Green Ports - Implementation Roadmap

Document Control

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1.0	04.02.2026	First Draft

List of Abbreviations

Abbreviation	Full Form
ADB	Asian Development Bank
BIS	Bureau of Indian Standards
CAPEX	Capital Expenditure
CII	Carbon Intensity Indicator
CO_2	Carbon Dioxide
CPCB	Central Pollution Control Board
DISCOMs	Distribution Companies (Power Utilities)
EIA	Environmental Impact Assessment
EMS	Energy Management Systems
GHG	Greenhouse Gas
GPPI	Green Port Performance Index
IMU	Indian Maritime University
IRS	Indian Register of Shipping
JIT	Just-In-Time
MoEFCC	Ministry of Environment, Forest and Climate Change
MoPSW	Ministry of Ports, Shipping and Waterways
MRV	Monitoring, Reporting and Verification
NCoEGPS	National Centre of Excellence for Green Ports & Shipping
NGSP	National Green Shipping Policy
OPEX	Operational Expenditure
OPS	Onshore Power Supply (Shore Power / Cold Ironing)
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
REC	Renewable Energy Certificate
SPCBs	State Pollution Control Boards
VGF	Viability Gap Funding

Contents

1. INTRODUCTION

India's ports form an essential backbone of the national economy and the maritime transport system, underpinning about 95 per cent of the country's trade by volume and almost 68 per cent by value. Backed by a coastline covering more than 7,500 kilometres, the country's port system includes **12 major ports in addition to over 200 non-major ports**, enabling international trade and coastal shipping while supporting inland waterways transport and port-based industrialisation.

Ports are not only gateways for freights, but they are also important logistics and industry hubs that integrate sea transport with rail, road, and inland waterways, and therefore are at the core of supply chain efficiency and competitive advantage. Port operations are becoming increasingly energy-intensive as India's trade volumes increase and the port infrastructure increases its capability while it makes room for large ships and throughput. Cargo handling, vessel berthing, port craft operations, building services, and auxiliary infrastructure all contribute to greenhouse gas emissions, local air pollution, noise and pressure on coastal and marine ecosystems. The impacts are mostly concentrated in and around port regions, which are typically situated neighbouring major urban centres and ecologically sensitive coastal areas

In consequence, **improving the environmental performance of ports** has risen from being a peripheral concern into central necessity for sustainable maritime growth and social acceptance and long-term operational resilience. National climate commitments set out in India, including its goal of becoming **net zero emissions by 2070** and its interim goals based on the Paris Agreement provide an opportunity to implement sector-level strategies that link macro-level targets with real-world action by the sector. With their long use lifetimes of assets, high energy consumption and prominent position in maritime logistics, ports constitute one of the most viable interfaces for promoting sustainable environmental reductions within the maritime industry.

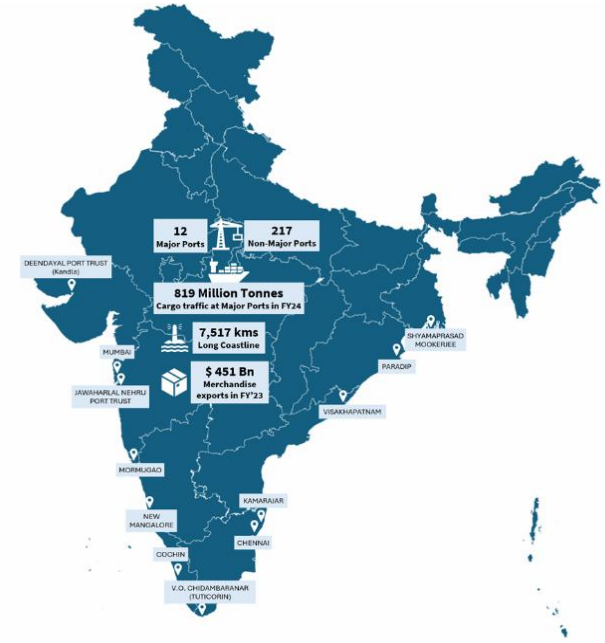


Figure 1 Ports of India

Therefore, responding to emissions and environmental impacts at ports not only **helps national targets for climate** but also contributes to **improved air quality, resource management efficiency and the resilience of the local coastline's infrastructure**.

2. GREEN PORTS IN INDIA

Green ports occupy a crucial facilitating position in India's green shipping and maritime decarbonisation trajectory. Ports therefore can impact emissions outcomes along multiple pathways across maritime value chains, as a set of fixed infrastructure nodes that interact face to face with vessels, fuels, energy systems and logistics infrastructure, directly from the port to ships, fuel sector with the fuel system to logistics network. Because of this, green ports are not just concerned with their own operational footprint, but they also provide the conditions for **cleaner shipping and sustainable maritime operations**.

By Indian policy framework green ports would aim to make the practice of environmentally sustainable operations systematic, infrastructural and governing. Common key areas include emissions reduction of port-controlled assets through electrification and energy optimisation, renewable generation of energy as part of port power solutions,

shore-to-ship power systems to minimise ship emissions on board ships, and environmental monitoring and management systems.

Simultaneously, ports are also believed to play a pivotal role in facilitating the switch to **alternative and low carbon fuels**, *providing storage, handling and bunkering infrastructure* and holding all these facilities to a high standard of safety and environmental sustainability. Ports also grow to be even more critical determinants of shipping emissions performance. Port infrastructure and services including effective berth allocation, reduced hold-up times, arrival through ports just-in-time system and shore power directly impact vessel fuel consumption and adherence to global indicators like the Carbon Intensity Indicator (CII). Green ports in this space serve as **systemic enablers** that help ship operators fulfil regulatory requirements and operating efficiency requirements while also helping with broader decarbonisation results.

