14067 and GHG Protocol standards.

3. **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 **common melting centres** near recycling clusters (e.g., Bhavnagar)
   - Offer **Pay-per-Use advanced equipment** to reduce CAPEX burdens on recyclers.

4. Utilisation of the **Ferrous Scrap Development Fund (FSDF)**
   In alignment with the **Ministry of Steel's** *Steel Scrap Recycling Policy* **and MoPSW's FSDF**[84], the NGSP recommends:
   - Allocation of FSDF grants/loans for upgrading Indian shipbreaking yards with **mechanized cutting, pollution control systems**, and **material sorting facilities**;
   - Funding joint R&D between recycling yards and secondary steel producers for **green steel loops**;

[84] 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/384405920oguideFSDF23042015_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.

- Developing a **certification framework** for ship-recycled ferrous scrap to ensure quality and traceability, making it eligible for green procurement and steelmaker use;
- 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** to reduce emissions intensity per tonne of recovered material.

5. **Circular Economy and Green Steel Linkages:**
   Introduce **reuse protocols** for select machinery/components (e.g., engines, pumps, compressors, valves, STPs etc.) and collaborate with **steelmakers** to establish **green steel recovery loops**, supported by guidelines on **safe rerolling and EPR-based traceability**.

6. **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**[85] (Norway–IMO–Bangladesh) can support policy alignment, worker training, and waste infrastructure upgrades.

7. **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**.

8. **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 labeling**, and **spill prevention**. Partnerships with IMU and GMB Training Centres will be leveraged for rollout.

9. **Worker Welfare and Environmental Insurance:**
   NGSP will consider **performance-linked incentives** based on safety and environmental records, while encouraging uptake of **occupational hazard insurance** and **welfare funds** for shipyard workers.

[85] 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.

10. Ship Recycling Carbon Accounting & Reduction Program

To close the current gap in emissions data from recycling activities, launch the **Ship Recycling Carbon Accounting & 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:

1. **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.

2. **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.

3. **MRV Integration:**
   Deploy 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).

4. **R&D Support:**
   Fund and test renewable-powered dismantling systems and alternative low-carbon cutting technologies.

4.3.2 Implementation Protocol

Phase 1 – Program Formation (0–6 Months)

- Constitute SRCARP Steering Committee under NGSCC 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.

Phase 2 – Baseline Study (7–18 Months)

- 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**.

Phase 3 – Target Setting & MRV Rollout (19–30 Months)

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

Phase 4 – R&D and Reduction Projects (Parallel to Phase 3 onwards)

- Fund pilots for:
  - Renewable-powered plasma cutting systems.
  - Heat recovery integration in dismantling processes.
  - Shared compressed-air systems to replace diesel compressors.
- Document operational and carbon performance impacts for sector-wide scale-up.

Phase 5 – Integration into GSRC Tiers (Post-36 Months)

- Incorporate verified carbon intensity performance into GSRC tier scoring.
- Recognise top-tier performers with green tender priority, and financial incentives yard certification.

Deliverables & Timeline

Deliverable	Target Date
SRCARP Steering Committee formed	Month 3
Carbon Accounting Methodology finalised	Month 6
SRTRS platform beta launch	Month 8
Baseline study complete	Month 18
Voluntary targets published	Month 20
IoT MRV system operational in 50% of yards	Month 24
R&D pilots concluded	Month 30
GSRC integration live	Month 36

4.4 Green Finance: De-risking Maritime Sustainability

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 2025 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 of ships, to hydrogen/ammonia bunkering—demands upwards of **INR 1.5–2 lakh crore (~USD 20–25 billion)** in investments over the next two decades. Without

dedicated financial tools, India risks delayed adoption and missed opportunities in the rapidly consolidating global green shipping economy.[86]

1. **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)**[87] 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.**

2. **Maritime Development Fund: Sector-Specific Blended Finance Platform**
   The existing **INR 25,000 crore Maritime Development Fund (MDF)**[88] (has been increased to INR 70,000 crores as announced by the Hon'ble Prime Minister in his Independence day address to the nation on the 15 August 2025) is being restructured under NGSP to serve as a **blended finance window** for:
   - Green vessel retrofits and newbuilds.
   - Port electrification and OPS (Onshore Power Supply) systems.
   - Circular economy-linked ship recycling infrastructure.
   - Digital traceability solutions (e.g., MRV platforms, NLP-Marine enhancements).

Instruments under the fund include:

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[86] 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/.
[87] 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/.
[88] 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.

- **Green Bonds (**SEBI-compliant),
- **Concessional Loans** (via SMFCL or IFSC),
- **Results-Based Finance (**RBF) for emission reduction per tonne of cargo,
- **Carbon Credit Advance Purchase Agreements** (linked to India's Voluntary Carbon Market framework under MoEFCC).

3. Green Investment Ecosystem: India Maritime Investment Meet & IFSC GIFT City

At **the India Maritime Investment Meet 2025 in London**[89], MoPSW showcased India's maritime green finance pipeline and attracted global interest through:

- **100% FDI allowance** in shipping and shipbuilding under 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:

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

4. 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
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

[89] 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.

5. Integration with ESG and Carbon Markets

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

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

In addition, **a Maritime Carbon Credit Registry** will be developed (linked with MoEFCC) to allow:

- Emission offsets from green fuel use, OPS, 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.

6. 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.
- **Mandatory ESG reporting** for major ports and public shipping entities by 2026.
- Creating a **Public-Private Green Finance Taskforce**, with representatives from banks, ports, IFIs, shipyards, and regulators.

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

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

4.5 Green Skill Development and Human Resources

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[90] could be created globally by 2030. India has the potential to contribute significantly to this shift, with 35 million green jobs projected by 2047,[91] especially across clean energy, port decarbonisation, and circular 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,[92] 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 and awareness generation** are critically needed.

4.5.1. Current Initiatives and Ecosystem Mapping

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

a. Skill Council for Green Jobs (SCGJ):

SCGJ has developed **25+ qualifications**[93] 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. Green Skill Development Programme (GSDP):

Launched in 2017 by the Ministry of Environment, Forest and Climate Change (MoEFCC), the GSDP has trained over **2 lakh candidates**[94], with over **60,000 placed**[95] in green sectors including pollution control, biodiversity, renewable energy, and sustainable agriculture. It adopts a **dual approach**: upgrading existing worker capacities (e.g., forest rangers) and creating new green employment pathways.

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

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[90] International Labour Organization. *World Employment and Social Outlook 2018: Greening with Jobs*. Geneva: ILO, 2018. https://www.ilo.org/global/publications/books/WCMS_628654/lang--en/index.htm.
[91] United Nations Partnership for Action on Green Economy (UN PAGE). "Assessment of India's Green Jobs and Just Transition Policy Readiness." October 2023. https://www.un-page.org/static/6363128baab8144d34a0c49d9d525d15/231023-assessment-of-indias-green-jobs-and-just-transition-policy-readiness-1.pdf.
[92] Ministry of Finance, Government of India. *Economic Survey 2023-24*. New Delhi: Government of India, 2024, 207. https://pib.gov.in/PressReleasePage.aspx?PRID=2034924..
[93] Skill Council for Green Jobs. *Green Jobs Handbook 2022*. New Delhi: SCGJ, 2022. https://sscgj.in/wp-content/uploads/2022/07/Green-Jobs-Job-Roles-Hand-Book.pdf.
Also See: International Energy Agency. "India's Skill Council for Green Jobs." 2023. https://www.iea.org/policies/17819-indias-skill-council-for-green-jobs.
[94] Ministry of Environment, Forest and Climate Change, Government of India. *Green Skill Development Programme (GSDP): Overview and Progress Report 2023*. New Delhi: MoEFCC, 2023. https://moef.gov.in/en/major-initiatives/green-skill-development-programme-gsdp/.
[95] *Ibid*

institutions are introducing green modules such as **solar PV systems, hydrogen systems, biofuels, and EV maintenance**.

4.5.2. Challenges in the Green Maritime Skills Ecosystem

Despite growing momentum, systemic issues remain:

- **Need of 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 in green maritime training pipelines.
- **Fragmented data systems and certification models**, limiting portability and recognition of green skills nationally and internationally.

4.5.3. Strategic Framework under NGSP 2025

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.

Key objectives:

- Develop 50+ Green Maritime Job Roles and QPs (e.g., green tug operator, hydrogen bunkering technician, shore power engineer).
- 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.

2. 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

3. Leverage **Power-to-X green shipping training** partnership with NCoEGPS and TERI; combining international best practices with local expertise, we can create a comprehensive and engaging training programme.[96]

4.5.4. Pathways for Implementation,

- **Regional Skill Clusters** near Green Hydrogen Ports (Paradip, VOCPA, Deendayal) aligned with state incentives.
- Leverage **Digital Platforms** (e.g., DGS e-learning, Swayam, SCGJ) for scalable dissemination.
- Promote **Train-the-Trainer models** for standardised delivery across the maritime value chain.
- **International Certification Equivalency** for high-demand job roles (e.g., through partnerships with BIMCO, EMSA, or ISO-accredited bodies).
- Encourage **Green Entrepreneurship** and MSMEs via mentoring, incubation, and access to finance.

4.5.5. Enabling Inclusion and Just Transition

- Ensure affirmative action policies to train and place **women, PwDs, and rural youth** in high-growth green maritime roles.
- Develop portable **green job registries** and career support services through MAITRI platform.
- Ensure social safety nets for legacy workforce transitioning out of fossil-fuel dependent roles (e.g., coal-handling dock workers).

4.5.6. Monitoring, Funding and Evaluation

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

4.5.7. Recommendations and Global Linkages

- Establish bilateral **Green Skills Cooperation Agreements** with IMO, Denmark (via GFAI), and Japan to imbibe best practices.
- 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.

[96] International Power-to-X Hub. "Power-to-X Green Shipping Training in India: Leading the Transition to Defossilised Maritime Practices." November 1, 2024. https://ptx-hub.org/power-to-x-green-shipping-training-in-india-leading-the-transition-to-defossilised-maritime-practices/.
Also See: The Energy and Resources Institute (TERI). "Power-to-X Green Shipping Training in India." February 6, 2025. https://energyforum.in/highlights/power-to-x-green-shipping-training-in-india/.

4.5.8 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.
- 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 alternative propulsion and energy storage systems.
- Deploy **floating training simulators** at IWAI hubs (Patna, Guwahati, Kochi) for manoeuvring and voyage optimisation in varying river conditions.

Cruise Shipping (Ocean & 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 Annexures compliance modules in all pre-sea and refresher cruise crew training.

Coastal Shipping

- Launch **Coastal Dual-Fuel Operator Certification** for safe handling of methanol, ammonia, and LNG 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.

4.5.9 Strategic Priorities: Green fuels specific training in domestic shipping

1. **Specialized Fuel Training for Inland and Cruise Operations:**

   - Expansion of NINI courses to cover alternative fuel bunkering, river-based OPS (Onshore Power Supply), emergency response, and pollution prevention for smaller passenger vessels.
   - Development of **practical simulation facilities** in Patna, Guwahati, and Varanasi to provide hands-on training for river cruise circuits on the Ganga, Brahmaputra, and Yamuna.

2. **Sector-Specific Safety Codes:**

   - Tailored safety protocols for river cruise terminals, 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.

3. **Institutional Coordination:**

   - Inclusion of **IWAI**, **NINI**, and **State Tourism Boards** in the **Maritime Fuel Safety & Training Council (MFSTC)**, ensuring inland and cruise sector needs are addressed alongside major port requirements.
   - 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.

4. **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.

5. **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.

6. **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, NIOT, and global experts on fuel spills, fire control, and evacuation protocols for cruise tourism.

4.5.10 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 FY2028.
- Use the MAITRI 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 MMM Copenhagen, WMU Stockholm, etc.

India stands at a transformative 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 2025's human capital vision must be realised through unified action, innovative public-private partnerships, and a deep commitment to environmental and economic justice.

4.6 Green Fuels: Decarbonizing Marine Energy

This green fuel shift is anchored in India's broader clean energy roadmap—backed by the **National Hydrogen Mission**, **Green Fuels Alliance India (GFAI)**, and ongoing investments under MIV 2030 and MAKV 2047—and reflects both national ambition and international obligation under the IMO GHG Strategy and COP targets.

4.6.1. India's Current Status and Ongoing Green Fuel Actions

- India's **fuel mix in shipping** remains 98% reliant on fossil-derived fuels (Heavy Oil, VLSFO), though this is changing[97]. As per the *Future Fuel Strategy* by IR Class and DGS, over **21% of global ship orders** are now dual-fuel capable or alternate-fuel enabled.
- **LNG Bunkering** is operational at **Cochin Port**[98] and is being scaled up across **Chennai, Paradip, and Ennore** with FSRU and onshore terminals. India has **14 LNG**

[97] Ministry of Statistics and Programme Implementation, Government of India. *Energy Statistics India 2025*. New Delhi: National Statistical Office, 2025. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2025/apr/doc202543532301.pdf.
[98] LNG Terminal, Cochin Port Authority https://cochinport.gov.in/lng-terminal

terminals with growing import capacity—an opportunity to become a regional LNG bunkering hub.[99]

- Companies like **J M Baxi Group**[100] is spearheading the private sector's readiness for LNG and future fuel bunkering infrastructure, based on decades of LNG terminal handling experience.
- Through Green Fuels Alliance India (GFAI)[101]—established under the **India–Denmark Green Strategic Partnership**—India is focusing on select **renewable-rich states and port clusters** (e.g., Gujarat, Tamil Nadu) to develop **green hydrogen and ammonia production zones** linked to maritime bunkering.

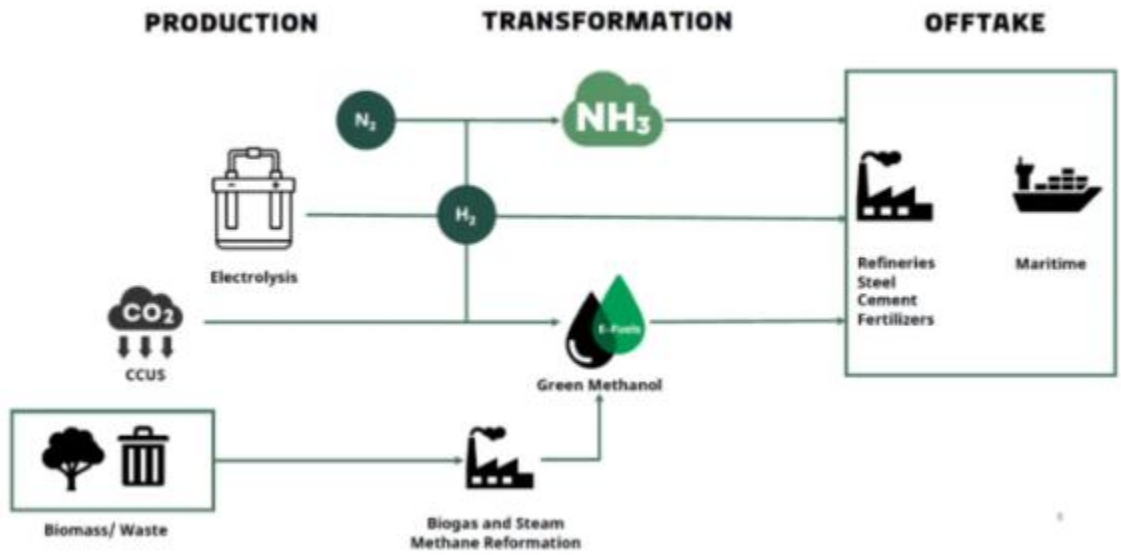

Figure 1:GFAI Value Chain Focus

[99] 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.

