Green Technology-Implementation Roadmap

Document control

Revision history

Revision No.	Date	Revision
1.0	xx	First Draft

List of Abbreviations

Abbreviation	Full Form
BRSR	Business Responsibility and Sustainability Reporting
CCS	Carbon Capture and Sequestration
CII	Carbon Intensity Indicator
DCS	Data Collection System (IMO)
DG Shipping	Directorate General of Shipping
EEDI	Energy Efficiency Design Index
EU ETS	European Union Emissions Trading System
IMO	International Maritime Organization
MARPOL	International Convention for the Prevention of Pollution from Ships
MEA	Ministry of External Affairs
MNRE	Ministry of New and Renewable Energy
MoF	Ministry of Finance
MoPSW	Ministry of Ports, Shipping and Waterways
NGSP	National Green Shipping Policy
NLP-Marine	National Logistics Portal – Marine
OEMs	Original Equipment Manufacturers
OPS	Onshore Power Supply

Contents

1 Introduction

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

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

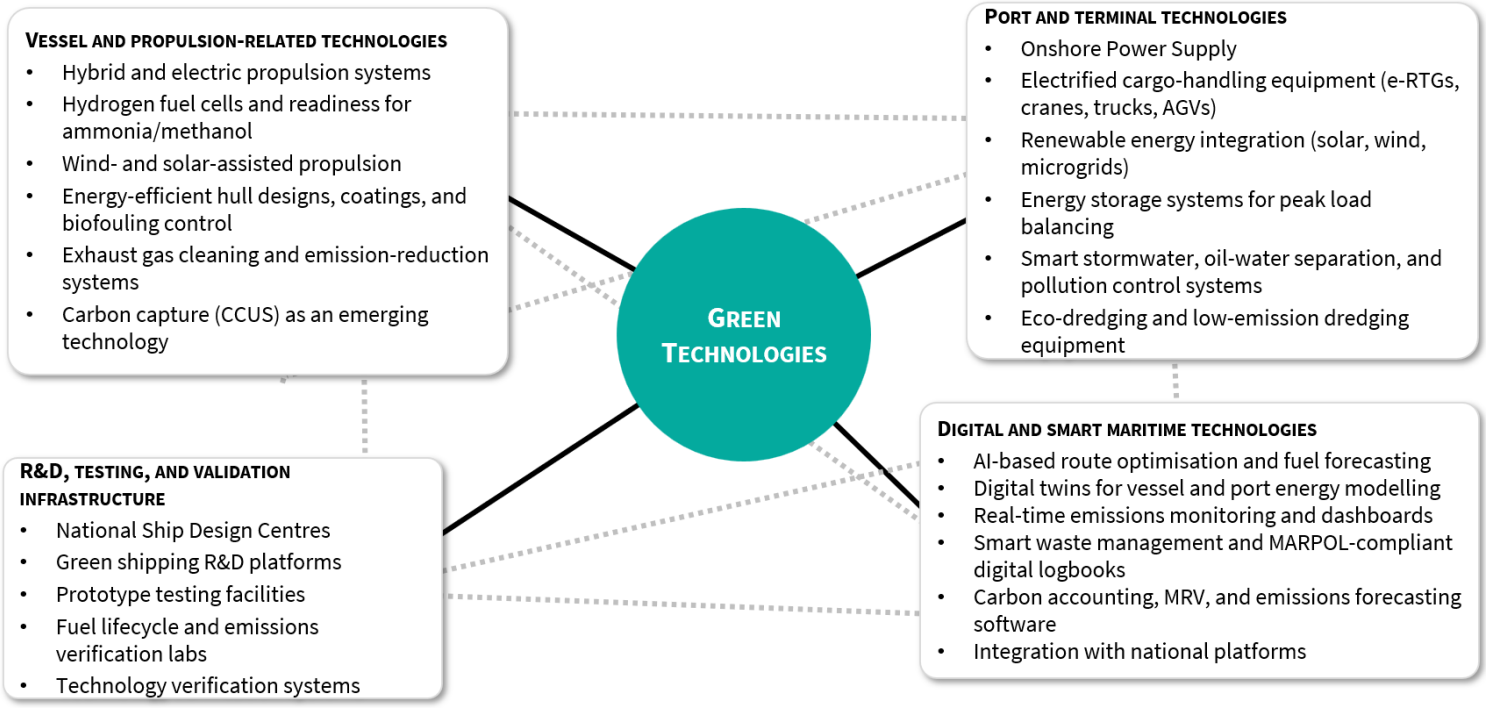
To maximize the impact of green technologies, seamless integration with existing vessel systems is crucial. By fostering collaboration between shipyards, operators, and technology providers, the maritime sector can create a robust ecosystem that accelerates the adoption of cutting-edge green solutions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