The National Green Shipping Policy recognises green ports as an essential component of India's maritime transition, supported by complementary instruments such as the **Harit Sagar Green Port Guidelines** (which gives guidance on implementation) and the **Green Port Performance Index (GPPI),** which provides a systematic framework for measurement and benchmarking of environmental performance.

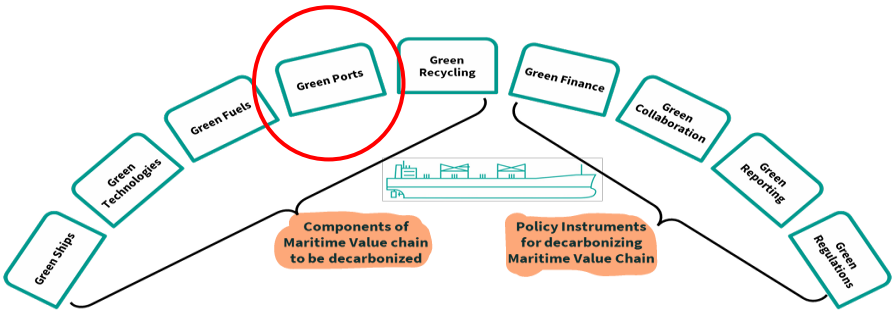


Figure 2 Core areas of NGSP

Together, these instruments create a coherent architecture that connects policy objectives to the **phased implementation and performance-based governance**. By implementing green port practice on an incremental basis with an emphasis on readiness to go green and pilot schemes to widespread and institutionalised application of this approach, Indian ports may become the anchors of port-led decarbonisation.

While the green ports have the capacity to act as systemic enablers of cleaner shipping and maritime decarbonization, translating this role into practice is constrained by a set of regulatory, infrastructure, technological, financial and coordination challenges. Understanding these constraints is essential for designing phased, targeted interventions that unlock effective and scalable implementation.

The following highlights they key barriers that must be addressed to enable green ports to deliver sustained environmental and operational outcomes

Figure 3 Green Shipping Challenge

3. KEY PILLARS OF GREEN PORT

Energy and Emissions

Energy consumption and reduction of emissions is the foundation of Green Port building because ports, located in dense hotspots for electricity, fuel use and GHG, the main sources of power/fuel usage along with GHG emission are highly concentrated ports. Emissions are generated by ships at berth, cargo handling apparatus, vehicles and auxiliary power facilities, and ports are important places for intervention to promote decarbonisation.

Green Ports focus on renewable energy uptake and electrification of port equipment, shore power installation and energy-saving measures to mitigate both direct and indirect CO2 emissions. These interventions are consistent with national climate targets and are also associated with enduring cost efficiencies and operational sustainability

Water and Waste Management

Successful water and waste management is a basic component of Green Ports, addressing effluents, ballast water, stormwater runoff and solid and hazardous waste left after port and shipping operations. Dysregulation of these streams may have the potential to damage marine ecosystems and erode the confidence of port communities, in the ports and marine pollution and pollution remediation by the port community.

Waste in Green Ports is governed along integrated water stewardship principles and circular waste management mechanisms promoting the reduction, reuse, recycling, and safe disposal. Such practices promote environmental protection and enhance regulatory compliance and operational efficiency.

Biodiversity and Ecosystem Protection

Ports are frequently situated in natural coastal zones, where human activities and construction can disrupt habitats, fisheries, and natural coastal systems. Loss and degradation of biodiversity, which is not only environmentally vulnerable but also leads to potential future operational and regulatory risk for ports

Green Ports includes biodiversity into planning and management and habitat restoration-oriented nature-based environmental solutions-based environment monitoring. This framework integrates port development with long-term challenges for environmental resilience and climate adaptation.

Digitalisation and Operational Efficiency

Digitalisation is a major enabler of Green Ports which helps them to monitor port operations in real time with performance optimization supported by data-driven decision making. Digital tools help ports monitor energy consumption, emissions, shipments flow, environmental impact more efficiently. It increases transparency and the efficiency of production thereby fulfilling the environmental sustainability and competitive goals, strengthening the connection of the two.

Stakeholder Engagement and Governance

Development of Green Port is supported by robust governance mechanisms and the proactive participation of stakeholders, port authorities, terminal operators, shipping lines, regulators, communities, and financiers. Good stakeholder participation will facilitate objectives alignment, transparency and shared ownership over sustainability results. Strong governance also enables ports to align sustainability with strategic planning, investment decision-making, and performance management thereby enhancing the likelihood of sustainability beyond projects or leadership cycles

4. KEY FOCUS AREA FOR IMPLEMENTATION

The Green Port Guidelines of the **Harit Sagar** target the sustainable development of the port ecosystem where national Green Port performance standards have been defined. These priorities center around **minimising the emissions** associated with port activity by electrifying plant equipment and vehicles, increasing the use of renewable energy, shore-to-ship power supply to reduce vessel emissions at berth, and transitioning port crafts to cleaner propulsion systems aligned with national energy targets. Collectively, these interventions aim to reduce the carbon intensity of port activities, while promoting energy efficiency, operational reliability, and environmental performance.

Aside from driving emissions reduction, the Guidelines focus very much on **resource and environmental efficiency** improving water and wastewater management, waste handling and recycling, protection of marine and coastal ecosystems, and green cover among port areas to create biodiversity and to operate as natural carbon sink mechanisms. The main focus areas include an emphasis on energy-efficient buildings, digital optimisation of port operations, promotion of coastal shipping as a low carbon transport mode, and good management of the environment with clear performance indicators, audits, and incentive structures

Collectively, these focus areas provide a comprehensive and flexible framework for ports to adopt best practices, resilient designs, and continuous performance improvement in line with national and global sustainability objectives.