[100] 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.

[101] Royal Danish Embassy in India. "Green Fuels Alliance India (GFAI): Accelerating Green Hydrogen & Ammonia for Shipping." https://india.um.dk/en/green-strategic-partnership/green-fuels-alliance-india-gfai.

Figure 2:GFAI secretariat manages interactions between external and internal stakeholders

4.6.2 Policy Imperatives:

1.Fuel Transition Targets Under NGSP

Overarching Principles

1. **Global Compliance for International Trade Vessels**

   - For **Indian-flagged ships on international trade**, the **Greenhouse Gas Intensity (GFI)** of marine fuels shall comply with the **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.

2. **Domestic Trajectory for Coastal & 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**.

3. **Commercial Sustainability Safeguards**

   - Mandatory clean-fuel adoption targets will be **subject to periodic feasibility reviews** (every 3 years) by the National Green Shipping Coordination Committee (NGSCC).
   - Uptake will be tied to **fuel price parity milestones** and **proven supply chain readiness**, preventing disruption of maritime trade or modal shift to higher-CO_2 emitting land transport.

Milestones & Recommended Implementation Conditions

Period	Target Clean Fuel Share*	Priority Fuels	Implementation Conditions / Exceptions
2025–2030	10–15% in coastal & IWT fleet	Drop-in fuels, biofuels, LNG, certified green methanol	- Prioritise **drop-in** and **dual-fuel** solutions to avoid stranded assets. - Carbon capture (Onboard CCS) pilots eligible for compliance credits. - OPS (Onshore Power Supply) to be used where available to reduce fuel dependency. - Fuel blending mandates applied **only where domestic supply meets ≥80% of projected demand**.
2030–2040	30% in Indian-flagged fleet (domestic & international)	Green hydrogen, green ammonia, bio-LNG	- Target contingent on **at least 5 domestic green-fuel hubs** operational by 2032. - 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.
2040–2047	70% across all vessel types	Hydrogen, ammonia, e-methanol	- Requires full-scale bunkering & safety infrastructure at all major ports and ≥50% of non-major ports. - Mandates reviewed in 2040 to align with global market maturity and IMO policy. - Carbon capture (onboard or port-based) recognised as a compliance mechanism for vessels unable to convert fuels. - Exceptions for specialised vessels with no viable alternative fuel pathway (case-by-case via DGS).

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

Additional Provisions

- **Lifecycle GHG Accounting:**
  All clean-fuel performance will be measured using lifecycle assessment (LCA) methodologies harmonised with IMO GHG Guidelines 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 subsidise clean-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 shift.

2. Production and Supply Chain Development

- **Green Hydrogen & Ammonia:** Leverage $10 billion private investments (e.g., Reliance Jamnagar hub), supported by the **National Hydrogen Mission** and renewable parks[102] in Kutch and Rajasthan.[103]
- **Biofuels:** Establish biofuel hubs in coastal states (e.g., Tamil Nadu, Maharashtra), 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, 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.

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 Shipping Coordination Cell (NGSCC)** in coordination with the **Directorate General of Shipping (DGS)** and the **National Centre of Excellence in Green Ports and Shipping (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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[102] *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/*

[103] 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 **NGSCC/ MoPSW**.
- **Blending Mandates:** Minimum blending thresholds for biofuels, renewable LNG, and other low-carbon fuels will be introduced to create **demand certainty** for producers. This will be coordinated by the **Ministry of Petroleum and Natural Gas (MoPNG)** 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 South-South cooperation by:

- Establishing green maritime corridors (e.g., **India–Singapore, India–UAE**) ,
- 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 Korea, Japan, and the EU 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** (e.g., India–Singapore, India–UAE, India–East Africa) 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 (Updated to ₹70,000) 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.
- Collaboration with **Green Fuels Alliance India (GFAI)** to jointly fund Indian-Danish pilot corridors and fuel supply chains.
- Creation of a **National Bunkering Map** by 2026 for LNG, ammonia, methanol, and hydrogen infrastructure.

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** 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 IGF Code, ISO standards, and updated IMO guidelines.

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

- **Mandate fuel-specific safety codes** with enforceable compliance requirements for both shore-based and onboard operations.
- **Require 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 & Training Council (MFSTC)** will be constituted under **MoPSW** and overseen by NGSCC. This council will:

- Oversee METF operations, curriculum development, and safety code enforcement.
- Coordinate **research, testing, and simulation exercises** for hazardous fuels in partnership with the **National Institute of Ocean Technology (NIOT)**, **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**.
- 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**.

4.6.3 Key Enablers & Global Lessons:

Drawing from DNV's *Maritime Forecast to 2050*[104] and Korea's Green Shipping[105] Roadmap:

- Develop a fuel-agnostic transition strategy, allowing the coexistence of multiple clean fuels during the shift.
- Carbon pricing instruments will be evaluated for phased introduction post-2030 to steer market behaviour.
- A Clean 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 clean energy nodes**.

4.7 Green Technology: Driving Innovation and Efficiency

Green technology stands at the core of India's maritime decarbonisation 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 is 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.

4.7.1. 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.

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[104] 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.

[105] 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.

- **Exploring Nuclear Energy for Port Decarbonization:** To achieve long-term GHG reduction goals, India will also 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 require 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)** 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** like air lubrication, hull coating improvements, wind-assist propulsion, and retrofits 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 **receive, 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 limited implementation.

d. Collaborative Platforms

- **The Indo–Norway Bilateral Green Maritime Cooperation,** under the **Green Voyage 2050** and Nor-Shipping dialogues, is catalyzing adoption of ferry electrification, e-methanol bunkering, and design of low-emission vessels.
- Bilateral R&D is proposed for **Arctic-class vessel design, AI port systems, and zero-carbon ship prototypes.**

4.7.2. Challenges

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

4.7.3. Opportunities and Strategic Recommendations

a. Technology Clusters and R&D Hubs

- Establish **Maritime Green Tech Parks** in partnership with academic institutions and shipyards to incubate indigenous technologies—e.g., electric vessel prototypes, hydrogen fuel cells, shore power modules.
- Develop an **Open Innovation Challenge Platform** under the Sagarmala Innovation initiative for green maritime solutions.

b. Technology Transfer and Co-development

- Operationalise India–Norway technology transfer agreements to scale up ferry electrification, autonomous green vessels, and clean propulsion R&D.
- Initiate a Maritime Technology Export Corridor targeting small vessel electrification for inland and Southeast Asian markets.

c. Policy Incentives and Standards

- Establish a Green Technology Fund within Sagarmala Finance Corporation Limited (SMFCL) 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 retrofits.
- Mandate green technology compliance scores under a revised port and ship audit regime.

d. Digital Integration for Green Outcomes

- Scale-up the **MAITRI platform** as a Virtual Trade Corridor linking energy-efficient and green-certified ports along IMEEC, INSTC, and Eastern Maritime Corridor.[106]
- 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**

[106] India Briefing. "India's 2025 Maritime Push with US$20 Billion Investment & 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.

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).[107]

4.7.4. 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),
- **Financing instruments**,
- **Monitoring and evaluation**, and
- **Global partnerships and trade alignment** (e.g., IMO decarbonisation targets, EU FuelEU Maritime).

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.

[107] 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.

Chapter 5: Implementation Mechanism and Institutional Architecture

India's maritime green transition—comprehensively mapped through the seven core pillars in previous chapters—requires more than strategic intent. Its success will ultimately rest on a cohesive institutional ecosystem that can deliver, monitor, and adapt this transformation over time. Recognising the scale, complexity, and urgency of decarbonising maritime operations, this chapter sets out the national implementation framework of the NGSP 2025.

Drawing from global models like **Norway's Green Shipping Programme (GSP) Service Centre** [108], **Korea's Green Ship-K governance architecture** [109], and **multi-stakeholder governance platforms recommended by Lloyd's Register**[110], this chapter proposes a layered, decentralised, and adaptive institutional design for India. This design is informed by extensive stakeholder feedback compiled during the June 2025 consultations, including explicit calls for coordination platforms, enforceable standards, and accountability mechanisms.

The framework presented here is also aligned with key national strategies including the **Maritime India Vision (MIV) 2030**, **Maritime Amrit Kaal Vision (MAKV) 2047**, **Harit Sagar Guidelines**, and India's climate commitments under the **LT-LEDS and NDCs**[111]. It aims to:

- Operationalise the seven green pillars through clear institutional mandates and inter-agency linkages;
- Establish robust **Monitoring, Reporting and Verification (MRV)** tools that track decarbonisation, circularity, and financing outcomes;
- Define governance roles across **MoPSW, DGS, State Maritime Boards, and statutory bodies**;
- Create technical secretariats and mission directorates modelled after Korea's Green Ship-K Bureau or India's National Hydrogen Mission;

[108] Norwegian Ministry of Climate and Environment. *The Green Shipping Programme (GSP)*. https://grontskipsfartsprogram.no/english.
[109] Ministry of Oceans and Fisheries, Republic of Korea. "2030 Green Ship-K Promotion Strategy." December 23, 2020. https://www.mof.go.kr/index.do?menuSeq=1588.
[110] Lloyd's Register Maritime Decarbonisation Hub. *Shipping's Role in a Decarbonised World: Pathways & Governance*. London: Lloyd's Register Group, 2023. https://www.lr.org/en/insights/articles/pathways-to-zero-report/.
[111] United Nations Framework Convention on Climate Change (UNFCCC). *India's Long-Term Low Emission Development Strategy (LT-LEDS)*. November 2022. https://unfccc.int/documents/624809.
Also See: Government of India. *Updated First Nationally Determined Contribution under the Paris Agreement*. August 2022. https://moef.gov.in/wp-content/uploads/2022/08/Revised-NDC-India-Submitted-to-UNFCCC-August-2022.pdf.

- Ensure independent, third-party validation, citizen oversight, and transparent progress reporting.

Critically, this chapter integrates the **Just Transition** and **Climate Justice** principles by embedding inclusive governance—ensuring MSMEs, informal workers, coastal communities, and port-dependent economies are not left behind in India's march toward maritime sustainability.

This implementation framework is not a static organogram. It is designed to evolve through feedback loops, regulatory reforms, and technology deployment, ensuring India's maritime sector remains agile in a rapidly transforming global environment.

5.1 Guiding Implementation Principles

The implementation of NGSP will be governed by the following principles:

- **Clarity and Consistency**: Clear definition of roles across central, state, and port-level authorities.
- **Convergence**: Alignment with ongoing missions such as Harit Sagar, MIV 2030, MAKV 2047, PM Gati Shakti, and the National Hydrogen Mission.
- **Scalability**: Interventions must be replicable across ports, shipyards, and fleets, with flexibility for local adaptation.
- **Technology-Neutral Execution**: All low-emission, resource-efficient solutions are eligible, irrespective of specific fuel or platform.
- **Just and Inclusive Transition**: Provisions for MSMEs, coastal communities, informal workers, and under-represented groups.

5.2 Institutional Architecture

India's green maritime transition requires not only sectoral strategies but also a robust, multi-tiered institutional architecture that can steer policy execution, regulatory harmonisation, technological standard-setting, and monitoring of results across all stakeholders. The National Green Shipping Policy (NGSP) 2025 proposes a federated, coordinated governance structure that integrates national, state, and institutional capacities while fostering international collaboration.

5.2.1 National-Level Anchoring Institutions

Ministry of Ports, Shipping and Waterways (MoPSW) will serve as the apex policy and coordination body, responsible for strategic oversight, policy reforms, and international engagement. It will anchor key green maritime missions and oversee alignment with the Harit Sagar Guidelines, Sagarmala, MIV 2030, MAKV 2047, and India's Long-Term Low Emission Development Strategy (LT-LEDS).

Directorate General of Shipping (DGS) (Directorate General of Maritime Administration in future) will act as the national regulatory authority for green shipping standards, ship certification, fleet decarbonisation pathways, and compliance under the Merchant Shipping Bill (forthcoming). DGS will also coordinate with classification societies and port authorities on GHG emissions standards, SEEMP compliance, and performance-based ship audits.

Sagarmala Finance Corporation Ltd. (SMFCL), the country's first NBFC dedicated to maritime finance, will serve as the financial backbone for green shipping investments. It will de-risk early-stage green technology ventures, provide viability gap funding, and manage innovative finance instruments such as green maritime bonds and ESG-linked loans.

5.2.2 Dedicated National Green Shipping Coordination Cell (NGSCC)

To operationalise the NGSP, a dedicated National Green Shipping Coordination Cell (NGSCC) shall be established within the Ministry of Ports, Shipping and Waterways (MoPSW). This Cell shall serve as the central nodal body for all policy planning, coordination, implementation, and monitoring functions related to maritime decarbonisation in India.

A. Institutional Mandate and Status

The NGSCC shall function as the **statutory coordination authority** for NGSP under the MoPSW and shall be supported by a **Maritime Green Transition Mission Directorate**, to be created as a sub-unit within NGSCC/MoPSW.

It shall be empowered to:

- Oversee cross-ministerial alignment and convergence of green shipping programmes.
- Act as the central coordinating entity for **all seven policy pillars** of NGSP.
- Anchor India's representation in bilateral, regional, and global green maritime forums (IMO, BIMSTEC, IORA).

B. Composition

The NGSCC shall include representatives from the following institutions:

- Directorate General of Shipping (DGS)
- Inland Waterways Authority of India (IWAI)
- Indian Maritime University (IMU)
- State Maritime Boards
- Ministry of Environment, Forest and Climate Change (MoEFCC)
- Ministry of Finance (DEA, SEBI)
- Ministry of Skill Development and Entrepreneurship (MSDE)
- Sagarmala Development Company Ltd. (SDCL)
- National Centre of Excellence for Green Ports and Shipping (NCoEGPS)

- NITI Aayog (Observer status)
- Maritime Think Tank / Academic Institution (rotational basis)
- Additional representation from Indian Register of Shipping (IRS), INSA, IPA, SRIA etc. should be considered (as applicable)

C. Functional Mandate

The NGSCC shall discharge the following key functions:

- **Regulatory Convergence**: Ensure alignment between DG Shipping, MoEFCC, and Port Authorities on emission norms, fuel mandates, and compliance certification.
- **Monitoring and Evaluation (M&E)**: Track state-level Green Port Action Plans and report progress through the **National Logistics Portal – Marine (NLP-Marine)**.
- **Incentive Governance**: Approve project proposals for PLI, SBFA, and green retrofit incentives based on compliance performance and third-party MRV reports.
- **Stakeholder Interface**: Conduct quarterly consultations with industry stakeholders, state governments, coastal communities, and international partners.
- **Technical Oversight**: Guide and review MRV data quality, green certification audits, and ESG disclosure standards.
- **Conflict Redressal**: Serve as the appellate body for disputes regarding green compliance classification or financing eligibility.