The main intent of the Green Technology pillar under NGSP is:

- Drive **technology adoption, localisation, and scaling**
- Reduce emissions through **efficiency, electrification, digitalisation, and automation**
- Create **domestic manufacturing and R&D capability** aligned with Make in India and Atmanirbhar Bharat, focused on energy-saving devices and emission reduction solutions.

1.1 Green Technologies Across the Maritime Value Chain

This framework illustrates how green technologies under NGSP span vessels, ports, digital systems, and enabling R&D infrastructure, collectively driving decarbonisation, efficiency, and global competitiveness across India's maritime value chain.



1.2 Key Opportunities

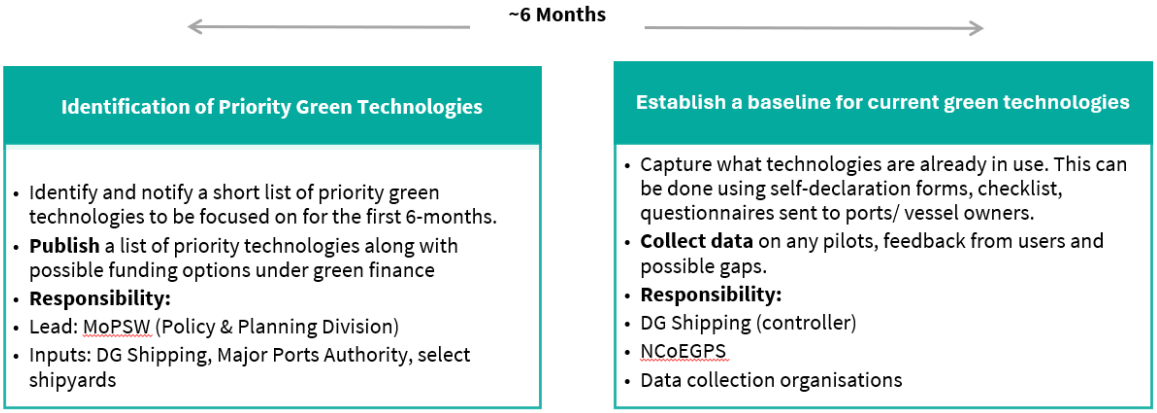
The table below outlines key solutions and opportunities for green technology.