The solutions and opportunity areas contained in this table are drawn upon and aligned with the possible solutions and Key opportunities outlined in the NGSP consultative framework

Solutions	Key Opportunities
Green Corridors	• Requires coordinated efforts among governments, industry bodies, and international partners. • India can leverage its bilateral and multilateral relationships to formalize Green Corridors
Just-In-Time Arrival and Port Efficiency	• Standardization of digital solutions and harmonization of port systems will enable seamless operations • Optimizing port design and berthing schedules can reduce congestion and emissions • Digitalization of port operations and intelligent scheduling can improve turnaround times • Linking port efficiency with CII compliance can drive sustainable practices. • National strategy for JIT implementation can ensure uniformity across ports
Shore Power (Cold Ironing)	• Variations in power tariffs and tax structures across states pose challenges • India's lower shore power costs compared to Western markets offer an opportunity • A centralized policy, similar to the EV Charging Policy, can standardize shore power infrastructure • PPPs can support the integration of solar energy and carbon sinks into port infrastructure.
Greener Dredgers & Harbour Crafts	• Current efficiency regulations (e.g., EEXI) do not apply to dredgers and harbour crafts • Gaps in maintenance and energy efficiency training need to be addressed. • Hybrid diesel-electric dredgers can serve as a transitional solution.

	• Phasing out inefficient harbour crafts through regulatory mandates can support energy transition.
Bunkering Hubs for Alternative Fuels	• India can emerge as a major bunkering hub for alternative fuels like hydrogen and ammonia • Demand-supply assessment and regional baseline planning are required. • Financial mechanisms such as concessional finance and partial credit guarantees can de-risk investments. • Collaboration across the fuel value chain is crucial for infrastructure development

Table 1 Solution and Key opportunities in green ports

5. INTERNATIONAL GREEN PORT BENCHMARKS

International experience shows that early-stage green port programmes succeed when they combine (i) phased delivery, (ii) credible benchmarking, and (iii) targeted incentives that reduce first-mover risk. LR's NGSP consultative work already points to the value of aligning national approaches with recognised green port benchmarking schemes (e.g., Eco Ports in Europe and Green Marine in North America), using tiered criteria, periodic verification, and public reporting to create transparency and a "race to the top".

A consistent lesson is that incentives and tariff design matter as much as technology. Early OPS/electrification roll-out is often constrained by power pricing, taxes, and grid readiness; therefore, national-level measures that harmonise the OPS policy approach and enable PPP delivery models can accelerate adoption and standardisation, while avoiding fragmented port-by-port approaches.

Green corridors are another proven accelerator because they concentrate demand, investment and collaboration across the value chain. Recent regional studies (e.g., UN ESCAP) highlight that corridors face barriers such as limited awareness and infrastructure, and stress that digitalisation enables decarbonisation through data-sharing, optimisation and port call synchronisation. In practical terms, tools that support Just-in-Time arrival and port call optimisation, together with IoT/AI-enabled monitoring and "digital twin" approaches, can unlock material efficiency gains and support scalable MRV.

Implication for India: adopt a staged "pilot → scale" pathway anchored in national enablers (standards, tariffs, finance, MRV) while using GPPI/certification to verify progress; the NGSP consultative milestones already envisage early designation of initial green ports with OPS and subsequent corridor scale-up."

6. INDICATIVE ACTION PATHWAY

The Green Ports implementation framework adopts a phased and outcome-oriented approach aligned with India's maritime decarbonization goals and national sustainability priorities. Rather than mandating specific technologies or uniform pathways, it establishes time bound actions, enabling measures, and clearly defined institutional roles to support the progressive adoption of low emission and resource efficient port systems. The framework translates policy direction into structured short term, medium- and long-term implementation pathways centred on deployable devices, systems and operational interventions, calibrated to port-level operational realities and capacity.

6.1 Green ports workstreams

Green Ports roadmap implementation is planned as a series of parallel workstreams. These workstreams map actions across governance, standards, finance, energy systems, port crafts, digitalisation, and environmental management. Each of the workstream progresses across the phased action plans that is, mobilisation, piloting, scale up and mainstreaming ensuring coordinated delivery and clear ownership

Governance & Institutional coordination – covers setting up the Port Sustainability cells, inter-agency collaboration, alignment with NGSP and Harit Sagar and oversight channels

Standards, Safety and Certification – Includes development and deployment of standards for OPS, electrification, safety approvals and convergence with GPPI and certification frameworks.

Finance & Market enablement – Financing, PPP, Incentives, VGF mechanisms and deployment of bankable project pipelines are covered

Energy system, Electrification and OPS – Covers shore power deployment, port equipment electrification, grid upgrades, integration of renewable energy and energy management systems

Port Crafts & Marine Services Transition – Discusses a transition to cleaner propulsion for tugs, pilot boats and service vessels, safety procedures and training

Digitalisation, Data and MRV – Includes energy and emissions monitoring, digital optimisation of port operations, GPPI – linked reporting, and verification systems

Environment, Water, waste and biodiversity – Involves water and waste management, pollution control, biodiversity protection, environmental monitoring and community interface

In the short term, most workstreams focus on governance set-up, baselining, and readiness; in the medium term, selected workstreams intensify through pilots and proof-of-concept projects; and in the longer term, successful measures are scaled up and institutionalised across the maritime sector.

Phase	What happens to workstreams?
Phase 1	Most workstreams are about **baseline & readiness**
Phase 2	Some workstreams become **very active** (OPS, finance, digital)
Phase 3	Workstreams become **embedded and routine**

Table 2 Workstreams development in each implementation phase

6.2 Responsibility tracking

Below is a table which highlights indicative ownership framework. This distinction ensures that systemic barriers are addressed centrally, while ports retain ownership of on-ground delivery.