D. Accountability and Reporting Structure

To ensure policy accountability and performance transparency:

- The NGSCC shall submit a **quarterly implementation and emissions progress report** and a consolidated **Annual Green Maritime Report** to the **Secretary, MoPSW**.
- An **Inter-Ministerial Taskforce on Green Shipping (IMTGS)** shall be constituted under the Chairpersonship of the Secretary, MoPSW, with rotating co-chair from MoEFCC or DEA, to ensure high-level convergence.

5.2.3 State Maritime Boards and Port-Level Authorities

State Maritime Boards (SMBs) and Port Authorities/Trusts will serve as implementing authorities at the sub-national level. Their roles include:

- Preparing and executing port-specific Green Port Action Plans
- Integrating Zero Emission Port Zones (ZEPZ) under Harit Sagar Guidelines
- Managing MRV data submissions to NLP-Marine
- Facilitating public-private partnerships for clean fuel and OPS infrastructure
- Supporting regional skill clusters for green maritime training

To ensure uniformity and capacity building, NGSCC will issue **Model Guidelines for Green Port Governance**, enabling the standardisation of planning, monitoring, and ESG performance benchmarking across major and non-major ports.

5.2.4 Centres of Excellence and Technical Backstopping

To build long-term institutional capacity, the NGSP proposes designating the following as **technical anchors**:

- **NCoEGPS (National Centre of Excellence for Green Ports and Shipping)**: Lead knowledge partner for MRV systems, ESG audits, and port decarbonisation strategy
- **IMU and allied maritime training institutes**: Green skill development, pre-sea and post-sea curriculum integration
- **IITs, NIOT, and IRS**: R&D, technology validation, and lifecycle assessment frameworks
- **SCGJ and NSDC**: Vocational skilling and capacity building at scale

These institutions will also collaborate with international bodies such as BIMCO, DNV, and IMO for technical exchange, standard development, and certification equivalency.

5.2.5 Stakeholder Platform for Co-Governance

The NGSP recommends institutionalising a **Green Maritime Stakeholder Forum (GMSF)**, with annual convenings and sectoral working groups. The forum will ensure inclusive co-governance by engaging:

- Shipowners, shipbuilders, ship repairers, ship recyclers, port operators
- Fuel suppliers and technology vendors
- Financial institutions and ESG investors
- Civil society, academia, and international observers

The GMSF will guide the NGSCC on policy improvements, grievance redressal, and pilot project feedback, and act as a gateway for public-private collaboration.

5.2.6 Integration with Climate Governance and Finance Systems

To ensure policy coherence, NGSP's institutional architecture will establish permanent coordination mechanisms with:

- **MoEFCC** – for MRV compliance, carbon market integration, and VCM readiness
- **SEBI and RBI** – for ESG compliance, climate risk disclosure, and green finance norms
- **DEA and IFSC GIFT City** – for sovereign guarantee schemes, blended finance platforms, and global investor outreach

This convergence will allow India's maritime green governance architecture to align with national climate goals under the Paris Agreement, SDG 13 (Climate Action), and emerging international carbon pricing mechanisms.

5.3 National Green Maritime Implementation Plan (NGMIP)

A rolling **5-year Implementation Plan** will be adopted (2025–2030, 2030–2035...), updated biennially and aligned with India's NDCs and IMO trajectories. To be prepared by NGSCC.

Each plan will include:

- **Pillar-specific action items**
- **State-wise and port-wise targets**
- **Fund allocation by SMFCL**
- **Technology milestones (e.g., OPS readiness, hydrogen bunkering)**
- **Skilling quotas and diversity targets**
- **Private sector engagement strategy**

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 ~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.

The NGMIP is structured into three interlinked components:

i. **Implementation Phases (2025–2047)**
ii. **Governance and Monitoring Framework**
iii. **Stakeholder Roles and Accountability Mechanisms**

5.3.1 Phased Implementation Strategy

The NGMIP adopts a *three-phase timeline* to guide India's green maritime transformation:

Phase	Timeline	Key Actions	Outcomes
Phase I: Foundation & Pilots	2025–2030	• Launch Green Ship and Green Port certification systems • Roll out OPS at 50% of major port berths • Initiate 10–15% fuel transition in coastal and IWT vessels	Defined baselines, early adoption incentives, pilot corridors, functional MRV and green finance instruments

Phase	Timeline	Key Actions	Outcomes
		• Operationalise ESG-linked finance tools via SMFCL • Rollout MRV platforms (NLP-Marine, NLP-Carbon) • Establish 5 Maritime Green Skills Clusters near green hydrogen ports	
Phase II: Expansion & Institutionalisation	2030–2040	• Scale Green Fuel hubs (e.g., Paradip, VOCPA) • Green Certification mandatory for new builds • Establish National Maritime Carbon Market • Digital traceability for ship recycling and emissions • Expansion of ZEPZs to non-major ports • 30% clean fuel adoption in Indian fleet	System-wide decarbonisation, green market development, carbon credit exchange, mid-term global alignment
Phase III: Consolidation & Global Leadership	2040–2047	• Zero-emission mandates in select zones (e.g., NW1, Gujarat coast) • Achieve 70% transition to clean fuels • Digitised MRV linked to global shipping networks • Export green vessels and maritime technologies (India as R&D-exporter) • Position India in top 5 green shipbuilding and recycling nations	Full-scale transformation of port–ship–fuel systems, global competitiveness, domestic technology leadership

This timeline is designed with flexibility to allow policy recalibration based on international developments (e.g., MEPC-85, COP decisions), market maturity, and evolving climate technologies.

5.3.2 Governance Structure for NGMIP

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

Level	Entity	Key Roles
Central Apex Body	**NGSCC** chaired by MoPSW	- Strategic oversight - Inter-ministerial coordination (MoEFCC, MNRE, MoF, MSDE) - Policy coherence with India's LT-LEDS and sectoral missions
Implementation Agency	**NCoEGPS**	- Technical implementation, monitoring support, training modules, MRV architecture, and innovation pilots
Finance Anchor	**Sagarmala Finance Corporation Ltd (SMFCL)**	- Fund mobilisation (green bonds, blended finance), ESG evaluation, project de-risking
Regulatory Arms	DG Shipping, Tariff Authority for Major Ports (TAMP), BIS	- Compliance monitoring, emission standards, performance-linked incentives, certification frameworks
Digital Backbone	NLP-Marine, MAITRI, and MRV Carbon Registry (MoEFCC-linked)	- Emission accounting, dashboard reporting, digital workflows
Port & State Nodes	Port Trusts, State Maritime Boards	- Project execution, local monitoring, community engagement, workforce skilling
Stakeholder Advisory Platform	Green Maritime Partnership Forum (Industry–Academia–NGOs–IFIs)	- Feedback integration, innovation co-creation, peer benchmarking

5.3.3 Monitoring, Reporting, and Verification (MRV)

A comprehensive MRV mechanism is essential for transparent delivery, mid-course correction, and international credibility.

- **Digital Carbon Dashboard (NLP-Carbon)**: Real-time emission tracking by port, ship type, and fuel cluster.
- **Annual Maritime Sustainability Report (AMSR)**: Mandatory reporting by all major ports and Indian-flagged shipping entities.
- **Green Compliance Index (GCI)**: Composite performance indicator used for eligibility to government incentives and green financing.
- **Third-Party Verification**: Biennial audits by accredited institutions under DGS/IMU/IRS ecosystem.
- **Alignment with Paris Article 6[112] & IMO GHG Metrics**: Emission data to feed into international offset and compliance mechanisms.

[112]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 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.

5.3.4 Stakeholder-Informed Design

The NGMIP design reflects key recommendations from the Stakeholder Inputs, including:

- Sector-specific implementation cells in ports, aligned with NCoEGPS.
- Green procurement mandates across central port and shipping entities.
- 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 IFSC GIFT City financing channels.
- Progressive alignment with global approaches (e.g., Korea's *Green Ship-K* phasewise targets; Norway's *GSP Service Centre* for project support).

Conclusion:

The National Green Maritime Implementation Plan (NGMIP) offers a clear, time-bound roadmap to translate the ambitions of NGSP into grounded, 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.

5.4 Stakeholder Alignment and Co-Ownership

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

- **Annual National Green Shipping Dialogue**: A multi-stakeholder conference to review implementation and foster partnerships. It can be included in the Maritime Week of India.
- **Sectoral Working Groups** for Green Fuels, Shipbuilding, Ship repair and Ship Recycling, Maritime Finance, and Digitalisation—anchored by NCoEGPS and DGS.
- **Green Maritime Help Desk & Grievance Portal**, hosted on the Swachh Sagar Digital Dashboard, for real-time resolution.

"Policy without participation becomes prescription. India's green maritime strategy must be co-created, co-owned, and co-delivered." — Stakeholder submission in stakeholder consultation done for NGSP formulation.

5.5 Emissions Baseline (2021) and SMART Decarbonisation Targets

5.5.1 National Emissions Baseline

Baseline Year and Principle

In keeping with the principle of **common 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.

Six-Month Confirmation Study

Immediately after the formation of the **National Green Shipping Coordination Cell (NGSCC)**, 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 NGSCC will oversee scope, methods, and deliverables.

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 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 waterways-specific considerations** (e.g., smaller vessel sizes, older fleets, lower access to compliant fuel, mixed-use terminals in eco-sensitive zones).

A. Scope and Applicability

Ships Covered:

- **International:** All ships ≥5,000 GT calling at Indian ports (cargo, passenger/cruise, service/support vessels) — aligned with IMO DCS thresholds.

- **Domestic/Coastal:** Indian-flagged vessels ≥400 GT in coastal, inter-island, and offshore service.
- **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:
  - 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 **IRS/class societies** under NGSCC protocols.
- **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 affected voyages.
- **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))[113] 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** (aggregate) by NGSCC; ships will not be penalised for verified unavailability but may be required to implement **operational efficiency measures** (e.g., **Just-in-Time arrivals**, slow steaming, weather routing) for the affected voyage(s).

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 new IMO GHG guidelines, domestic MRV enhancements, and technology adoption.
- The framework will **evolve through feedback loops**, regulatory reforms, and tech deployment—balancing environmental ambition with **commercial viability** to keep India's maritime sector competitive.

5.5.2 SMART Decarbonisation Targets (2025–2070)

The NGSP 2025 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)**.

Each target is defined in accordance with the SMART framework—**Specific, Measurable, Achievable, Realistic, and Time-bound**—and is categorised into short-term (2025–2030), medium-term (2030–2040), and long-term (2040–2070) implementation windows.

Coverage & applicability:

- **Ships:** All **Indian-flagged** ships ≥400 GT (coastal & international) and **all foreign ships ≥5,000 GT** calling Indian ports. Priority segments: container, bulk, tankers; plus **tugs, ferries, and barges** for retrofits.
- **Ports:** All **major ports**; phased inclusion of **non-major/private ports** and **IWT terminals** (IWAI & SMBs).

[113] "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.

- **Data principle:** Where 2021 activity/fuel data are incomplete, actions below prioritize **MRV deployment first**, then lock targets to the confirmed baseline values.

A. Short-Term Targets (2025–2030)

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

A1. MRV & Baseline

- **National Maritime Emissions Registry** live by **Q4-2026**; **tiered MRV** mandatory by **2027** for:
  - Ships: Indian-flagged ≥400 GT; all foreign ≥5,000 GT calling India.
  - Ports: all major ports (2026), **≥50% of non-major** by 2028.
- **2021 carbon footprint (whole maritime sector)** compiled and published by **Q3-2026** (shipping + port Scopes 1–2, with guidance for Scope 3 where material).
- **Baseline confirmation step:** Within **6 months of NGSCC formation**, **DGS + SCI** (with MoPSW-appointed stakeholders) deliver a **feasibility & data integrity review**. If ≥90% coverage/quality is confirmed, **2021 is notified as the national baseline in 2026**; if not, adopt an **interim rolling-average intensity baseline (2019–2023)** for target tracking until **full 2021 confirmation** (no later than **2028**).

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

- **Just-in-Time (JIT) & 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).
- **Voyage optimisation & weather routing** required in **SEEMP** for Indian-flagged ≥5,000 GT by **2027**.

A3. OPS & port electrification

- **OPS energized at ≥50% berths** at major container/cruise/O&G terminals by **2029** (starting with high-aux-load berths).
- **Port equipment electrification**: **≥30%** of new RTGCs/RMGs/yard tractors electric or hybrid from **FY27** tenders onward.[114]

[114] Instituting a ≥30% 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. 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 & Waterways, Government of India

A4. Fuels & 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).
- **Two multi-fuel bunkering hubs** (e-methanol/LNG/biofuels, ammonia-ready) certified by **2029**; national **Fuel Safety Code** updates issued by **2026**.
- **Fuel unavailability SOP:** Adopt **Fuel Unavailability Report (FUR)** process nationally by **2026**, with **documented mitigation** (JIT speed, OPS use, routing to nearest compliant supply).

A5. Retrofits & newbuild signals

- **Retrofit 300–500 small workboats/tugs/ferries** (hybrid/battery or biofuel-ready) by **2030** with viability-gap/SLB support.
- **Green Ship – Basic**: **≥30% of Indian-flag newbuilds (2026–2030)** certified; all **public procurement** tugs/ferries **zero-emission-capable from 2029**.

A6. Green corridors & skills

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

A7. Finance & commercial viability

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

Special notes (coastal/IWT):

- **5 fully electric ferry corridors** (e.g., Kochi, Kolkata–Haldia, Guwahati, Varanasi) by **2029**; **shore charging** at corresponding terminals.
- Mandate **Tier II/III equivalent** emissions for **all new IWT/coastal vessels** from **FY28**.

B. Medium-Term Targets (2030–2040)

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

B1. Fleet standards & 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 2024**.
- **Mandatory weather routing/speed optimisation** for **Indian-flag ≥5,000 GT** by **2032**; demonstrate **≥10% voyage fuel reduction** Vs 2024 baselines on comparable routes.

B2. Ports & OPS

- **OPS at 100% berths of major ports by 2035**; **≥75% berths at non-major ports by 2038**.
- **Port Scope 1–2 intensity** (tCO_2e per tonne handled): **–50% vs confirmed 2021 baseline by 2035** (supersedes 2020 ref); **≥60% RE share** in port electricity by **2032**.