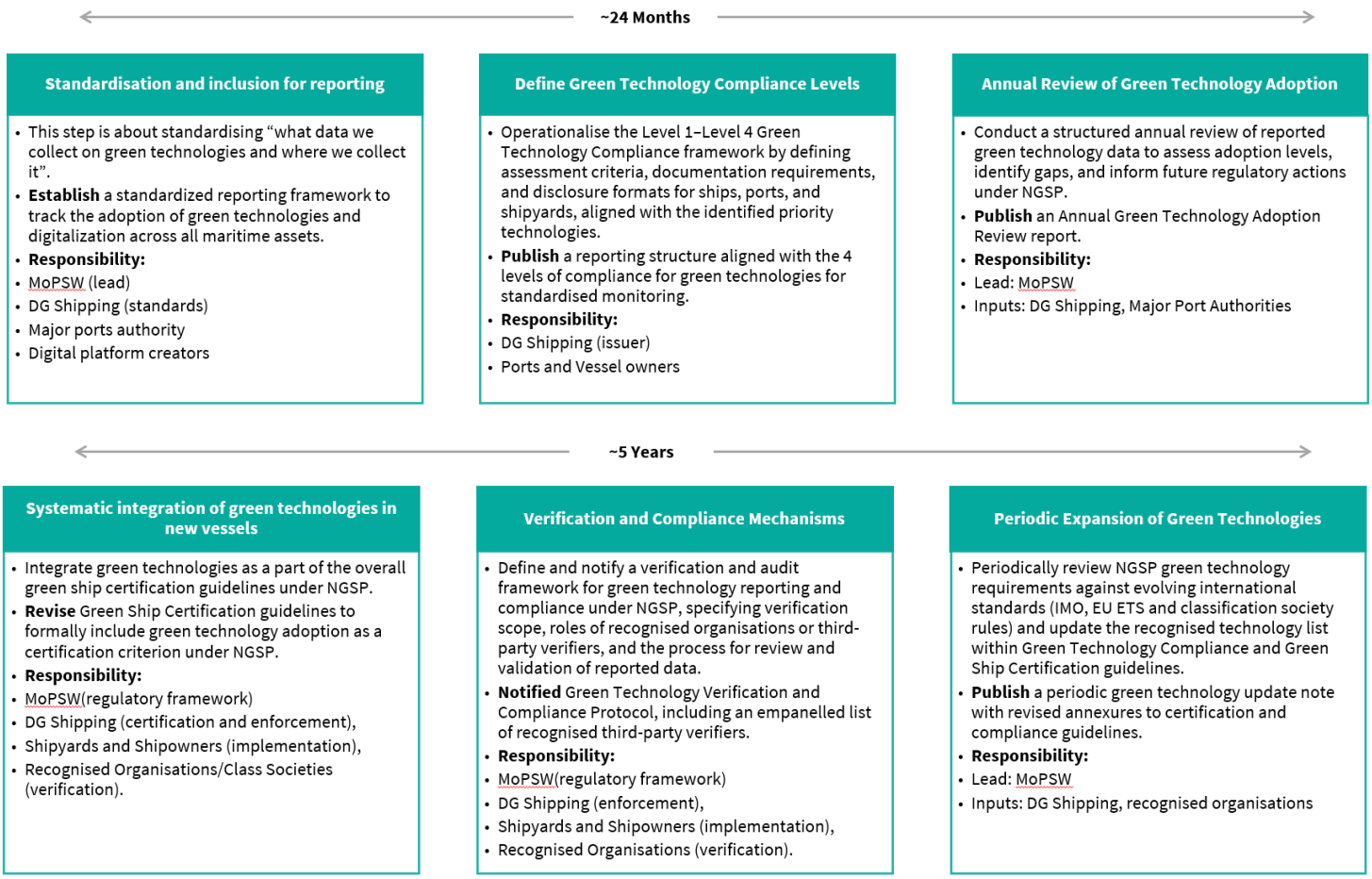
Solutions	Key Opportunities
Access to Technology for Refit & New Builds	India's engine suppliers have the capability to support refits and new builds, but leveraging European expertise can accelerate progress.
Improved Technology Knowhow & Service Availability	Global engine manufacturers (Wartsila, MAN,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

2 Indicative Action Pathway

The NGSP defines a phased, outcome-oriented pathway for the adoption and integration of green technologies across the maritime sector, aligned with India's decarbonisation goals and international standards.