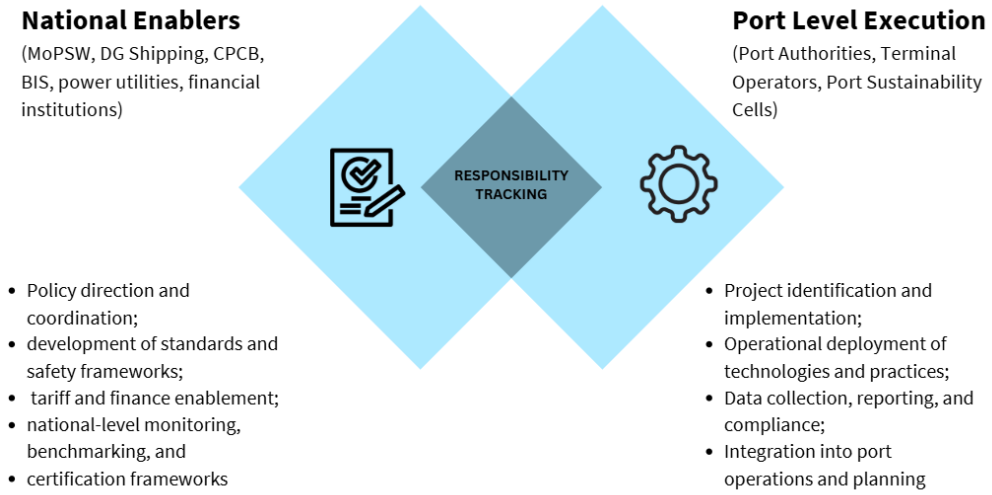


Figure 4 Indication Ownership Framework

This distinction ensures that systemic barriers are addressed centrally, while ports retain ownership of on-ground delivery.

At the implementation stage, detailed responsibility assignment for individual actions may be operationalised by ports and implementing agencies using **RACI-style frameworks**, as appropriate. At this roadmap stage, ownership is intentionally defined at a functional and institutional level to retain flexibility across diverse port contexts.

6.3 Key Dependencies and Enablers

Implementation of the Green Ports roadmap is subject to several cross-cutting dependencies that influence sequencing and pace of delivery. The dependencies are addressed through national enabling actions and phased implementation.

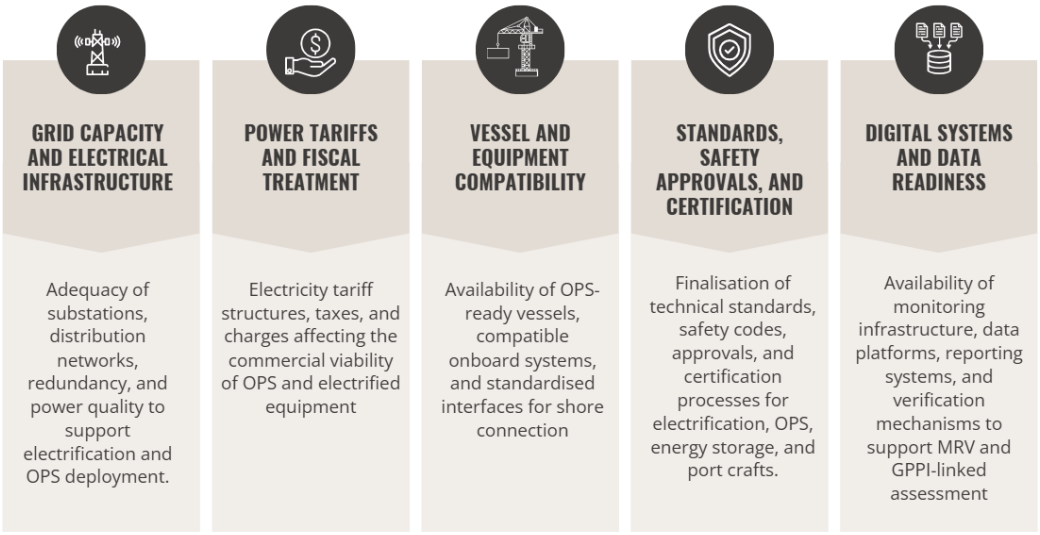


Figure 5 Key dependencies and Enablers

6.4 Green Port Performance Index and Certification

The Indicative Action pathway is aligned with the GPPI and the certification logic proposed under NGSP. The plan to implement action items determined at each step of the roadmap is created to increase indicators of environmental performance, allowing ports to progress from baseline compliance toward higher levels of environmental performance and certification.

The diagram below illustrates the indicative relationship between roadmap phases and GPPI outcomes.

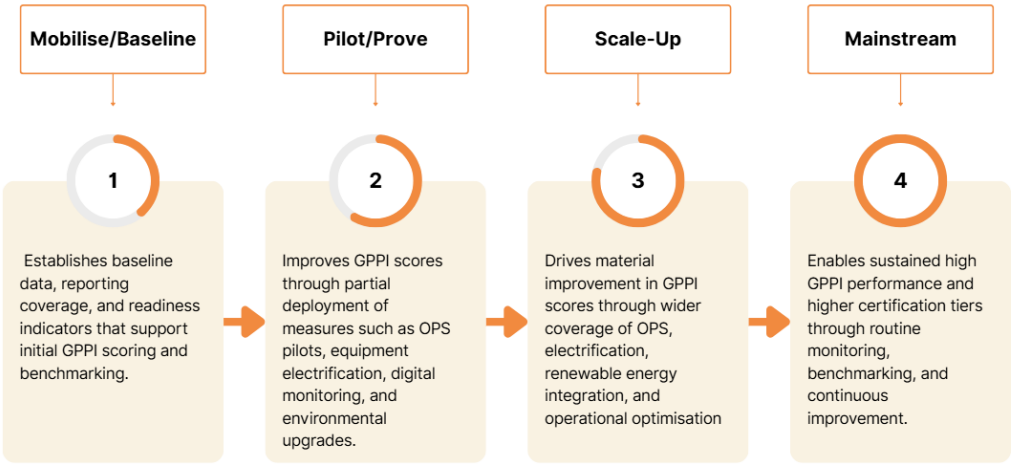


Figure 6 Roadmap phases and GPPI outcomes

The phased roadmap encourages a tiered certification model which has ports recognized based on based on improvements to performance rather than solely relying on one time project implementation. This indicative roadmap aligns with milestones proposed previously withing NGSP policy.