B3. Retrofits & segment focus

- **Retrofit ≥50% of eligible coastal/IWT vessels by 2038**, prioritising **tugs, ferries, barges** (hybrid/battery/biofuel/e-methanol kits).
- **Shore-side equipment**: **≥80% new cargo-handling equipment** electric/hybrid from **FY33** tenders.

B4. Fuels & 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** (top 8 ports) certified **ammonia-ready** by **2036**, with full safety & emergency systems.

B5. Certification & green ports

- **≥60% of national cargo throughput** under **Green Port Certification** by **2036**; **≥50% of Tier-1 ports** at **'Green Port – Level 2' or higher**.
- **Zero-Emission Port Zones (ZEPZ)** at top-10 ports by **2038** (OPS-only berths, zero-emission yard equipment, JIT compliance, low-emission landside access).

B6. Finance & markets

- **Blended finance at scale** (MGTF, NIIF, IFSC-GIFT): cumulative **₹50,000+ crore** mobilised for OPS, retrofits, bunkering by **2035**.
- **Domestic carbon credit methodology** (well-to-wake where applicable) for JIT/OPS/retrofits in place by **2032**; voluntary market participation by **2034**.

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 & market integration.)

C1. Newbuilds & fleet turnover

- **100% of newbuilds delivered post-2045 zero-emission capable** (fuel-flex for green ammonia/methanol/hydrogen; lifecycle carbon thresholds aligned with global standards).
- **Last diesel-only newbuild for public procurement** no later than **2035** (policy signal retained for industry planning).

C2. Net-zero outcome & zones

- **Sectoral net-zero (Scope 1–2, ports & Indian-flag shipping) by 2070**; publish **5-yearly** carbon budgets starting **2040**.
- **Zero-Emission Zones (ZEZ)** across **all major cargo & coastal corridors by 2060** (JIT compliance, OPS-only at berths, zero-emission last-mile at ports).

C3. Full fuel transition & infrastructure

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

C4. Markets & disclosure

- **Indian fleet MRV integrated with global carbon markets/MBMs by 2047** (subject to equity safeguards); robust **LCER** (life-cycle emissions reporting) standard in national regulation by **2047**.

Cross-cutting guardrails

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

5.6 Integration with Global Frameworks and Regional Platforms

To ensure regulatory harmony and global market access, the NGSP shall:

- Adopt **IMO-aligned compliance instruments** (MEPC 80/83, MARPOL Annexures, SEEMP Phase III).
- Enable **bilateral cooperation** with Norway, Singapore, EU, Japan, and Korea on technology, training, and carbon markets.
- Facilitate participation in **regional initiatives** such as GreenVoyage2050, ASEAN Smart Ports Network, BIMSTEC and IMEEC for corridor-level decarbonisation.
- Synchronize with the **Article 6 framework** under the Paris Agreement for carbon market access.

5.7 Funding and Resource Mobilisation

Implementation will be primarily financed via:

- **Maritime Development Fund** and **Sagarmala Finance Corporation Ltd. (SMFCL)**
- Dedicated instruments: green bonds, VGF, carbon credit purchase, and blended finance vehicles
- **CSR fund and state budget allocations**
- **Multilateral support** (GCF, WB, ADB) for technology pilots and skill hubs

5.8 Immediate Policy Triggers and Fast-Track Actions

To ensure that the National Green Maritime Implementation Plan (NGMIP) gains early momentum, the following actions are proposed for fast-tracked execution by 2025–27. These actions reflect critical stakeholder suggestions, global replication potential, and inter-ministerial coordination needs:

Action Area	Recommended Measure	Lead Agencies
Regulatory Activation	Notify Green Port and Green Ship Certification Rules under the **Major Port Authorities Act, 2021** and **Merchant Shipping Act, 1958 (revised)**	MoPSW, DGS
Green Budget Mandate	Mandate that **minimum 10% of port CAPEX** is aligned with green infrastructure by FY2027	MoPSW, MoF
Startup Ecosystem	Launch a **Green Maritime Innovation Grant Scheme** through **SMFCL**, targeting startups in green fuel, clean propulsion, carbon tracking, and smart port tech	MoPSW, SMFCL, Invest India, NITI Aayog
Sub-National Alignment	Release a **Model State Green Maritime Policy Template**, enabling maritime states to align with NGSP pillars	MoPSW, NCoEGPS, NITI Aayog

Action Area	Recommended Measure	Lead Agencies
Green Corridor Planning	Develop a **National Green Corridor Master Plan** (2025–2030), prioritising high-density container and Ro-Ro corridors along east-west and coastal chains	MoPSW, IWAI, DGS, NCoEGPS, States
Digital Enablers	Operationalise the **NLP–Carbon Registry** and link to **MRV compliance** protocols for Indian-flagged vessels and major ports	MoPSW, MoEFCC, DGS
Human Capital Development	Issue mandate for **Green Skill integration** into all maritime training institutions (IMU, ITIs, port training centres)	MoPSW, MSDE, SCGJ
Financial Reform	Finalise ESG evaluation criteria under SMFCL and define green project eligibility under Maritime Development Fund	MoPSW, SMFCL, MoF

Rationale:

This section ensures policy acceleration by:

- Consolidating **early-stage policy levers** without repeating NGMIP's medium-to-long-term roadmap;
- Translating **stakeholder feedback** into actionable steps;
- Providing a **checklist for 2025–27** that can be easily reviewed during mid-term evaluations;
- Laying the foundation for cross-sector convergence and fiscal alignment with other missions (Hydrogen, Gati Shakti, E-Mobility).

5.9 Implementation Plan for Green Skilling – Linked to NGMIP 2047

Objective: Establish a comprehensive baseline of workforce skills, training infrastructure, and capability gaps across the maritime sector, with a specific focus on vessel crew, training institutes, and service providers.

Actions:

1. **Lead:** NGSCC (MoPSW) in coordination with DGS, IMU, SCGJ, IWAI, NCoEGPS, IMU, IITs, NIOT.
2. **Tasks:**

    - Map **current skill inventory** for:
      a) Vessel crew (officers, engineers, ratings).
      b) Training institutes (capacity, trainers, simulators).
      c) Service providers (OEMs, shipyards, repair yards, technical managers).
    - Assess **digital literacy levels** for operation of MRV dashboards, IoT monitoring systems, and green fuel safety systems.

- Identify **role-specific gaps** in emerging technologies (hydrogen bunkering, ammonia handling, CEMS operation, shore power integration, hybrid propulsion maintenance).
- Audit current **monitoring & evaluation practices** at training institutes and industry facilities.
- Map **collaboration channels** and knowledge-sharing networks; identify missing linkages between academia, regulators, and industry.

3. **Output: National Green Skills Baseline & Gap Analysis Report** (Q4 FY2026), including a target capacity roadmap as per NGSP.
4. **Integration:** Directly feeds into the "Human Capital" pillar of NGMIP 2047 and guides all subsequent phases.

Phase 2 – Launch of Green Maritime Skills Mission (GMSM) (Year 1–3)

Objective: Create a national framework for closing the identified skill gaps through structured, role-based training with digital and regulatory integration.

Actions:

1. **Lead:** MoPSW with MSDE, DGS, IMU, SCGJ, IWAI, IITs, NIOT, OEM partners.
2. **Tasks:**

    - Define **50+ Green Maritime Job Roles & Qualification Packs (QPs)**, aligned with IMO/ILO standards.
    - Embed **digital literacy and MRV operations** into all QPs.
    - Integrate **green fuel safety protocols** and emerging technology modules in pre-sea and post-sea training (via DGS and IMU).
    - Establish **Regional Skill Clusters** at Paradip, VOCPA, Deendayal, Kochi, Guwahati, and Goa, with sectoral focus (inland, cruise, deep sea, ship building, ship repair and ship recycling).
    - Develop **National Green Skills Trainer Accreditation (NGSTA)** framework; train first 200 trainers within 18 months.
    - Formalise **collaboration platforms** bringing together IMU, IITs, NIOT, OEMs, shipyards, and shipping companies for joint curriculum development.

3. **Output:** GMSM Operational Framework launched (FY2027).
4. **Integration:** Becomes a core delivery mechanism of NGMIP workforce strategy.

Phase 3 – Training Infrastructure Modernisation (Year 2–5)

Objective: Equip training hubs with technology-driven, simulator-based, and OEM-supported facilities for hands-on green maritime training.

Actions:

- Retrofit **Green Maritime Centres of Excellence (GMCoEs)** at 6 hubs with:
    - Alternative fuel handling labs (hydrogen, ammonia, methanol, LNG).
    - CEMS & MRV dashboard simulators (linked to NLP-Marine).
    - Shore power connection mock-ups for cruise and port operator training.
    - Battery-electric propulsion maintenance bays for inland waterways.
    - Digital classrooms with VR/AR simulation for zero-emission navigation and fuel changeover.
- Fund upgrades through **SMFCL Green Skill Capital Grants**, CSR allocations, and OEM co-funding.
- Ensure blended learning via **DGS e-learning, SCGJ, and Swayam**, with progress monitoring through MAITRI-linked dashboards.

Phase 4 – Certification & Regulatory Integration (Year 3–6)

Objective: Align workforce qualification with licensing and compliance requirements.

Actions:

- DGS amends licensing rules to require **mandatory green skills certification** for key roles (e.g., CEMS Operator, Riverine Compliance Officer, Cruise Sustainability Officer).
- Integrate **digital literacy competency** as a prerequisite for operational licenses.
- Upgrade MAITRI platform to store **portable, verifiable skill records** accessible via QR code.
- Link certification to **regulatory incentives**:
    - Reduced port dues for certified vessels.
    - Harit Sagar compliance credits for ports with fully certified staff.

Phase 5 – Inclusion & Just Transition Programmes (Year 2–10)

Objective: Ensure equitable access to green maritime careers and smooth transition for fossil-fuel-dependent workforce.

Actions:

- Target **30% participation** of women and PwDs in GMSM programmes by FY2032.
- Offer **upskilling scholarships** for rural youth in collaboration with state maritime boards.
- Implement **transition training packages** for legacy workforce (coal handling, oil tanker crews).
- Launch **mentorship programmes** for green MSMEs, linked to GMCoEs.

Phase 6 – Scaling, Collaboration, and Continuous Upgradation (Year 5–2047)

Objective: Maintain global competitiveness through ongoing skill enhancement and collaboration.

Actions:

- Conduct **biennial curriculum reviews** against IMO, ILO, OECD standards and emerging tech needs.
- Establish **international certification equivalency agreements** (IMO, BIMCO, EMSA, Japan, Denmark).
- Strengthen **collaboration forums** between IMU, IITs, NIOT, OEMs, shipyards, and regulators for R&D-driven training updates.
- Expand programmes to cover **future fuels, AI-based navigation, autonomous vessel operations, and maritime cyber resilience**.

Key Milestones – Linked to NGMIP 2047

Year	Milestone
2026	National Green Skills Baseline & Gap Analysis Report completed; GMSM launched
2027	First 20 QPs rolled out; NGSTA framework operational; collaboration platform active
2028	GMCoEs fully functional with simulator and lab facilities; trainer base 200+ certified
2030	70% of operational workforce certified in role-specific green skills
2035	100% workforce compliance; Indian certifications recognised by top 10 maritime nations
2047	India globally recognised as a leading exporter of digitally skilled, green maritime professionals

5.10 Way Forward

With the institutional framework and implementation roadmap now established, the focus shifts to defining the enabling environment—financial, regulatory, technological, and capacity-building mechanisms—that will support the delivery of NGSP's green maritime goals. The next chapter presents a comprehensive framework for Monitoring, Reporting, Verification (MRV) and Performance Assessment, ensuring transparency, accountability, and course correction in India's green maritime transition.

Chapter 6: Monitoring, Reporting, Verification (MRV) and Performance Assessment

6.1 MRV as the Backbone of Green Maritime Governance

The green transformation of India's maritime sector, as outlined in NGSP 2025, hinges not just on policy intent but on credible and transparent systems of **Monitoring, Reporting, and Verification (MRV)**. MRV is the foundational enabler for:

- **Evidence-based policy implementation**
- **Climate finance mobilisation**
- **Performance benchmarking**
- **Global compliance (e.g., IMO, EU ETS, FuelEU Maritime)**

India's current MRV systems in the maritime sector are nascent and fragmented. This chapter lays out a structured national MRV framework that integrates **digital platforms**, leverages **existing institutional capacity**, and adapts global best practices to the Indian context.

Institutional Trigger:
The MRV system under NGSP will commence immediately after the constitution of the **National Green Shipping Coordination Cell (NGSCC)**, which will serve as the apex technical and coordination body for maritime MRV in India.

NGSCC Core MRV Functions:

1. **Standards & Protocols Development**
    - Formulate India's national MRV guidelines harmonised with IMO DCS, EU MRV, and FuelEU Maritime standards.
    - Define vessel category-specific reporting templates (coastal cargo, IWT vessels, cruise ships, offshore support, tugs).
    - Establish inland waterways and cruise-specific emission intensity metrics (e.g., *gCO_2e/passenger-nautical-mile*, *gCO_2e/tonne-km*).
2. **Digital Infrastructure Governance**
    - Oversee integration of MRV modules into **NLP-Marine** and other national maritime digital platforms.
    - Approve data security protocols, API interoperability standards, and blockchain-based audit trail mechanisms.
3. **Verification Oversight**
    - License and audit third-party MRV verifiers (classification societies, accredited MRV firms).
    - Maintain a national registry of certified verifiers with sectoral expertise.

4. **National Green Maritime Implementation Plan (NGMIP) Alignment**
    - Translate MRV outputs into actionable inputs for NGMIP target-setting and course correction.
    - Synchronise MRV data with performance-linked incentive schemes and green finance eligibility.
5. **Cross-Sector Coordination**
    - Liaise with **DG Shipping, MoEFCC, BIS, BEE, IWAI, State Maritime Boards**, and **tourism ministries** for integrated MRV coverage.
    - Coordinate with international MRV systems to ensure mutual recognition of reports for global compliance.

6.2 MRV Scope under NGSP

The MRV system will extend to **all seven NGSP pillars**, with specific indicators and data requirements for each:

NGSP Pillar	Core MRV Scope
Green Ports	Port-level GHG inventories, renewable energy share, OPS usage hours, cargo handling equipment emissions, waste & water management KPIs.
Green Shipping-Shipbuilding and Ship Repair	Vessel-level fuel consumption, energy efficiency indices (EEDI, EEXI, CII), alternative fuel uptake, voyage optimisation gains.
Green Ship Recycling	Yard-level emissions, hazardous material recovery rates, % steel recycled, worker safety compliance metrics.
Green Finance	Fund disbursement tracking, emissions avoided per ₹ invested, ESG compliance reports of financed projects.
Green Skills & HR	Number of green-certified professionals, training hours delivered, skill adoption rates in emerging tech.
Green Fuels	Production capacity, lifecycle carbon intensity (gCO_2e/MJ), bunkering volumes, supply chain emissions.
Green Technology	Technology adoption rates, performance data of deployed tech, GHG savings verified through trials.