Below is a representation of the actions summarized as high level outcomes:





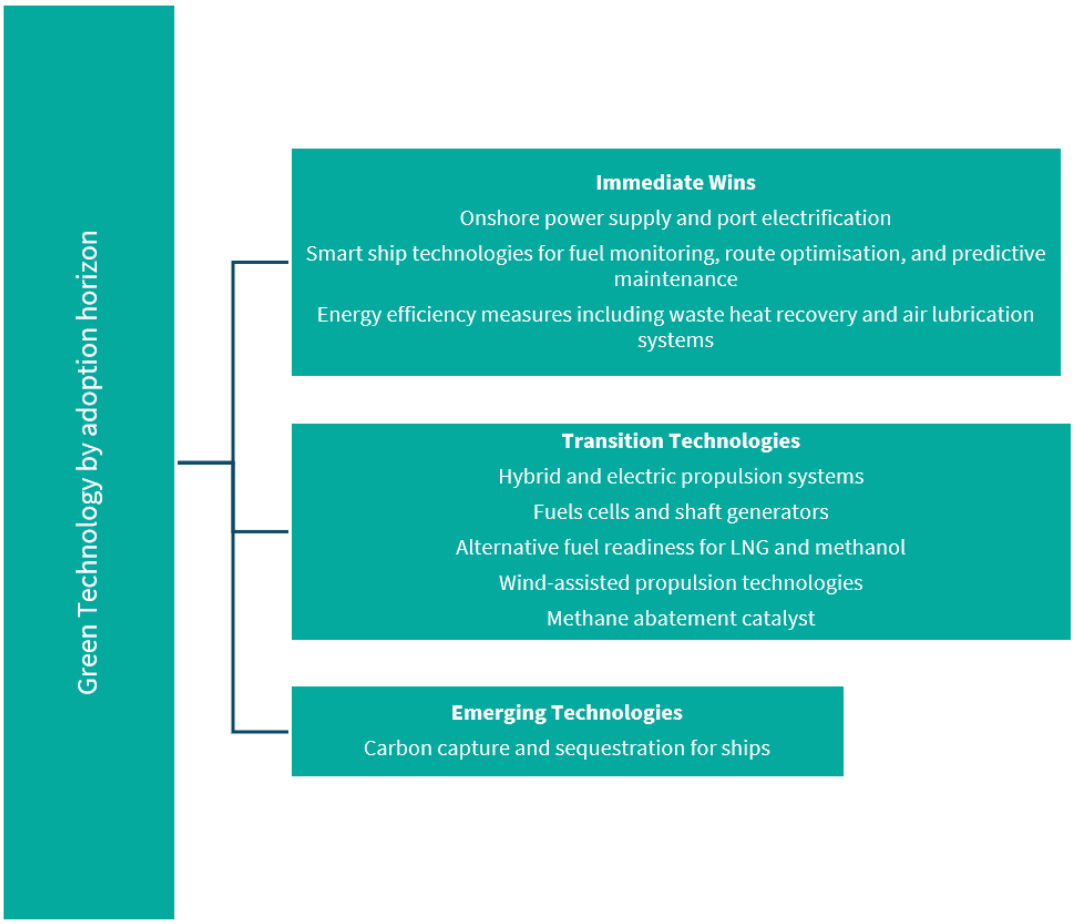
1.1 Short-term Action Plan (0-6 Months)

The short-term focus under the Green Technology pillar is to create clarity and establish a factual baseline, without introducing new mandates or compliance requirements. This phase aims to identify priority green technologies and assess their current level of adoption across the Indian maritime sector to inform subsequent phases of implementation.

A. **Identification of Priority Green Technologies under NGSP:** As an immediate first step, NGSP implementation should focus on identifying a limited set of priority green technologies that are already visible in the Indian maritime ecosystem

Suggestive list:**:**

1. Hybrid and Electric Propulsion Systems –such as marine batteries and electric motors for coastal and inland vessels
2. Alternative Fuel Readiness Technologies – tank and fuel handling systems for LNG and methanol
3. Onshore Power Supply (OPS) and Port Electrification –electrified cargo handling equipment
4. Emission Reduction Technologies – wind-assisted propulsion, air lubrication systems, waste heat recovery
5. Smart Ship Technologies – fuel monitoring systems, route optimisation, predictive maintenance software



B. **Establish a baseline for current green technologies**, capture what technologies are already in use. This can be done using self-declaration forms, checklist, questionnaires sent to ports/ vessel owners. This will give a realistic picture of what already exists from the identified technologies. Collect data on any pilots, feedback from users and possible gaps. The aim should be that the baseline report shall capture both technology presence and estimated fuel/emissions impact, linked to IMO DCS or equivalent fuel consumption datasets where feasible.