Over the short term, the roadmap focuses on early pilot interventions, including the designation on initial green ports with shore power. Over the longer term, it is consistent with the larger goal of expanding the share of green energy use at major ports. The phased roadmap supports a tiered certification approach, where ports are recognised based on demonstrated performance improvements rather than one-time project implementation. The phased actions described in the roadmap represent progressive steps between the two reference points

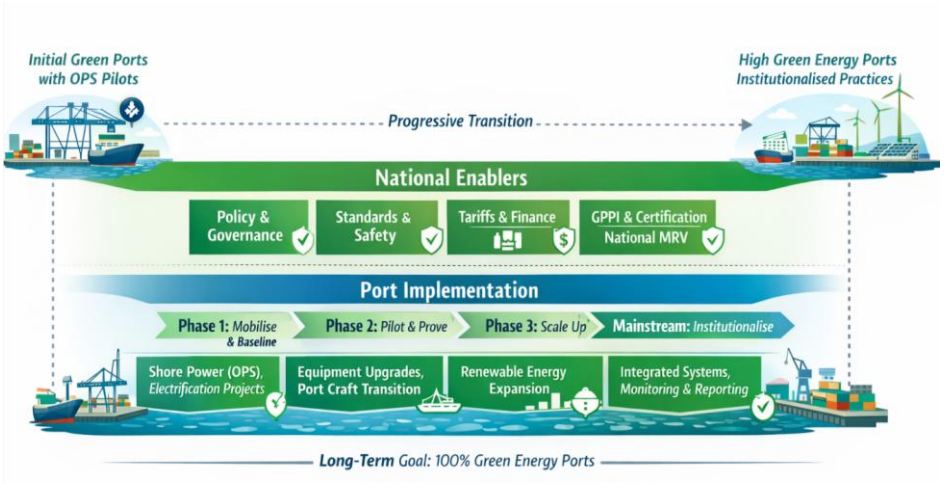


Figure 7 Indicative Green Ports Roadmap

6.5 Port Readiness & Prioritisation

Considering that there is significant heterogeneity in infrastructure maturity, grid readiness, institutional capacity and local environmental situation in Indian ports, the development of the Green Port cannot be undertaken consistently in all locations. For this reason, **Phase 1 results are employed for the structured port readiness and prioritisation process**, enabling the DGS and MoPSW to identify where pilot and early-scale interventions should be initiated. The readiness and prioritisation procedure proceeds directly from the baseline assessments and gap analysis undertaken in Phase 1 and outlines a transparent process that is evidence-based and allows for the sequencing of implementation to follow in consecutive steps.

Indicative Readiness Screening Criteria Port readiness is evaluated by a limited group of pragmatic screening criteria used for assessing port status includes practical testing criteria, which include:

- ✓ **Grid capacity and substation** upgrade complexity, including availability of power, redundancy, and upgrade timelines
- ✓ **Berth configuration and vessel** mix, with reference to suitability for OPS deployment
- ✓ **Equipment fleet profile** (e.g., age, replacement cycles, retrofit versus new procurement feasibility)
- ✓ Emphasis on **local air quality sensitivity and community exposure**, especially in urban or environmentally sensitive port areas
- ✓ The **feasibility of renewable energy procurement**, especially access to PPAs, captive generation or REC mechanisms
- ✓ **Institutional capability**, including environmental management systems, digital maturity, and internal coordination capacity

Port Readiness Tiers and Implementation Sequencing

Based on the above criteria, ports may be grouped into indicative readiness tiers to guide implementation sequencing:

Readiness Tier	Description	Indicative Roadmap Alignment
Tier A - Ready	Ports with high grid readiness, suitable berth and vessel profiles, strong institutional capacity, and minimal enabling gaps	Priority candidates for Phase 2 pilot and early scale-up actions
Tier B - Requires enabling upgrades	Ports with clear potential but constrained by grid, infrastructure, or institutional gaps	Focus of targeted national enabling actions during Phase 2, followed by phased implementation
Tier C -Long term	Ports requiring substantial enabling upgrades or with limited near-term suitability	Addressed in later phases once systemic enablers and market readiness improve