6.3 Operational MRV Workflow

The MRV workflow will follow a **6-stage operational cycle** managed centrally by the **NGSCC**:

1. Data Capture at Source

- **Vessels**:
    - Shipboard fuel flow meters, GPS, AIS, engine logs, and emissions sensors feed real-time data to NLP-Marine MRV module.
    - Inland & cruise vessels use a simplified digital logbook system linked to IWAI/Cruise Tourism Green Transition Committee (CTGTC) servers.

- **Ports & Terminals**:
    - IoT sensors for OPS usage, cargo handling equipment fuel data, energy meters for renewable integration, waste & water discharge logs.
- **Ship Building, Ship Repair and Ship Recycling Yards**:
    - **Real-Time Energy and Emissions Monitoring** – All yards to be equipped with calibrated energy meters and emissions sensors to measure direct consumption of electricity, diesel, gas, oxy-fuel, and related emissions (CO_2, VOCs, particulates). Continuous and historical data shall be transmitted to the NGSCC MRV system.
    - **Process-Specific Emissions Tracking** – Yards must digitally log material and energy inputs for high-emission activities such as welding, blasting, painting, steel cutting, scrapping, and hot-work. Reporting shall capture process-level emissions per vessel built, repaired, or dismantled.
    - **Hazardous Waste and Material Flow Management** – Blockchain-enabled manifests shall be mandatory for hazardous and restricted materials (paints, solvents, batteries, asbestos, oils, PCBs, electronics, insulation). For ship recycling, this must extend to **Inventory of Hazardous Materials (IHM) compliance** and **end-to-end disposal tracking** in line with the Hong Kong Convention and the Recycling of Ships Act, 2019. All records must be connected to MRV for audit trails and international reporting.
    - **Renewable Energy Integration and Certification** – Yards will be encouraged to adopt renewable electricity (solar rooftops, open access PPAs, on-site green hydrogen pilots) and energy-efficient retrofits (LEDs, electrified cranes, OPS for test berths). Automated certification of renewable usage will be uploaded to MRV, supporting *green maritime clusters* and *net-zero yard* objectives.
    - **Lifecycle Emissions Data for Newbuilds, Retrofits, and Recycling** – Mandatory submission of lifecycle assessment (LCA) data and ISO 14067 verified GHG intensity certificates for every vessel constructed, major retrofit, or recycled. For recycling yards, reporting shall include *material recovery ratios, recycling efficiency, and end-use destination of recovered materials*. These datasets will be linked to vessel MRV records for cradle-to-grave emissions transparency.
    - **Digital Compliance Workflow & National Integration** – All Shipbuilding, Ship-Repair and Ship Recycling yards must maintain standardized digital compliance logs accessible to NGSCC, including worker-safety audits, waste manifests, emissions reporting, and certification records. This enables central monitoring, predictive analytics, and evidence-based policy interventions across the maritime manufacturing and recycling ecosystem.

- **Green Fuel Producers**:
    - Lifecycle GHG intensity certification data from BIS/ISCC/RSB standards integrated into MRV.

2. Secure Data Transmission

- Encrypted, time-stamped uploads via **API gateways** to NLP-Marine MRV servers.
- Blockchain ledger to create immutable audit trails for compliance evidence.

3. Automated Pre-Verification

- AI-based anomaly detection flags missing, inconsistent, or suspicious data (e.g., unrealistically low fuel consumption).
- Cross-check with AIS voyage history, port entry/exit records, and bunker delivery notes.

4. Third-Party Verification

- Accredited MRV verifiers conduct audits — on-site for random samples, remote for regular checks.
- Cross-validation against IMO DCS, EU MRV, and India's domestic baselines.

5. Data Integration & Analytics

- Central dashboard at NGSCC with tiered access:
    - **Policy-makers**: National emission trends, KPI performance vs. targets.
    - **Port/Vessel Operators**: Operational efficiency reports, benchmarking against peers.
    - **Public View**: Aggregated, anonymised data for transparency.

6. Reporting & Feedback Loop

- **Annual Maritime Sustainability Report (AMSR)** published by NGSCC consolidating verified MRV data.
- Findings fed into NGMIP for mid-course corrections, funding reallocations, and policy updates.

Institutional Roles Across the 6 Stages

1. **Data Capture at Source**

    - **Primary responsibility**: Vessel operators, ports/terminals, all yards, and green fuel producers.
    - **Supervisory bodies**: Directorate General of Shipping (DGS), IWAI (for inland), Cruise Tourism Green Transition Committee (CTGTC), and State Maritime Boards.

- **Technical backbone**: NCoEGPS for templates, standards, and digital tools.

2. **Secure Data Transmission**

   - **NGSCC to operate national API gateways and blockchain ledgers.**
   - **NIC/MeitY may provide cybersecurity and encryption protocols.**

3. **Automated Pre-Verification**

   - **Body appointed by NGSCC/MoPSW** to design anomaly-detection algorithms (fuel efficiency, emissions intensity).
   - **DG Shipping** to mandate corrective reporting when anomalies are flagged.

4. **Third-Party Verification**

   - **Accredited Verification Agencies**: Could include classification societies (IRS, DNV, ABS), empanelled technical auditors, and CPCB-approved environmental auditors.
   - **Coordination**: DGS to license verifiers; NGSCC to assign and manage audits.

5. **Data Integration & Analytics**

   - **NGSCC** operates the national dashboard.
   - **NITI Aayog, MoPSW, and BEE** given tiered access for policy and planning.
   - **State Maritime Boards** access regional slices for port-level benchmarking.

6. **Reporting & Feedback Loop**

   - **NGSCC** to publish the *Annual Maritime Sustainability Report (AMSR)*.
   - **NGMIP Steering Committee** (under MoPSW) to review findings, set corrective actions, and recommend policy/funding adjustments.

6.4 Inland Waterways and Cruise Ship Tourism MRV Protocols

6.4.1 Why bespoke MRV?

IWT vessels and cruise ships have very different duty cycles from blue-water ships: frequent short voyages; low/variable loads; high "hoteling" demand (cruise); seasonally constrained drafts (IWT); and diverse propulsion (diesel, CNG/LNG, biofuels, methanol, electric, hybrid). The MRV below reflects that reality.

6.4.2 Applicability & Thresholds

- **Inland Waterways (IWT)**: All powered vessels ≥400 GT; passenger ferries regardless of tonnage.

- **Cruise**: All vessels carrying >100 passengers overnight or day-cruise vessels >250 pax.
- **Micro-operators** (below thresholds): simplified annual self-declaration + random audits.

6.4.3 Core Metrics (beyond CO_2)

IWT cargo

- gCO_2e/tonne-km (primary intensity metric)
- gNOx/tonne-km, $gPM_{2.5}$/tonne-km (air quality co-pollutants)
- Fuel blending share (% bio/CNG/LNG/methanol/hydrogen)
- Energy use per lock transit / per river km (optional where locks exist)

IWT passenger (ferries/ro-pax)

- gCO_2e/passenger-km (primary)
- On-time energy per trip (kWh/trip for electrics/hybrids)
- Idle time ratio (% of engine-on time at zero way)

Cruise (ocean & river)

- gCO_2e/passenger-nautical-mile (primary)
- Hoteling energy intensity (kWh/pax-night)
- Shore-power usage (% time connected; kWh imported)
- Wastewater & solid waste handled per pax-day (m^3/kg) — MR only (verification by port manifests)
- Sulphur compliance evidence (fuel logs or scrubber data) where relevant routes apply

Common optional metrics

- Black carbon index (where measured), underwater radiated noise proxies (RPM vs speed curve), and methane slip (for gas fuels) when sensors exist.

6.4.4 Minimum Data Set (MDS)

Per voyage/leg (IWT & Cruise):

- Vessel ID (IMO/CIN/IWAI reg), engine/propulsion type, rated kW
- Departure/arrival timestamp & location, route/section ID
- Distance through water & over ground (km/NM), lock/bridge transits (if any)
- Payload (tonnes) or passengers carried (validated by ticketing/turnstile)
- Fuel by type (litres/kg) or electricity (kWh) consumed; for hybrids, split traction vs hotel
- For cruise: hoteling duration; OPS (shore power) connected time & imported kWh

- For IWT seasonality: average draft, river stage (low/normal/flood), current estimate (kts)

Per month (roll-up):

- Maintenance/calibration logs; downtime; sensor exceptions; biofuel certificates (if any)

6.4.5 Data Capture & Instrumentation

- **Fuel/Energy**:
  - Flow meters (OIML R117/ISO compliant) or tank level sensors with event logs; BDN scans where bunkering occurs.
  - Electricity meters on traction and hoteling circuits (class 1 accuracy).
- **Operations**:
  - AIS/RTK-GPS for track & speed; mandatory for cruise; for IWT, AIS where mandated + mobile app fallback.
- **Passenger counts** (IWT & cruise):
  - Automated turnstiles or e-ticketing export; manual counts only as exception with photo proof.
- **Shore power**:
  - Smart meter with API to port MRV gateway.
- **Alternative fuels**:
  - Monthly upload of LCA emission factors (gCO_2e/MJ) from accredited schemes; verifier cross-checks.

Calibration

- Fuel/energy meters: 12-month calibration from an accredited laboratory with NABL; seal & certificate ID stored in registry.
- GPS/AIS: functional check quarterly.
- Passenger counting: quarterly reconciliation vs revenue reports.

6.4.6 Reporting Frequency

- **IWT cargo & passenger**:
  - **Voyage-level** auto-upload within 24 hours (app/API).
  - **Monthly** consolidated submission (M1) + **Quarterly** verification cycle (Q).
- **Cruise**:
  - **Per voyage segment** (sailing & hoteling) within 24 hours of berthing/departure.
  - **Monthly** consolidation; **Quarterly** verifier review.
- **Annual** verified statement for both, feeding the AMSR and NGMIP.

6.4.7 Verification Methods (risk-based)

- **Desk checks**: Automated anomaly flags (fuel vs distance vs speed), payload plausibility, OPS claims vs port meter data, pax counts vs ticketing.
- **Field audits**: Random 5–10% sample per year; seal checks; spot PEMS tests for NOx/PM on selected engines; stack opacity for legacy units.
- **Cross-validation**:
  - IWT: compare declared distance with AIS/GPS/path library for river sections; season/draft against IWAI hydrology data.
  - Cruise: cross-check hoteling logs with port call records; shore power kWh with port utility export.
- **Data Quality Grade (DQG)** assigned per operator per quarter:
  - **A** (instrumented, consistent, <1% gaps), **B** (minor gaps <5%), **C** (material gaps 5–20%), **D** (>20% or discrepancies).
  - DQG feeds compliance weighting and incentives.

6.4.8 Inland Waterways Specificities

- **Seasonal profiles**: Operators tag each voyage with **seasonal draft band**; MRV normalizes performance to bands for fair benchmarking.
- **Section IDs**: IWAI publishes river-section IDs with standard distances and typical currents; MRV pre-loads these for validation.
- **Small-vessel app**: A low-friction Android/iOS app with offline caching for ferries and community boats; QR-based pax capture where gates aren't available.
- **Battery-electric IWT**: Charger logs (kWh/session), battery SoC histories, regen kWh (if captured), and charging source RE proofs.

6.4.9 Cruise-Specific Requirements

- **Hoteling split**: Mandatory separation of hotel vs propulsion energy (metered circuits).
- **Shore power**:
  - Auto-ingestion of OPS meter data via port API; no manual entry permitted.
  - OPS usage factored into port and ship performance scores.
- **Waste streams** (monitoring only): Upload MARPOL Annexures delivery receipts (volumes/weights) — used in sustainability dashboards, not CO_2e.
- **Excursions/tenders**: Fuel/energy used by tenders reported as part of voyage segment.
- **Itinerary disclosure**: Publish planned vs actual route segments to support public transparency and destination management metrics.

6.4.10 Exceptions & Data Gaps

- **Grace window**: 7 days to correct flagged gaps; after that, imputation rules apply (conservative estimates based on last verified intensity × activity).

- **Force majeure**: Weather/river closures logged via IWAI/port notices; penalties waived for non-attributable gaps.

6.4.11 Roles & Responsibilities

- **Operators**: Install/maintain meters, submit data, keep calibration up to date, rectify gaps.
- **Ports/IWAI**: Provide OPS/utility data via API; publish section libraries & hydrology bands; host verifier inspections.
- **Verifiers (accredited)**: Quarterly checks, annual statement, grade DQG, recommend corrective actions.
- **NGSCC**: Maintain factors & protocols, run analytics, publish leaderboards, link MRV results to incentives/compliance, update NGMIP targets.

6.4.12 Digital Integration

- **Single MRV API** within the national maritime digital stack (NLP-Marine/IWAI modules).
- **Operator dashboard**: live anomaly flags, intensity trends, and "what-if" tools (e.g., fuel switch, OPS uptake).
- **Audit trail**: Hash-chained event logs for all edits; role-based access; data residency in India.

6.4.13 Compliance & Incentives Linkage

- **Compliance**: DQG ≤ B and verified submissions required to maintain route permits (IWT) and priority berthing slots (cruise).
- **Incentives**:
    - OPS rebates, green tariff reductions, and concessional financing tiers tied to verified intensity improvements year-on-year.
    - Public **Leaderboards** for fair-weather vs low-draft bands (IWT) and for hoteling efficiency (cruise).

6.4.14 Interface with NGMIP

Quarterly MRV outputs (by river section, port, and cruise homeport) feed **NGMIP** to:

- Re-target OPS rollouts where cruise hoteling intensity is highest,[115]
- Prioritise dredging/river-aids where IWT intensities spike due to chronic low drafts,[116]

[115] MRV data on cruise hoteling (when ships run engines at berth for hotel loads) helps identify where onshore power supply (OPS) yields the biggest air quality and GHG benefit. International and Indian guidelines call for targeting OPS where emissions and ship time-at-berth are highest, maximizing public health and environmental returns. Regular MRV outputs enable timely adjustment to changing cruise patterns and fleet composition, making infrastructure investments more cost-effective.

[116] Maintenance and capital dredging are major expenditures driven by waterway utilization, siltation, and operational depth needs. By mapping spikes in IWT (Inland Water Transport) intensity with quarterly MRV, we

- Allocate green-fuel pilots to corridors/operators with verified readiness.[117]

6.5 Performance Assessment Framework

Purpose: Establish a structured process to identify, test, and operationalize performance assessment parameters across all seven NGSP pillars, ensuring that metrics are relevant, comparable, and actionable.

6.5.1 Institutional Responsibility

The **National Green Shipping Coordination Cell (NGSCC)** shall serve as the nodal authority to:

1. **Lead parameter identification** for each NGSP pillar — Green Ports, Green Shipping – Shipbuilding and Ship Repair, Green Ship Recycling, Green Fuels, Green Technology, Green Finance, and Green Skills & HR.
2. **Engage technical partners** (DG Shipping, MoEFCC, IWAI, BIS, BEE, State Maritime Boards, port trusts, research institutions, classification societies) for sector-specific expertise.
3. **Ensure alignment** with international frameworks (IMO, EU MRV, FuelEU Maritime) and national reporting systems.