1.2 Medium-term Action Plan (Upto 2 Years)

The medium-term focus is to move from identification to standardisation by establishing common reporting structures, compliance references, and review mechanisms for green technologies. This phase enables consistent data capture, comparability, and informed decision-making, while preparing the sector for future regulatory actions under NGSP.

A. Using the short-term baseline, **notify a standard green technology classification and reporting framework** for the identified priority technologies and integrate it with existing systems such as IMO DCS, BRSR Core, and NLP-Marine, ensuring uniform data capture across ships, ports, and shipyards. Technology classification should align with recognized international efficiency and emissions-reduction categories to ensure global comparability and avoid divergence from IMO frameworks

B. Create a common, usable **compliance reference** across ships, ports, and shipyards. Define and apply the Level 1–Level 4 Green Technology Compliance Levels by specifying assessment and disclosure requirements for priority green technologies. Level 1 to 4 are:

- Level 1: Basic compliance with minimal green technology adoption, achieving low emissions reduction

- Level 2: Adoption of low-carbon technologies leading to moderate emissions reduction through technology-driven optimisations
- Level 3: Integration of advanced green technologies and digital solutions, resulting in significant emissions reduction
- Level 4: Adoption of deep decarbonisation technologies across the value chain, achieving near net-zero emissions

C. Establish a structured **annual review mechanism** to analyse reported green technology data, identify adoption trends, implementation gaps, and technology-specific challenges, and feed these insights into future regulatory and policy decisions.

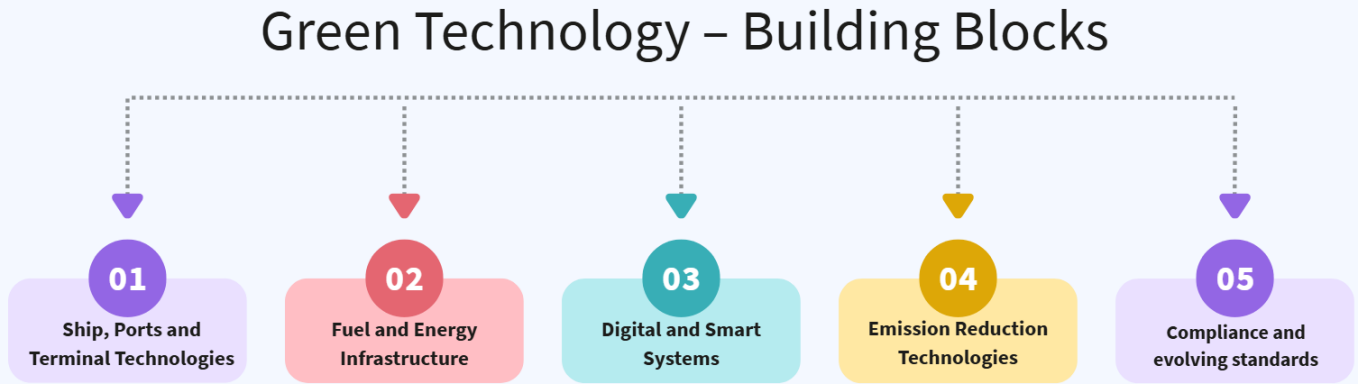
1.3 Long-term Action Plan (Upto 5 Years)

The long-term focus is on transitioning from voluntary frameworks to mandatory compliance, supported by robust verification and international alignment. This phase embeds green technologies into certification and regulatory systems to ensure sustained decarbonisation and global acceptability of India's maritime sector.

A. Implement mandatory Green Ship Certification for all new merchant ships built from the specified cut-off year, aligned with EEDI, CII, alternative fuel compatibility, MARPOL Annex VI, and **green technology compliance levels**.