Figure 8 Indicative Port Readiness Tiers

6.6 SHORT TERM ACTION PLAN : PHASE 1 : BASELINE

Action Item	Output	Stakeholders	Inputs / Data Sources	Approach	Issued by	Used / Implemented by
Publish National Guidance for Green Ports Implementation	National Green Ports Implementation Guidance defining scope, phased approach, minimum reporting dataset, GPPI reporting cadence, and alignment with certification framework	MoPSW (Lead), DG Shipping, MoEFCC/CPCB, Ministry of Power/DISCOMs, select Major Ports (2–3), technical advisors (as required)	Harit Sagar Guidelines, existing port energy and environmental audits, OPS standards, international best practices	1. MoPSW prepares draft guidance outline 2. Draft circulated to agencies for comments 3. Structured consultation meetings 4. Inputs consolidated and document finalised 5. Guidance issued formally	MoPSW	Port Authorities (planning and alignment reference)
Notify priority port-controlled emission and energy segments	Consolidated inventory of port-controlled assets eligible for early decarbonisation (equipment, harbour craft, buildings, utilities)	MoPSW, Port Authorities, Terminal Operators	Existing port asset registers, terminal concession agreements, Harit Sagar submissions	1. MoPSW issues standard data template 2. Ports submit asset-level data 3. Assets classified by ownership/control 4. Priority segments identified	MoPSW	Port Authorities, Terminal Operators
Undertake port-level readiness and gap assessments	Completed readiness assessments covering grid capacity, safety, space, skills, institutional capacity, and baseline energy & emissions inventory; establishment of Port Sustainability Cells	MoPSW (template), Port Authorities, Terminal Operators, DISCOMs, Safety Authorities	Grid data from DISCOMs, port engineering data, manpower details, safety compliance records	1. MoPSW issues standard readiness assessment checklist 2. Ports complete self-assessment (2–4 weeks) 3. Inputs collected from terminals and utilities 4. Review call to validate gaps 5. Readiness status and baselines recorded	MoPSW	Port Authorities, Terminal Operators
Define institutional roles, approvals, and coordination mechanisms	Governance and responsibility framework including National Steering Group, thematic Technical Working Groups (OPS, port craft, digital/MRV, environment), and clarified approval pathways	MoPSW, DG Shipping, MoEFCC/CPCB/SPCBs, State Authorities, Port Authorities	Existing regulations, approval workflows, safety rules, environmental clearance processes	1. Map existing approval and oversight processes 2. Validate roles and overlaps 3. Identify gaps and duplications 4. Issue consolidated governance and coordination framework	MoPSW	All implementing agencies
Select and notify priority pilot ports, terminals, and themes	Official notification identifying readiness-ranked pilot ports, terminals, and focus themes (OPS, electrification, fuels, monitoring)	MoPSW, Port Authorities, Terminal Operators, Utilities	Readiness assessment results, expressions of interest, feasibility inputs	1. MoPSW reviews readiness scores 2. Shortlist eligible ports 3. Validation meeting 4. Pilot notifications issued	MoPSW	Selected Port Authorities & Operators
Develop port-level 3-year project pipeline	Prioritised 3-year pipeline of quick wins, pilot projects, and scale-up investments aligned to readiness outcomes	Port Authorities, Terminal Operators, MoPSW	Readiness assessments, asset inventory, grid feasibility inputs, pilot scope definitions	1. Ports consolidate candidate projects 2. Classify into quick wins / pilots / scale items 3. Validate alignment with national guidance 4. Finalise pipeline for Phase 2 implementation	—	Port Authorities, Terminal Operators

Table 3 Short Term Action Plan

6.7 MEDIUM TERM ACTION PLAN : PHASE 2 : PILOT

Action Item	Output	Stakeholders	Inputs / Data Sources	Approach	Issued / Led by	Implemented by
Electrification of priority port-owned equipment and internal fleets (pilot scale)	Electrified or low-emission port-owned equipment and harbour craft deployed at pilot ports with defined performance targets	Port Authorities (Lead), Terminal Operators, Equipment OEMs, Utilities	Asset lists from Phase 1, readiness assessments, equipment specifications, power availability data	1. Identify priority assets from Phase 1 inventory 2. Prepare asset-wise electrification plans 3. Finalise technical specifications aligned to standards 4. Procure/retrofit equipment 5. Commission and monitor pilot performance	Port Authorities	Port Authorities, Terminal Operators
Deploy OPS at selected high-impact berths (pilot deployment)	Operational shore-to-ship power systems at selected pilot berths with safety, metering, and tariff arrangements	Port Authorities, DG Shipping, Utilities, Terminal Operators, OEMs	Berth usage data, vessel call profiles, grid studies, OPS technical standards	1. Select pilot berths based on traffic and emissions impact 2. Conduct detailed engineering and safety studies 3. Finalise power supply and tariff arrangements 4. Install and commission OPS 5. Undertake vessel compatibility trials	Port Authorities	Port Authorities, Terminal Operators
Finalize OPS, electrification, and safety standards pathway	Approved technical, safety, metering, and interface standards for OPS and port electrification	MoPSW, DG Shipping, BIS, Electrical Authorities, Port Authorities	Draft OPS standards, electrical codes, international benchmarks	1. Consolidate draft standards 2. Coordinate with BIS and safety authorities 3. Validate through pilot feedback 4. Issue final standards and guidance	MoPSW / DG Shipping	All implementing agencies
Expand renewable energy deployment and integrate energy management systems (pilot ports)	On-site/off-site renewable energy installations and operational port energy management systems at pilot ports	Port Authorities, Utilities, RE Developers, Energy Service Companies	Land availability, rooftop assessments, energy consumption data	1. Assess renewable energy potential at pilot ports 2. Identify delivery model (CAPEX / RESCO / PPA) 3. Install renewable systems 4. Integrate with port energy management platforms	Port Authorities	Port Authorities, Utilities, RE Developers
Transition port crafts under national programmes (pilot phase)	Replacement or retrofit of selected port crafts under approved national transition programmes	Port Authorities, MoPSW, Shipyards, DG Shipping	National programme guidelines, fleet age data, operational profiles	1. Identify eligible port crafts 2. Align with national programme criteria 3. Place construction/retrofit orders 4. Commission vessels and train crew	MoPSW / Port Authorities	Port Authorities
Implement GPPI-linked monitoring, reporting, and verification (pilot roll-out)	Operational monitoring, reporting, and verification system aligned to GPPI indicators at pilot ports	Port Authorities, NCoEGPS, Digital Platform Providers	GPPI framework, port operational data, energy and emissions data	1. Map GPPI indicators to data points 2. Configure digital monitoring tools 3. Train port teams 4. Begin periodic reporting and verification	Port Authorities	Port Authorities
Embed green requirements into PPPs and concession agreements (pilot application)	Revised PPP and concession clauses incorporating energy, emissions, OPS use, and reporting obligations	MoPSW, Port Authorities, Legal Advisors, Terminal Operators	Existing concession agreements, model concession templates	1. Review existing concession templates 2. Draft standard green clauses 3. Apply to new/renewed concessions at pilot ports 4. Monitor compliance through contract management	MoPSW / Port Authorities	Port Authorities, Terminal Operators
Publish finance pack for pilot projects	Standardised business case templates and eligibility guidance for VGF / green port funding mechanisms	MoPSW, Financial Institutions, Port Authorities	Pilot project data, CAPEX/OPEX estimates, financing models	1. Consolidate pilot cost data 2. Develop standard business case template 3. Issue finance eligibility guidance	MoPSW	Port Authorities