6.5.2 Process and Timeline

Phase 1 – Scoping & Literature Review *(0–3 months after NGSCC constitution)*

- Map existing global and national performance metrics for each pillar.
- Identify data availability, instrumentation needs, and gaps.
- Draft preliminary Key Performance Indicator (KPI) lists for each pillar.

Phase 2 – Stakeholder Consultation *(Month 4–5)*

- Conduct focused workshops with operators, ports, fuel suppliers, recyclers, financiers, training institutes, and technology providers.
- Refine KPI definitions, boundaries, and normalization methods based on operational realities.

Phase 3 – Pilot Studies *(Month 6–11)*

- Select representative pilots (minimum one per pillar, including inland waterways and cruise segments where applicable).

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can prioritize dredging or navigation aids precisely during periods/sections of greatest impact, protecting investments and supporting modal shift to greener transport.

[117] Green-fuel corridors and pilots require both operator and ecosystem readiness (infrastructure, vessel compatibility, demand). MRV helps verify actual operational patterns, identifying corridors/operators where early adoption is feasible and will be used. This data-driven prioritization ensures government funding and pilots go where they will scale fastest, reduce risk, and maximize learning-by-doing.

- Implement draft KPIs using the MRV framework to test data collection, verification, and reporting feasibility.
- Assess reliability, accuracy, and cost-effectiveness.

Phase 4 – Evaluation & Revision *(Month 12–13)*

- Review pilot findings, adjust KPIs, and finalize methodology for each pillar.
- Prepare a consolidated "NGSP Performance Assessment Parameter Manual" with definitions, calculation methods, and verification protocols.

Phase 5 – Operational Rollout *(Month 14 onwards)*

- Integrate finalized KPIs into the MRV digital platform.
- Begin official scoring and public reporting cycles.
- Establish annual review and update mechanism.

6.5.3 Deliverables

- **Month 3:** Preliminary KPI Catalogue (all 7 pillars)
- **Month 5:** Stakeholder-validated KPI list with definitions
- **Month 11:** Pilot implementation report (including inland waterways & cruise adaptations)
- **Month 13:** Final KPI Manual ready for operational integration
- **Month 14+:** Performance assessment live, linked to NGMIP for policy action and incentives.

6.6 Capacity Building, Finance, and Support

Objective: Ensure that the MRV system is backed by trained personnel, adequate financing, and enabling infrastructure, so it becomes a permanent capability within the maritime sector.

Action Plan:

1. Institutional Capacity Building

- **Responsibility:** NGSCC in partnership with IMU, NTCPWC, and selected training providers.
- **Action:** Develop and deliver a "Certified MRV Officer" training programme for port authorities, vessel operators, inland waterways agencies, cruise operators, ship builders, ship repairers, ship recyclers, fuel suppliers, and technology providers.
- **Timeline:** Curriculum development in 6 months from NGSCC constitution; first training batches completed by Month 12; recurring annual certification cycles.

2. Financial Enablement

- **Responsibility:** Ministry of Ports, Shipping and Waterways (MoPSW) in collaboration with Sustainable Maritime Finance Credit Line (SMFCL).
- **Action:** Allocate targeted funding windows for:
  - Installation of real-time emissions and fuel monitoring systems.
  - Procurement of data loggers, shore power metering, and port-level monitoring equipment.
  - Deployment of MRV-compatible voyage optimisation tools.
- **Timeline:** Grant scheme design within 9 months; first disbursements in Year 2.

3. Innovation & Technology Support

- **Responsibility:** NGSCC with Startup India and innovation labs.
- **Action:** Launch a **Green MRV Grant Programme** to support:
  - Development of digital dashboards and data analytics platforms.
  - Sensor innovation for hard-to-measure pollutants and operational parameters.
  - Verification pilot projects for inland waterways and cruise vessels.
- **Timeline:** Call for proposals within 12 months; first pilots launched by Month 18.

6.7 Roadmap to 2047

Objective: Provide a phased pathway from initial MRV deployment to full traceability and performance-linked incentives across the maritime value chain.

Milestone	Action Owner	Target Year	Implementation Notes
Launch of NLP-Marine integrated MRV module	NGSCC, NIC, IWAI, Major Ports	2026	Includes initial integration of vessel, port, and fuel producer data streams.
100% MRV compliance for major ports and vessels >5000 GT	DG Shipping, Port Authorities	2028	Compliance verification tied to port entry/clearance processes.
Green MRV Certification Framework operational	NGSCC, BIS	2030	Certification covers data quality standards, verifier accreditation, and KPI definitions.
Sector-wide performance benchmarking with ESG linkage	NGSCC, SEBI, MoPSW	2035	MRV outputs linked to ESG disclosures and financing incentives.
Full digital MRV traceability across entire maritime value chain	NGSCC, MoPSW	2047	Blockchain-enabled audit trail; all NGSP pillars integrated; automatic policy feedback into NGMIP.

Review Cadence: NGSCC to conduct biennial roadmap reviews, adjusting milestones as technology, regulations, and sector readiness evolve.

Chapter 7: Enabling Innovation, Cooperation, and Future Readiness

The long-term success of India's green maritime transition hinges not only on regulatory ambition and financial preparedness, but also on sustained innovation, multi-stakeholder cooperation, and institutional future-readiness. Chapter 7 sets the policy vision and instruments for unlocking a dynamic ecosystem that fosters technological breakthroughs, nurtures public-private innovation coalitions, and embeds future-proofing into national maritime governance.

7.1 Innovation as a Driver of Maritime Transformation

India's maritime decarbonisation journey—from green fuels to circular ship recycling—requires bespoke technologies and systemic innovation. However, current maritime R&D funding is limited, fragmented, and largely public-sector driven. To address this gap, NGSP 2025 proposes a **Green Maritime Innovation Mission (GMIM)** anchored in three pillars:

- **R&D Clusters and Innovation Hubs**: Establish green maritime technology clusters in Tamil Nadu (green shipbuilding), Gujarat (circular ship recycling), and Kerala (digital shipping platforms), anchored by IMU, National Technology Centre for Ports Waterways and Coasts (NTCPWC), Cochin Shipyard, NCoEGPS and industry partners.
- **Innovation Challenge Fund**: Launch a national Green Maritime Innovation Challenge (Green MarIC) with dedicated annual funding to support:
  - Hydrogen/ammonia-compatible retrofit kits,
  - Zero-emission tug designs,
  - AI-based emission monitoring tools,
  - Ship scrapping automation prototypes.
  - Cruise Ship on renewable energy
  - Green Shipping Corridor in Inland Waterways
- **Patent Pool and Open Innovation Exchange**: Create an IPR-sharing platform for collaborative pre-commercial R&D and rapid scale-up. This exchange will be linked to the National Digital Public Infrastructure (DPI) ecosystem.

Following priority areas have been identified to accelerate maritime innovation:

Priority Area	Focus Areas
Green Vessel Technologies	R&D on hybrid-electric propulsion, dual-fuel engines, carbon capture on board, wind-assisted systems, and modular fuel-flexible ship design

Priority Area	Focus Areas
Port Electrification & Ops Efficiency	Shore power integration kits, AI-powered berth scheduling, autonomous cargo handling, energy storage for RE buffering
Digital MRV & Lifecycle Monitoring	Blockchain-based traceability, NLP-Marine-linked dashboards, digital twins for route optimisation and emissions modelling
Circular Economy Integration	Ship dismantling automation, ferrous scrap value chains, component reuse protocols, marine eco-design standards
Blue Economy Innovation	Offshore wind structures, tidal energy applications, maritime ecotourism infrastructure, clean aquaculture logistics

7.1.1. Innovation Policy Gaps and Challenges

Despite promising advances, India's maritime innovation pipeline remains fragmented and underfunded. Key gaps include:

- Low R&D intensity in the shipping sector (less than 0.1% of sectoral GDP).
- Need of standardised testing and verification infrastructure for green maritime technologies.
- Limited tech transfer mechanisms and co-development platforms between research institutions and shipyards/port operators.
- Absence of dedicated innovation finance beyond limited startup schemes.
- Siloed governance across shipping, environment, energy, and port development, leading to duplication and regulatory friction.

7.1.2. Institutional Response: Formation of Green Maritime Innovation Mission (GMIM)

To overcome these structural gaps and catalyse innovation-driven decarbonization, the NGSP 2025 mandates the formation of a Green Maritime Innovation Mission (GMIM) under MoPSW.

The GMIM will function as a dedicated innovation facilitation body, anchored within the NCoEGPS including collaboration with academic bodies like think tanks, IMUs, IITs, etc. with the following mandate:

- Develop and update a National Maritime Innovation Roadmap, aligned with decarbonization goals and industrial policy.
- Coordinate public–private innovation consortia for emerging fuel technologies, autonomous vessels, and circular ship lifecycle solutions.
- Manage competitive innovation challenge calls, field pilots, and grant support for high-risk technologies.
- Serve as India's nodal agency for international R&D collaboration on maritime sustainability (e.g., with Norway, Korea, EU, IMO, GEF).
- Maintain an interactive digital repository of green maritime patents, use cases, and standards.

This institutional mechanism will ensure continuity, co-investment, and convergence of efforts across states, research institutions, and industrial stakeholders.

Key Lessons from International Experience

Drawing from global maritime innovation strategies:

- **South Korea's "Green Ship-K" Roadmap** created a dedicated Green Ship R&D programme linked to export targets and industrial development. It institutionalised a **Green Technology Verification System (GTVS)** to certify emerging solutions.
- **Norway's Green Shipping Programme (GSP)** used public-private co-financing and open innovation calls to deploy over **50 low/zero-emission vessels** by 2024, with active participation of clusters, universities, and ports.
- **Singapore's Maritime and Port Authority (MPA)** has adopted a **sandbox-based regulatory innovation** approach to allow early piloting of smart and sustainable maritime solutions.

India's NGSP draws from these models, while adapting to the domestic innovation and infrastructure landscape.

7.1.3. Proposed Innovation Enablement Framework under NGSP

To translate these insights into action, the NGSP will operationalise a structured Green Maritime Innovation Framework consisting of:

Component	Action Areas
National Innovation Priorities Registry	Define 25–30 pre-approved R&D and tech demonstration priorities (e.g., AI-based vessel routing, electric ferry platforms, hydrogen bunkering skids)
Green Maritime Technology Verification Platform	Create a central testbed and certification system (with IRS/IMU/NTCPWC) for validation of emerging ship and port technologies
Open Innovation Sandbox	Launch an annual innovation sandbox call (linked with SMFCL financing) for field pilots in partnership with ports, shipyards, and startups
Maritime Innovation Clusters	Anchor 3–4 Green Shipping Clusters (e.g., Cochin, Goa, Chennai, Gujarat) combining R&D, training, and incubation under PPP model
Digital Twin Integration with NLP-Marine	Build NLP-linked innovation modules to simulate and test new technologies before field deployment
Innovation-linked Public Procurement Mandate	Mandate inclusion of green technology pilots in central and state port procurements above a threshold value

7.1.4. Role of Government and Stakeholders

The NGSP envisages the **Ministry of Ports, Shipping and Waterways (MoPSW)** as the lead enabler for maritime innovation, in coordination with:

- **Sagarmala Innovation Division**: for innovation funding and pilot project coordination.
- **National Centre of Excellence for Green Ports and Shipping (NCoEGPS)**: for technical review and sandbox design.
- **IITs, IMU, IRS, NTCPWC**: for R&D, simulation environments, and testing standards.
- **Private sector and startups**: for solution design, deployment, and scaling.
- **State Maritime Boards**: for local adaptation and co-investment.

7.2 Strengthening Bilateral and Multilateral Cooperation

India's NGSP aligns closely with global norms and leverages cooperation under multilateral climate and maritime mechanisms. NGSP calls for:

- **Bilateral Green Corridors**: Fast-track the formulation of at least three bilateral green shipping corridors by 2030, including:
  - India–UAE (methanol and LNG corridor),
  - India–Singapore (zero-emission container route),
  - India–Europe (green steel and clean ammonia).
- **IMO and ASEAN Engagement**: Deepen India's role in IMO's GHG strategy implementation, and ASEAN's Smart Green Ports Network through technical assistance, capacity building, and pilot projects.
- **South-South Maritime Climate Alliance**: Launch an Indo-Pacific coalition of climate-resilient maritime nations for collective action on:
  - Low-carbon infrastructure planning,
  - Capacity support for MRV and ESG frameworks,
  - Joint technology validation programs.

7.3 Digital Foundations for Future Maritime Governance

Building on NLP-Marine and the Maritime Single Window, the NGSP proposes a **Maritime Digital Innovation Stack (MDIS)** to embed transparency, traceability, and data-driven decision-making into green governance:

- **Digital Twins for Ports and Vessels**: Scale up the deployment of digital twin technology for predictive port planning, vessel routing, and infrastructure lifecycle GHG estimation.

- **ISRIS for Ship Recycling**: Deploy the Integrated Ship Recycling Information System (ISRIS) to enable traceable dismantling, material recovery analytics, and compliance benchmarking.
- **Maritime Carbon Registry**: Operationalize a unified registry, interoperable with MoEFCC's Voluntary Carbon Market framework, for tracking emission savings, offsets, and project eligibility for Article 6 transactions.

7.4 Enabling Maritime Startups and Entrepreneurial Ecosystems

India's startup ecosystem remains under-leveraged in the maritime sector. NGSP supports targeted innovation through:

- **Maritime Green Startup Accelerator** under Startup India and Invest India, with sector-specific cohorts on:
  - Clean propulsion,
  - Waste-to-energy in port zones,
  - AI for port logistics and MRV.
- **Green ShipTech Incubators** within IMU campuses, NTCPWC, and IRS—with access to model test basins, simulation tools, and ESG-integrated design sandboxes.
- **Procurement-linked Innovation (PLI-Sustain)**: Mandate innovation-linked green procurement pilots in MoPSW and public port agencies for MSME-developed technologies.

7.5 Future-Proofing Maritime Governance Systems

Sustained success requires adaptive institutions that can evolve with new risks and technologies. NGSP recommends:

- **Foresight and Scenarios Unit** within MoPSW and DG Shipping or assigned by them to:
  - Track climate risks and regulatory trends,
  - Simulate carbon pricing impacts,
  - Model technology adoption curves.
- **Maritime ESG Authority (MEA)** to anchor:
  - ESG disclosure standards,
  - Green port and vessel ratings,
  - Cross-sectoral taxonomy compliance.
- **Legislative Integration**: Future-proof the Merchant Shipping Bill and Major Ports Authorities Act by embedding clauses on:
  - Zero-emission compliance,
  - Just transition for affected workers,
  - Periodic review mechanisms (every 5 years) for NGSP objectives.