B. Periodically review NGSP green technology requirements **against evolving international standards** (IMO, EU ETS, FuelEU and classification society rules) and regional schemes to update the recognised technology list within Green Technology Compliance and Green Ship Certification guidelines.

To summarize, the building blocks for the Green technology pillar implementation are as indicated in the diagram below:



3 Responsibility Mapping

The following section outlines the key stakeholders responsible for planning, implementation, reporting, and verification of green technologies under the NGSP, ensuring clear accountability across the policy lifecycle.

Stakeholder	Role under Green Technology Pillar (NGSP)
MoPSW	Overall policy owner; defines implementation pathways, notifies green technology frameworks and guidelines, coordinates across agencies, and ensures alignment with NGSP objectives and international developments.

DG Shipping	Technical authority for ships; defines technical criteria, integrates green technologies into certification and compliance frameworks, oversees reporting, verification, and enforcement for Indian-flagged vessels.
Major Port Authorities	Responsible for implementation and reporting of port and terminal-related green technologies, application of compliance frameworks, and facilitation of verification at port level.
Shipowners and Operators	Adopt, operate, and disclose green technologies onboard vessels; participate in baseline assessments, reporting, certification, and verification processes.
Shipyards	Integrate green technologies into new builds and retrofits in accordance with Green Ship Certification and notified green technology requirements.
Recognised Organisations / Classification Societies	Provide technical expertise, support certification processes, and conduct verification and compliance assessments in line with notified protocols and international standards.
Third-Party Verifiers / Auditors	Carry out independent verification and audits of green technology disclosures to ensure accuracy, consistency, and prevention of greenwashing.
NLP-Marine / National Maritime Digital Platforms	Enable digital capture, integration, and management of green technology data through existing maritime digital systems.

Additional stakeholders include:

- Ministry of Finance (MoF) – financing, incentives, budgetary alignment
- NITI Aayog – strategic alignment, inter-ministerial coordination
- Ministry of External Affairs (MEA) – international cooperation and alignment
- Ministry of Power / MNRE – electrification and renewable energy linkages
- Industry Associations – consultation and feedback
- Technology Providers / OEMs – supply-side actors

4 Critical Barriers

Blow are the barriers to green technology implementation in the short and long term horizons:

1- Participation in green technology adoption remains uneven across the maritime sector, with a limited number of shipowners, ports, and operators taking early action while many others adopt a wait-and-see approach in the absence of immediate requirements.

2- Decision-making on green technology investments is often delayed due to uncertainty around technology maturity, interoperability, and the pace at which international regulations and standards may evolve.

3- Learning from international experience is largely ad hoc, with limited structured mechanisms to systematically adapt proven approaches and technologies from leading maritime nations to Indian operating and climatic conditions.

4- Green technology initiatives are being pursued in a fragmented manner across ships, ports, and shipyards, resulting in limited coordination, duplication of effort, and missed opportunities for integrated planning.

5- Operational familiarity with newer green technologies is still developing, with gaps in skills, experience, and confidence affecting deployment, operation, and maintenance by ship operators and port authorities.

6- Feedback from existing deployments and early initiatives is not consistently captured or shared across the sector, limiting collective learning and slowing refinement of policy and implementation approaches.

5 Conclusion

The Green Technology pillar under the National Green Shipping Policy provides a structured and phased pathway to support India's maritime decarbonisation objectives through targeted adoption, standardisation, and integration of green technologies. By focusing initially on clarity and baseline assessment, progressing towards common reporting and compliance frameworks, and ultimately embedding green technologies into certification, verification, and internationally aligned regulatory systems, the NGSP enables a pragmatic and scalable transition. This approach balances ambition with realism, supports informed decision-making, and positions India's maritime sector to remain competitive, credible, and aligned with evolving global sustainability expectations. This pathway is expected to progressively reduce the emissions intensity of India's maritime sector while improving fuel efficiency and long-term operational resilience.