Table 4 Medium Term Action Plan

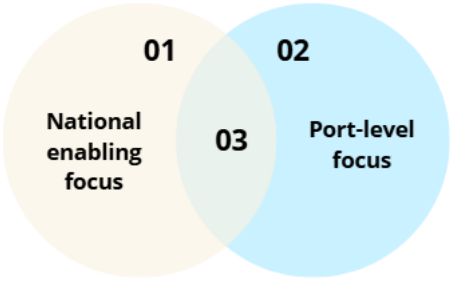
6.8 LONG TERM ACTION PLAN : PHASE 3 : SCALE UP

Action Item	Output	Stakeholders	Inputs / Data Sources	Approach	Issued / Led by	Implemented by
Standardise OPS deployment at major ports	OPS deployed as a standard service at high-impact berths across major ports, with harmonised safety and tariff principles	MoPSW, DG Shipping, Port Authorities, Utilities	OPS pilot performance (Phase 2), berth usage data, safety standards, tariff studies	1. Review OPS pilot outcomes 2. Identify high-impact berths for expansion 3. Finalise standard safety, metering, and tariff principles 4. Roll out OPS across selected berths	MoPSW	Port Authorities, Terminal Operators
Harmonise national tariff and fiscal treatment for OPS	Nationally consistent power tariff and tax treatment for shore power	MoPSW, Ministry of Power, State Governments, Utilities	State tariff structures, electricity regulations, pilot cost data	1. Assess inter-state tariff variations 2. Develop national harmonisation approach 3. Issue tariff and fiscal guidance	MoPSW	Utilities, Port Authorities
Expand electrification and renewable energy integration at major ports	Significant expansion of electrified equipment fleets and increased renewable share of port electricity	Port Authorities, Utilities, Renewable Energy Developers	Phase 2 pilot data, energy demand forecasts, renewable feasibility studies	1. Prioritise high-impact equipment and berths 2. Integrate PPAs / captive renewables 3. Deploy port energy management systems	Port Authorities	Port Authorities, Utilities, RE Developers
Institutionalise JIT arrival and port-call optimisation across corridors	JIT arrival and port-call optimisation implemented across selected shipping corridors	Port Authorities, DG Shipping, Shipping Lines, Digital Platform Providers	Port call data, vessel schedules, digital optimisation tools	1. Identify priority corridors 2. Deploy digital JIT tools 3. Align optimisation with CII efficiency objectives	Port Authorities	Port Authorities, Terminal Operators
Introduce GPPI-linked performance incentives and benchmarking	Performance-based incentives framework linked to GPPI improvement and benchmarking results	MoPSW, CPCB/SPCBs, Financial Institutions	GPPI framework, MRV data, benchmarking outcomes	1. Define incentive criteria linked to GPPI scores 2. Publish benchmarking results 3. Implement incentive mechanisms	MoPSW	Port Authorities
Establish Green Port Monitoring Cell / Centre of Excellence	National monitoring and benchmarking function providing guidance and best practices	MoPSW, NCoEGPS	MRV data, audit outcomes, GPPI reports	1. Define mandate and governance 2. Consolidate monitoring functions 3. Issue periodic guidance	MoPSW	NCoEGPS

Table 5 Long term action plan

6.9 Mainstreaming and Institutionalization

Beyond the scale-up phase, Green Port implementation transitions from time-bound programmes to **mainstream, system-wide practice**. This stage focuses on integrating green port measures into routine planning, operations, investment decision-making, and international collaboration frameworks, aligned with evolving market readiness and global maritime decarbonisation pathways.



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- Roll-out of a phased, risk-based national framework for alternative fuel bunkering readiness, aligning infrastructure investment, safety approvals, and regulatory oversight.
- Expansion of international collaboration platforms and green corridor initiatives, supporting shared standards, interoperability, and coordinated deployment, as envisaged under the NGSP.

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- Development of alternative fuel hubs at selected ports, where justified by demand–supply assessments, incorporating safety cases, emergency response arrangements, and workforce training.
- Transition from project-based interventions to portfolio-based energy transition management, enabling continuous improvement against GPPI and certification benchmarks.

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- Ports positioned as green corridor nodes with mature monitoring, reporting and verification (MRV) systems, stable investment mechanisms, and institutionalised sustainability practices

Figure 9 Action plan for Mainstreaming phase

7. STAKEHOLDER MAPPING

Effective implementation of Green Ports under the National Green Shipping Policy requires clear delineation of responsibilities across policy, regulation, execution, monitoring, and community interface. Given that green port actions span energy systems, infrastructure, environmental compliance, safety, digital monitoring, and workforce capability, implementation cannot rely on ad hoc coordination. This stakeholder mapping complements the institutional responsibility framework by illustrating implementation-level interactions and coordination pathways across phases.