7.6 Key Policy priority Actions for future proofing

Action Area	Responsible Stakeholders	Timeline
Launch Green Maritime Innovation Mission (GMIM)	MoPSW, DST, IMU, NTCPWC, DHI	2025–26
Operationalize Digitalisation for ship recycling	MoPSW, GMB, CPCB, DGS	Pilot: 2026
Formalize bilateral green corridors	MoPSW, MEA, DEA, partner nations, all stakeholders from complete maritime eco- system	By 2030
Establish Maritime Carbon Registry	MoEFCC, MoPSW, IBBI	2026
Create Maritime ESG Authority	MoPSW, SEBI, MCA	2026–27
Set up Green ShipTech Startup Hubs	Startup India, MoPSW, IMU	2025–28

A Maritime Sector That Listens, Learns and Leads

By embedding innovation, cooperation, and anticipatory governance into its green transition, India positions itself not merely as a policy taker, but as a policy shaper. This chapter reflects a systemic shift—from compliance to capability, from isolation to integration, and from project to platform thinking.

Together with robust monitoring (Chapter 6), institutional architecture to all seven pillar strategic transition (Chapters 3–5), this final enabling chapter will ensure that India's maritime sector is not only cleaner, but also smarter, fairer, and future-ready.

Chapter 8: Conclusion – Charting India's Green Maritime Future

India's maritime sector stands at the threshold of a transformational leap—one that redefines the country's engagement with oceans not merely as trade conduits but as catalysts of climate action, technological innovation, and inclusive prosperity. The **National Green Shipping Policy (NGSP) 2025** emerges not as a standalone initiative but as a strategic convergence of decades of experience, visionary commitments, stakeholder wisdom, and global environmental obligations.

This policy is shaped by India's unique geopolitical position, resource endowments, and developmental imperatives. With over 11,098 km of coastline, 200+ ports, and handling nearly 95% of India's trade by volume, the maritime sector's decarbonization is not a peripheral agenda—it is **central to India's Net Zero by 2070 ambition**. But this decarbonization must be **just, inclusive, and innovation-driven**.

The NGSP 2025 is anchored in that vision. It offers a **whole-of-sector transformation plan**—not only for reducing emissions, but for elevating operational standards, digital readiness, social inclusion, and economic resilience.

A Systemic Policy Shift

This policy is not a prescriptive checklist. It establishes the **architecture of a green maritime state**: one that is digitally monitored, financially de-risked, and globally integrated.

- **From fragmented to unified governance**: NGSP creates a single institutional architecture to guide, regulate, finance, and measure green maritime action across ports, ships, fuels, and human resources.
- **From compliance to competitiveness**: The policy doesn't treat environmental action as a burden—but as a driver of global competitiveness, export readiness, and strategic autonomy in green fuel, shipping, and shipbuilding.
- **From follower to innovator**: With the creation of the **Green Maritime Innovation Mission (GMIM)** and Green Clusters, NGSP positions India to co-lead technology development—not just adopt it—across hydrogen shipping, AI-based port logistics, circular ship recycling, and digital MRV.

Setting the Global Standard for a Developing Maritime Power

Unlike top-down environmental regimes in developed economies, NGSP is **built for scale, equity, and replicability** across the developing world. It recognizes that green maritime sector in the Global South requires:

- Blended finance to reduce technology risk,
- Capacity building for workforce transformation,
- Clear performance signals (e.g., MRV, green certifications),
- And strategic diplomacy for global fuel access, investment, and regulatory parity.

India, through this policy, signals its readiness to lead on all these fronts—through partnerships with the **IMO**, **ASEAN**, **Africa**, and **like-minded nations** pursuing equitable and science-driven transitions.

Implementation as the Real Test

The true success of NGSP will lie in its **execution**—through annual reviews, green corridor launches, zero-emission vessel trials, and green port transformations across all maritime states. While this policy offers direction, it demands unwavering commitment—from **public agencies**, **private innovators**, **financial institutions**, and **seafarers alike**.

By 2030, this policy envisions:

- At least **25% of India's coastal shipping powered by clean fuels**,
- **All major ports achieving Tier-2 Green Certification**, and
- A **national maritime MRV dashboard** guiding real-time emissions data for all stakeholders.

Towards 2047: A Maritime Republic for the Planet

As India approaches the centenary of it's independence in **2047**, this policy serves as a compass towards building a **"Maritime Republic"**—a nation where oceans are navigated not only for trade but for **sustainability**, **technological sovereignty**, and **blue economy leadership**.

This is **not the conclusion**, but the **commissioning**—of a greener, fairer, and more resilient maritime future

Annexure – Consolidated Action Plan Table (Chapters 4–7)

This annexure consolidates all action plans outlined in Chapters 4 to 7 of the Draft National Green Shipping Policy (NGSP) 2025 into a single structured reference.

Green Ports:

Baseline year for all targets is **2021**. The **National Green Shipping Coordination Cell (NGSCC)** under the **Ministry of Ports, Shipping and Waterways (MoPSW)** will oversee implementation, with **inter-ministerial coordination** (MoEFCC, MoF, MSDE, Ministry of Tourism, State Maritime Boards, IWAI, etc.) wherever required. Annual review cycles will track progress against port-level sustainability reports and the Green Port Index.

Action Plan	Timeline	Responsible Body	Oversight
Introduce a National Green Port Certification and Indexing Framework with multi-tier benchmarks covering GHG emissions, waste recycling, renewable energy share, carbon capture infrastructure, and ecosystem impact	Short-term (2025–2026)	MoPSW, NCoEGPS, Major Port Authorities, IWAI	NGSCC under MoPSW
Mandate integration with international standards (ISO 14001, ISO 50001) and voluntary to EcoPorts and WPSP indicators for all major ports	Short-term (2025–2027)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Include a port-level Fuel Readiness Index for alternative fuels	Short-term (2025–2027)	MoPSW, Major Port Authorities, IWAI	NGSCC under MoPSW
Implement phased Onshore Power Supply (OPS) at 50% of berths by 2030, with full coverage at major ports by 2040	Medium-term (2027–2030) and Long-term (2040)	MoPSW, Major Port Authorities, DISCOMs	NGSCC under MoPSW
Enforce emission limits on cargo handling equipment, dredging operations, and vessels at berth, aligned with NAPCC, MARPOL Annex VI, and IMO GHG regulations	Short-term (2025–2027)	MoPSW, SPCBs, Major Port Authorities	NGSCC under MoPSW with MoEFCC
Develop port guidelines for low-emission dredging technologies and electric/hybrid equipment	Short-term (2025–2026)	MoPSW, NTCPWC, Major Port Authorities	NGSCC under MoPSW
Phase-in IoT- and GIS-enabled monitoring systems for emissions, air and water quality, and waste discharges	Short-term (2025–2027)	MoPSW, Major Port Authorities, SPCBs	NGSCC under MoPSW
Require periodic third-party environmental audits with summary results disclosed on Swachh Sagar Portal	Short-term (2025–2026, annual thereafter)	MoPSW, Major Port Authorities	NGSCC under MoPSW

Action Plan	Timeline	Responsible Body	Oversight
Pilot Continuous Emissions Monitoring Systems (CEMS) for ships at berth and critical port areas	Short-term (2025–2026)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Enforce green building standards for all new/upgraded port terminals (low-carbon concrete, smart HVAC, daylighting, LEDs)	Short-term (2025–2027)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Adopt eco-dredging and biodiversity-safe port design (artificial reefs, mangrove buffers, sediment control)	Short-term (2025–2027)	MoPSW, NTCPWC, Major Port Authorities	NGSCC under MoPSW
Mandate MARPOL-compliant waste reception facilities (oily waste, sewage, garbage, cargo residues)	Short-term (2025–2027)	MoPSW, Major Port Authorities, IWAI	NGSCC under MoPSW
Promote closed-loop water reuse and enforce the 5R framework in port operations	Short-term (2025–2027)	MoPSW, Major Port Authorities, IWAI	NGSCC under MoPSW
Integrate CO_2 reception facilities to store or channel captured CO_2 into domestic industrial use	Medium-term (2027–2035)	MoPSW, Major Port Authorities, IWAI, Industry partners	NGSCC under MoPSW
Require minimum 60% renewable energy share in port operations by 2030, scaling to 100% for major ports by 2047	Medium-term (2030) & Long-term (2047)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Deploy Battery Energy Storage Systems (BESS) for OPS integration and grid stability	Medium-term (2027–2030)	MoPSW, Major Port Authorities, IWAI, DISCOMs	NGSCC under MoPSW
Deploy AI-driven port optimization and digital twins for terminal planning	Short-term (2025–2027)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Implement predictive maintenance of port assets using IoT	Short-term (2025–2027)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Facilitate PPP models for OPS, bunkering, and carbon capture infrastructure	Short-term (2025–2028)	MoPSW, Major Port Authorities, Private sector	NGSCC under MoPSW
Align with IMO GreenVoyage2050, ASEAN Smart Port Network, and CEM-Hubs	Short-term (2025–2026)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Set annual GHG reduction targets per port and publish Fuel Readiness Index	Short-term (2025–2027, annual thereafter)	MoPSW, IWAI, Major Port Authorities	NGSCC under MoPSW
Establish Green Skills Training in partnership with IMU, IITs, SCGJ	Short-term (2025–2027)	MoPSW, IWAI, Training institutes	NGSCC under MoPSW
Engage coastal communities through CSR-led green livelihood programs	Short-term (2025–2027)	MoPSW, Major Port Authorities	NGSCC under MoPSW

Action Plan	Timeline	Responsible Body	Oversight
Identify/designate nuclear-ready berths or zones for nuclear-powered merchant ships	Medium-term (2027–2035)	MoPSW, Major Port Authorities, AERB	NGSCC under MoPSW
Ensure preparedness for autonomous shipping, offshore wind servicing, ocean-based carbon removal	Medium-term (2027–2035)	MoPSW, Major Port Authorities	NGSCC under MoPSW

Green Shipping

Baseline year for all vessel-related emission and operational targets is **2021**. The **National Green Shipping Coordination Cell (NGSCC)**, under **MoPSW**, will oversee implementation with **DG Shipping, Indian Register of Shipping (IRS), IWAI (for Inland Waterways), Ministry of Finance, Ministry of New & Renewable Energy (MNRE), and private shipowners/operators** in an inter-ministerial and industry-partnered framework. Annual reviews will align targets with IMO GHG Strategy milestones (2030, 2040, 2050) and India's net-zero 2070 goal.

Action Plan	Timeline	Responsible Body	Oversight
Establish a **National Green Ship Certification Framework**, aligned with EEDI, EEXI, CII, and forthcoming GFI/GFS	Short-term (2025–2026)	MoPSW, DG Shipping, IRS, IWAI, BIS/BEE	NGSCC under MoPSW
Define tiered compliance thresholds for fuel carbon intensity using the GFI/GFS model	Short-term (2025–2026)	MoPSW, DG Shipping, IRS	NGSCC under MoPSW
Integrate lifecycle GHG accounting into vessel certification (covering shipbuilding, retrofits, operations, end-of-life)	Short-term (2025–2027)	MoPSW, DG Shipping, IRS	NGSCC under MoPSW
Develop penalties for non-compliance and tariff rebates for outperformers at major ports	Short-term (2025–2026)	MoPSW, DG Shipping, Major Port Authorities	NGSCC under MoPSW
Mandate low-/zero-emission propulsion for **all new domestic vessels** from 2035 onwards	Long-term (from 2035)	MoPSW, DG Shipping, Shipbuilders	NGSCC under MoPSW
Launch a **Green Shipbuilding Strategy** incorporating embedded carbon reduction in steelmaking, materials transport, manufacturing, and outfitting	Short-term (2025–2027)	MoPSW, Shipyards, Steel Industry, BIS	NGSCC under MoPSW with inter-ministerial coordination

Action Plan	Timeline	Responsible Body	Oversight
Provide targeted incentives (VGF, tax breaks) for dual-fuel, electric, hybrid, and hydrogen-fuelled vessels	Short-term (2025–2027)	MoPSW, MoF, DG Shipping	NGSCC under MoPSW
Retrofit at least 20% of Indian-flag vessels to low-/zero-emission propulsion by 2035	Medium-term (2027–2035)	MoPSW, DG Shipping, Shipowners	NGSCC under MoPSW
Implement **Just-In-Time (JIT) arrivals** and weather routing systems for fuel efficiency	Short-term (2025–2026)	MoPSW, DG Shipping, Port Authorities	NGSCC under MoPSW
Integrate fuel consumption and voyage data into **NLP-Marine digital backbone** for real-time MRV	Short-term (2025–2027)	MoPSW, DG Shipping, NCoEGPS	NGSCC under MoPSW
Establish R&D partnerships for hydrogen, ammonia, methanol propulsion and onboard carbon capture	Short-term (2025–2028)	MoPSW, DST, Shipbuilders, Research Institutes	NGSCC under MoPSW
Create a **National Ship Design Centre** for indigenous green vessel prototypes	Short-term (2025–2027)	MoPSW, Shipyards, IITs, IMU	NGSCC under MoPSW
Transition 50% of tugs under **Green Tug Transition Programme (GTTP)** to battery-electric/hybrid by 2030	Medium-term (2027–2030)	MoPSW, Major Port Authorities	NGSCC under MoPSW
Pilot nuclear-powered merchant ship readiness framework in line with IMO–IAEA safety standards	Medium-term (2027–2035)	MoPSW, DG Shipping, AERB	NGSCC under MoPSW
Achieve 10% adoption of low-/zero-emission fuels in national fleet by 2030	Medium-term (2027–2030)	MoPSW, DG Shipping, Fuel Suppliers	NGSCC under MoPSW
Require all inland/coastal ferries procured post-2030 to be battery-electric, hybrid, or hydrogen-fuelled	Medium-term (2030 onwards)	MoPSW, IWAI, State Maritime Boards	NGSCC under MoPSW
Support pilot projects for autonomous or semi-autonomous green vessels	Short-term (2025–2028)	MoPSW, DG Shipping, Shipyards, Tech Providers	NGSCC under MoPSW
Integrate ship recycling end-of-life planning into vessel registry and certification	Short-term (2025–2026)	MoPSW, DG Shipping, GMB, IRS	NGSCC under MoPSW

Inland Waterways, Cruise Ship Tourism and Coastal Shipping

The baseline year for all actions is **2021**. Implementation will be overseen by the **National Green Shipping Coordination Cell (NGSCC)** under the **Ministry of Ports, Shipping and Waterways (MoPSW)**, with inter-ministerial coordination involving the **Ministry of Environment, Forest and Climate Change (MoEFCC)**, **Ministry of Finance (MoF)**, **Ministry of Tourism**, **State Maritime Boards**, **Inland Waterways Authority of India (IWAI)**, **Directorate General of Shipping (DG Shipping)**, and other relevant agencies. A dedicated **Cruise Tourism Green Transition Committee (CTGTC)** will guide cruise-specific implementation. Biennial roadmap reviews will track progress, using performance metrics such as **gCO_2e/tonne-km**, **gCO_2e/passenger-km**, and **port turnaround emissions**.