Category	Stakeholder	Primary Role in Green Ports Implementation	Interface with Port Sustainability Cell
Policy & Strategic Oversight	Ministry of Ports, Shipping and Waterways (MoPSW)	Overall policy owner of Green Ports pillar; issuance of guidelines; coordination across ministries; monitoring national progress	Receives consolidated implementation updates and performance inputs from ports
	NITI Aayog	Strategic alignment with national climate, infrastructure, and energy transition priorities	Uses aggregated insights for national strategy alignment
Regulation & Environmental Oversight	Directorate General of Shipping (DG Shipping)	Maritime safety regulation; oversight of port crafts and harbour vessels; approvals related to OPS and safety	Coordinates on port craft transition, safety protocols, and approvals
	Ministry of Environment, Forest and Climate Change (MoEFCC)	Environmental safeguards; EIA processes; emissions and climate reporting alignment	Reviews compliance data consolidated by Sustainability Cell
	CPCB / SPCBs	Air, water, noise, waste monitoring; environmental compliance enforcement	Receives monitoring data and compliance reports
Port Authorities & Governance	Major Port Authorities	Planning, execution, and coordination of green port actions; integration into master plans and procurement	Hosts and oversees the Sustainability Cell
	State Maritime Boards	Oversight and coordination for non-major ports; alignment with state agencies	Coordinates implementation support for state ports
Port-Level Execution (Key Node)	Sustainability Cell / Green Port Cell	Central coordination unit for planning, implementation, monitoring, GPPI reporting, pilots, and inter-departmental alignment	Acts as nodal interface across all stakeholders
Terminal & PPP Operations	Terminal Operators / Concessionaires	Electrification of terminal equipment; compliance with green requirements; operational data sharing	Coordinates implementation, reporting, and compliance
Energy & Utilities	State Electricity Utilities / DISCOMs	Grid capacity upgrades; power supply reliability; OPS integration	Coordinates on grid readiness, outages, and load management
	Renewable Energy Developers	Supply of on-site and off-site renewable energy	Aligns renewable sourcing with port demand
	Energy Storage & EMS Providers	Deployment of battery systems and energy management solutions	Supports peak load management and optimisation

Port Crafts & Marine Services	Port Craft Operators (Tugs, Pilot Boats, Service Vessels)	Operation of cleaner port crafts under GTTP alignment	Coordinates pilots, training, and safety procedures
Safety, Standards & Certification	Bureau of Indian Standards (BIS)	Development of standards for electrified equipment, OPS, and safety systems	Provides standards guidance for implementation
	Classification Societies (IRS, others)	Technical approval and certification of port crafts and systems	Coordinates approvals and compliance checks
	Port Fire & Emergency Services	Emergency preparedness, firefighting, and response readiness	Develops and updates SOPs for new technologies
Monitoring, Data & Performance	National Centre of Excellence for Green Ports & Shipping (NCoEGPS)	Technical guidance, best practices, and performance frameworks	Provides technical backstopping and benchmarking
	Monitoring System Providers / Data Auditors	Installation and validation of monitoring systems (air, water, noise, emissions)	Supplies validated data for GPPI and compliance
Finance & Market Enablement	Port Financing Bodies / Sagarmala-linked entities	Funding mechanisms; project structuring; viability gap support	Works with Sustainability Cell on financing pathways
	Multilateral Development Banks (ADB, World Bank, etc.)	Concessional finance and technical assistance	Supports large-scale infrastructure upgrades
Knowledge & Capacity Building	Indian Maritime University (IMU)	Training and curriculum development for port operations and safety	Delivers structured training programmes
	OEMs, Technical Institutes, Think Tanks	Equipment-specific training; pilots; technical studies	Supports skill development and pilot evaluations
Local & Community Interface	Urban Local Bodies / Municipal Corporations	Coordination on air quality, waste management, and urban integration	Aligns port actions with city-level initiatives
	Coastal Communities / Fishermen Groups	Community engagement and feedback on environmental impacts	Participates in consultation and awareness activities
	Educational Institutions	Awareness, internships, and future workforce development	Supports long-term skill pipeline

Table 6 Key stakeholder mapping

8. CHALLENGES

Currently there are significant structural, operational and institutional barriers to implementing green port activities that restrict and shape the pace and extent of its success. These challenges should be managed in a phased and coordinated manner to implement the Green Ports Pillar within the NGSP effectively.

1. **Uneven port readiness and physical constraints:** There is wide variation in port readiness throughout India because of differences in land availability, terminal configuration, grid connectivity, and age of infrastructure. Most ports face difficulties in integrating electrification, shore power, and renewable energy systems alongside ongoing commercial operations, which slows down the pace at which green port measures are deployed

2. **Grid capacity, Energy integration and Infrastructure limitations:** Port equipment electrification and shore-to-ship power installations considerably increase demand for electricity. In some ports, existing substations, distribution networks, and grid connections cannot cope with these loads, creating bottlenecks that limit the scalability of green port interventions

3. **Regulatory and Safety frameworks still evolving**: Standards and approval frameworks still vary for electrified port equipment, OPS interfaces, energy storage systems, and emerging clean energy infrastructure. The lack of fully harmonised processes across ports means that approvals, timelines, and compliance obligations are uncertain

4. **Institutional coordination and governance complexity:** Implementation of green ports involves coordination among ministries, regulators, utilities, port authorities, terminal operators, and safety agencies. Aligning responsibilities across shipping, energy, environment, and port governance remains challenging and is not yet robust in practice.

5. **Limited operational experience and performance data :** Although pilot projects and initial deployments are increasing, many ports have little insight into the performance, cost, safety, and maintenance of green technologies specific to India. This slows decision-making, heightens risk aversion, and limits rapid scale

9. CONCLUSION

India's ports are a key player in the country's maritime economy and environmental transition. Ports as critical nodes of energy use, emission production and coastal interface act as a hub at which it is possible to address potential to convert the national climate commitments into practice at the sectoral level

The understanding suggests that an effective green port implementation is a stepwise, adaptable solution responsive to the capacity required, rather than one-size-fits-all instruction. Differences in port size, infrastructure maturity, grid readiness, and institutional capacity require stepwise actions and progression from readiness assessment and piloting of the facility to standardisation and system wide embedding. The short-, medium- and long-term options outlined here lay the underpinning for the strategic response that will overcome technical, regulatory, financial and operational constraints and provide for learning, risk reduction and scalability across the Indian port system.

Ultimately, sustainability should be built into port planning, operations, governance and the decisions on investment to deliver outcomes that are truly environmental. With a operationalisation and implementation of performance monitoring through GPPI, enhanced institutional coordination and stakeholder alignment at policy, regulation, execution and finance levels, we envisage Indian ports becoming active enablers of maritime decarbonisation. A well-implemented framework will put India's ports in a position not only to be compliant infrastructure assets, but also to become the strategic drivers of clean shipping, resilient coastal development and sustainable maritime growth.