A. Inland & Coastal Waterways (IWAI / State Maritime Boards)

Action Plan	Timeline	Responsible Body	Oversight
Baseline assessment of emissions, waste, and energy use at all operational IWAI and coastal terminals	Short-term (2025–2027)	IWAI, State Maritime Boards, MoPSW	NGSCC under MoPSW
Pilot 3–5 fully electric ferry corridors (e.g., Kolkata–Haldia, Kochi waterways)	Short-term (2025–2027)	IWAI, State Maritime Boards, Port Authorities	NGSCC under MoPSW
Deploy OPS at 50% of high-traffic IWT terminals	Medium-term (2027–2035)	IWAI, Major Port Authorities, State Maritime Boards	NGSCC under MoPSW
Achieve 50% renewable energy share in operations at IWT/coastal terminals	Medium-term (2027–2035)	IWAI, State Maritime Boards, Major Port Authorities	NGSCC under MoPSW
100% renewable-powered and zero-emission fleet for inland/coastal terminals	Long-term (2035–2047)	IWAI, State Maritime Boards, Vessel Operators	NGSCC under MoPSW
Mandate Tier II/III or equivalent IMO emission compliance for all newbuilds operating on National Waterways	Short-to-Medium (from 2025, phased)	IWAI, DG Shipping, Shipbuilders	NGSCC under MoPSW
Set up modular repair and charging stations along National Waterways to support green ferries and tugs	Medium-term (2027–2035)	IWAI, State Maritime Boards, Port Operators	NGSCC under MoPSW
Use gCO_2e/tonne-km and gCO_2e/passenger-km as key MRV metrics; require adapted data logbooks for smaller vessels with seasonal variability	Short-term (2025–2027)	IWAI, MoPSW, DG Shipping	NGSCC under MoPSW

B. Cruise Tourism Terminals (CTGTC / Cruise-specific actions)

Action Plan	Timeline	Responsible Body	Oversight
Establish Cruise Tourism Green Transition Committee (CTGTC) under MoPSW to guide cruise terminal greening	Short-term (2025)	MoPSW, DGS, IPA, Ministry of Tourism, IWAI, NCoEGPS, State Tourism Depts, Cruise Operators	NGSCC under MoPSW
Retrofit existing cruise terminals at Mumbai, Kochi, and Goa with OPS, waste reception, and passenger flow management	Short-term (2025–2027)	Major Port Authorities, State Tourism Departments	CTGTC; NGSCC periodic review
Mandatory OPS capability at all major Indian cruise terminals	Medium-term (by 2030)	MoPSW, Major Port Authorities, Cruise Terminal Operators, DISCOMs	NGSCC under MoPSW
Require hybrid propulsion (LNG + battery, methanol-ready) for all new cruise vessels in Indian waters	Short-to-Medium (from 2028)	DG Shipping, Cruise Operators, Shipbuilders	NGSCC under MoPSW
Incentivise waste heat recovery and advanced wastewater treatment on all Indian-flagged cruise vessels	Medium-term (2027–2035)	DGS, Cruise Operators, Major Port Authorities	NGSCC under MoPSW
Adopt gCO_2e/passenger-nautical-mile as MRV metric; require real-time passenger occupancy reporting linked to emission dashboards	Short-term (2025–2027)	MoPSW, DGS, Cruise Operators, NCoEGPS	NGSCC under MoPSW
Provide Annex IV sewage reception facilities with tertiary treatment; install advanced solid waste segregation and waste-to-energy plants at cruise hubs	Short-to-Medium (2025–2035)	Major Port Authorities, Cruise Terminal Operators	CTGTC; NGSCC under MoPSW
Pilot carbon capture reception at one cruise port	Short-term (2025–2027)	MoPSW, Major Port Authority (pilot site), Industry partners	CTGTC; NGSCC periodic review
Implement paperless ticketing, digital customs/immigration processing, and AI-based passenger scheduling to cut congestion and energy use	Short-term (2025–2027)	Ministry of Tourism, Port Authorities, Customs, Immigration	CTGTC; NGSCC periodic review
Create a Fuel Readiness Index for all cruise terminals	Short-term (2025–2026)	MoPSW, Major Port Authorities, Cruise Operators	CTGTC; NGSCC under MoPSW
Fully zero-emission cruise terminals integrated with sustainable coastal tourism corridors	Long-term (2035–2047)	MoPSW, State Tourism, Port Authorities, Cruise Operators	NGSCC under MoPSW

C. Coastal Shipping

Action Plan	Timeline	Responsible Body	Oversight
Mandate 20% green fuel blending (bio-LNG, biomethanol) for all coastal vessels above 400 GT	Medium-term (by 2030)	MoPSW, DG Shipping, MoPNG, Fuel Suppliers	NGSCC under MoPSW
Develop coastal green bunkering hubs at Chennai, Kandla, Kochi, and Paradip with multi-fuel capability	Medium-term (2027–2032)	MoPSW, Major Port Authorities, Private bunkering operators	NGSCC under MoPSW
Provide cold-ironing (OPS) for RoPax and coastal passenger ferries at high-traffic ports	Medium-term (2027–2032)	Major Port Authorities, MoPSW, DISCOMs	NGSCC under MoPSW
Apply Just-in-Time (JIT) arrivals at all major ports for coastal vessels	Short-term (by 2027)	MoPSW, Port Authorities, Vessel Operators	NGSCC under MoPSW
Introduce slow-steaming incentives for voyages under 500 nautical miles	Short-term (2025–2028)	MoPSW, Shipping Associations, SMFCL	NGSCC under MoPSW
Track cargo emission intensity (gCO_2e/tonne-nm) and port turnaround emissions for frequent-calling coastal vessels	Short-term (2025–2027)	MoPSW, DG Shipping, NCoEGPS	NGSCC under MoPSW
Pilot wind-assisted propulsion on short-sea coastal bulk carriers	Medium-term (2027–2035)	MoPSW, Shipbuilders, Shipowners	NGSCC under MoPSW
Certify National Gateway Terminals (top 8 ports) as ammonia-ready with full safety/emergency systems	Medium-to-Long (by 2036)	MoPSW, Major Port Authorities, DGS, MoPNG	NGSCC under MoPSW

Sustainable Ship Recycling

Baseline year for all actions is **2021**. Implementation will be overseen by the **National Green Shipping Coordination Cell (NGSCC)** under the **Ministry of Ports, Shipping and Waterways (MoPSW)** in coordination with the **Gujarat Maritime Board (GMB) (and other state maritime board wherever applicable)**, **Directorate General of Shipping (DG Shipping)**, **Ministry of Environment, Forest and Climate Change (MoEFCC)**, and other relevant ministries. All actions align with the **Recycling of Ships Act, 2019**, the **Hong Kong International Convention (HKC)** (in force from 26 June 2025), and the **EU Ship Recycling Regulation (EUSRR)**.

Action Plan	Timeline	Responsible Body	Oversight
Upgrade all Indian ship recycling facilities to be **fully HKC-compliant** with certified infrastructure, trained workforce, and documented environmental safeguards	Short-term (2025–2027)	GMB/SMBs, MoPSW, DG Shipping, Ship Recycling Yard Owners	NGSCC under MoPSW
Achieve **100% Inventory of Hazardous Materials (IHM)** compliance for all ships recycled in India	Short-term (2025–2027)	DG Shipping, GMB/SMBs, IRS	NGSCC under MoPSW
Establish a **Green Ship Recycling Park** at Alang with centralised hazardous waste management, stormwater control, and shared decontamination facilities	Medium-term (2027–2035)	GMB/SMBs, MoPSW, State Pollution Control Board (SPCB), Industry partners	NGSCC under MoPSW
Create a **National Ship Recycling Database** integrated into the NLP-Marine platform for real-time reporting of recycling activity, IHM data, and end-of-life material recovery rates	Short-term (2025–2027)	MoPSW, DG Shipping, GMB/SMBs, NCoEGPS	NGSCC under MoPSW
Develop an **End-of-Life Ship Circular Economy Roadmap** to maximise steel and non-ferrous metal recovery, promote material reuse, and link to the domestic manufacturing sector	Short-term (2025–2027)	MoPSW, MoEFCC, GMB/SMBs, Ministry of Steel, Ship Recycling Industry	NGSCC under MoPSW
Mandate **carbon accounting** for ship recycling yards, including embedded carbon in recovered steel	Medium-term (2027–2030)	MoPSW, GMB/SMBs, MoEFCC, Industry	NGSCC under MoPSW
Provide targeted **financial incentives** (credit lines, tax rebates) for yards adopting dry-dock or pier-side dismantling and advanced containment systems	Short-term (2025–2028)	MoPSW, MoF, GMB	NGSCC under MoPSW
Establish a **National Training & Certification Scheme** for green ship recycling workers covering occupational health, hazardous waste handling, and emergency response	Short-term (2025–2026)	MoPSW, GMB/SMBs, IMU, Skill Council for Green Jobs (SCGJ)	NGSCC under MoPSW
Develop **bilateral agreements** with ship-owning nations to channel end-of-life vessels to certified Indian yards under transparent green contracts	Short-term (2025–2027)	MoPSW, MEA, GMB	NGSCC under MoPSW
Integrate **third-party environmental auditing** into recycling yard certification, with public disclosure of compliance status	Short-term (2025–2026, annual thereafter)	MoPSW, GMB/SMBs, Accredited Auditors	NGSCC under MoPSW
Pilot **digital twin monitoring** for high-volume yards to track dismantling progress, emissions, and waste streams in real time	Medium-term (2027–2030)	MoPSW, GMB/SMBs, Tech Providers	NGSCC under MoPSW
Establish a **centralised hazardous waste treatment and disposal facility** at Alang	Medium-term (2027–2035)	GMB/SMBs, MoPSW, SPCB	NGSCC under MoPSW

Action Plan	Timeline	Responsible Body	Oversight
for asbestos, PCBs, and heavy metal residues			
Achieve **zero wastewater discharge** from ship recycling facilities through advanced effluent treatment	Long-term (2035–2047)	GMB/SMBs, MoPSW, SPCB, Industry	NGSCC under MoPSW
Mandate **minimum material recovery rates** (target: 98% by mass for steel) for all recycled ships	Medium-term (2027–2035)	MoPSW, GMB/SMBs, MoEFCC	NGSCC under MoPSW
Align with **global best practices** for worker safety, environmental protection, and automation in dismantling	Short-term (2025–2027)	MoPSW, GMB/SMBs, DG Shipping	NGSCC under MoPSW
Facilitate **technology transfer partnerships** for mechanised cutting, remote-operated cranes, and AI-based hazard detection	Medium-term (2027–2035)	MoPSW, GMB/SMBs, Industry partners	NGSCC under MoPSW

Green Skill Development and Capacity Building

Baseline year for skill development targets is **2021**. Implementation will be overseen by the **National Green Shipping Coordination Cell (NGSCC)** under **MoPSW**, in coordination with the **Skill Council for Green Jobs (SCGJ)**, **Indian Maritime University (IMU)**, **Maritime Training Institutes (MTIs)**, **Directorate General of Shipping (DG Shipping)**, **National Skill Development Corporation (NSDC)**, and other academic, industry, and research partners. The programme aims to align with India's **National Education Policy 2020**, **Skill India Mission**, and **Harit Sagar Guidelines**, ensuring a skilled workforce for the transition to net-zero by 2070.

Action Plan	Timeline	Responsible Body	Oversight
Establish a **National Green Maritime Skill Development Framework** integrating IMO model courses, domestic regulations, and emerging green technology skills	Short-term (2025–2027)	MoPSW, SCGJ, IMU, DG Shipping	NGSCC under MoPSW
Develop a **Green Skills Competency Catalogue** for ports, shipping, shipbuilding, recycling, and fuel sectors	Short-term (2025–2026)	MoPSW, SCGJ, IMU, Industry Partners	NGSCC under MoPSW
Mandate **green operations training** as part of certification for seafarers, port operators, and ship recycling workers	Short-term (2025–2027)	DG Shipping, MTIs, GMB, SCGJ	NGSCC under MoPSW
Set up **five regional Green Maritime Training Hubs** (East, West, South, North, Inland) to deliver specialised training	Medium-term (2027–2035)	MoPSW, IMU, State Maritime Boards, Industry	NGSCC under MoPSW
Incorporate **low-/zero-emission vessel operations** into DGS STCW refresher courses	Short-term (2025–2026)	DG Shipping, MTIs, IMU	NGSCC under MoPSW
Create a **national certification scheme** for Green Port and Green Vessel Auditors	Short-term (2025–2027)	MoPSW, DG Shipping, BIS, BEE	NGSCC under MoPSW

Action Plan	Timeline	Responsible Body	Oversight
Provide **specialised training on MRV systems** for port, shipping, and IWAI staff	Short-term (2025–2026)	MoPSW, NCoEGPS, IWAI, Port Authorities	NGSCC under MoPSW
Launch **Green Maritime Awareness Campaigns** targeting industry, academia, and communities in port cities	Short-term (2025–2027)	MoPSW, MoT, Industry Associations	NGSCC under MoPSW
Partner with universities, IITs, and research institutes for **R&D-linked skill programmes** in hydrogen, ammonia, methanol, electrification, and AI/digital twins	Short-term (2025–2028)	MoPSW, DST, IMU, IITs	NGSCC under MoPSW
Offer **upskilling grants** for seafarers transitioning from conventional to green fuel operations	Short-term (2025–2027)	MoPSW, MoF, DG Shipping	NGSCC under MoPSW
Integrate **waste management and circular economy modules** into port and ship recycling training	Short-term (2025–2026)	MoPSW, GMB, IMU, SCGJ	NGSCC under MoPSW
Develop a **Green Skills Digital Platform** for course access, tracking, and certification verification	Medium-term (2027–2030)	MoPSW, NSDC, NCoEGPS	NGSCC under MoPSW
Establish a **Women in Green Maritime Programme** to promote gender diversity in green jobs	Short-term (2025–2027)	MoPSW, MoWCD, IMU, Industry	NGSCC under MoPSW
Integrate **sustainability metrics** into maritime curriculum accreditation criteria	Medium-term (2027–2035)	MoPSW, AICTE, IMU, UGC	NGSCC under MoPSW
Implement **mandatory annual green skills refresher training** for all port and shipping staff	Medium-term (2027–2035)	MoPSW, Port Authorities, Shipping Companies	NGSCC under MoPSW
Develop **training simulators** for hydrogen, ammonia, and methanol vessel operations	Medium-term (2027–2035)	MoPSW, DG Shipping, Shipyards, Tech Providers	NGSCC under MoPSW
Achieve **100% green skills compliance** for all maritime sector jobs by 2047	Long-term (2035–2047)	MoPSW, All Maritime Stakeholders	NGSCC under MoPSW