COAST CONNECT WORKSHOP, 2026

Workshop on the Coastal Shipping Act, 2025

Gujarat Maritime University

Directorate General of Maritime Administration

1. MIV-2030 & MAKV 2047 Vision 9
1.1. Maritime India Vision (MIV) 2030 9
1.2. Maritime Amrit Kaal Vision (MAKV) 2047 10
2. Maritime National Games 2027 11
2.1. Strengthening Maritime Community Engagement Through Sports 11
3. Gujarat Coastal State Workshop, under the aegis of DGMA 13
3.1. Developing a Gujarat-Specific Maritime Action Agenda 13
4. GIFT City as a Catalyst for an India International Ship Registry and Maritime Financing Ecosystem 15
4.1. Strengthening India's Maritime Financial Competitiveness 15
4.2. Licensing and Flagging Reforms 15
4.3. Expected Impact on the Maritime Ecosystem 17
5. Maritime Single Window 17
5.1. Digital Integration of Port-Clearance Processes 17
5.2. Significance 18
6. Digitalisation 18
6.1. E-Samudra 18
6.2. E-Navik 21
6.3. Maritime Single Window 23
6.4. Shipbuilding scheme portal 25
6.5. Comprehensive shipbuilding portal 27
6.6. Training Ecosystem 29
6.7. E-Pariksha 31
6.8. Just Transition in Maritime 33
6.9. Abandonment Scenario in India 35
6.10. Key interventions taken by DG Shipping 37
6.11. Towards Stronger social security for seafarers 41
6.12. Towards stronger welfare for seafarers 43
6.13. Steps are being taken by the DG Shipping for the welfare of seafarers 45
6.14. Seafarer welfare infrastructure - SWBAT 47
6.15. Ensuring zero tolerance for corruption in crewing 49

6.16. Mission 20 51

6.1. Sagar Mein Yog 55

6.2. Sagar Mein Samman 56

6.3. Zero Tolerance for Fraud in Training 58

7. Ship Building and Repairs 60

7.1. Introduction 60

7.2. The Global Shipbuilding Market: Demand Context 61

7.3. India's Policy Architecture for Shipbuilding 68

7.4. Pillar 1: Shipbuilding Financial Assistance Scheme 71

7.5. Pillar 2: Maritime Development Fund 76

7.6. Pillar 3: Shipbuilding Development Scheme 78

7.7. Demand Aggregation 91

7.8. Ship Component Manufacturing 94

7.9. Container Manufacturing Promotion Scheme 100

7.10. Gujarat Strengthening India's Shipbuilding and Ship Repair Ecosystem – Kuchhadi and Vadinar Initiatives 102

8. Gujarat: 98% of Ship Recycling 105

8.1. Ship Recycling 105

8.2. Hong Kong Convention (HKC) 108

8.3. ISO Standards for Ship Recycling 110

8.4. Green Steel 111

9. Ship Recycling Workforce Training Framework (proposed) 113

Core Training Areas 114

10. Proposed International Ship Recycling Conclave – Alang 119

11. Social Welfare, Health and Education Infrastructure at Alang–Sosiya Ship Recycling Yard 124

12. Gujarat - Maritime institutes and GANPAT university - host of the Martime National Games 131

13. Strengthening Maritime Security: Bureau of Port Security (BoPS) and National Centre of Excellence for Port Security 133

14. Gujarat Maritime Investments 135

15. Gujarat Coastal State Workshops 137

16. Proposal for scheme for the traditional Seafarers on mechanized sailing vessels 139
17. “Ek Ped Maa ke Naam” Initiative 141
17.1. Maritime Sector Participation in India's Afforestation Mission 141
17.2. Sustainability and Stakeholder Engagement 141
17.3. Monitoring and Implementation Framework 142
18. Pilotage Rule – consolidation and uniform rules 142
18.1. Modernizing the Regulatory Framework 143
18.2. Uniform Navigation and Accountability 143
18.3. Relevance for Gujarat's Multi-Port Ecosystem 143
19. Establishing GIFT City as a Hub for Maritime Arbitration and Dispute Resolution 144
19.1. Gujarat International Maritime Arbitration Centre (GIMAC) 144
19.2. Specialized Maritime Dispute Resolution 144
19.3. Building a Maritime Services Ecosystem 144
20. Establishing GIFT City as a Hub for Maritime Arbitration and Dispute Resolution 145
20.1. Gujarat International Maritime Arbitration Centre (GIMAC) 145
20.2. Specialized Maritime Dispute Resolution 145
20.3. Building a Maritime Services Ecosystem 145
21. DGS to DGMA Transition 146
21.1. Key Functional Domains of DGMA 147
21.2. Strategic Outcomes 148
21.3. Why This Transformation Matters 150
22. Suraksha Sarvapratham – Safety in Maritime 153
23. Imperative for Maritime Energy Transition 154
24. National Maritime Decarbonization Policy Framework 157
25. Alternative Fuels for Maritime 164
25.1. Fossil-Liquefied Natural Gas (LNG) 166
25.2. Biofuels 167
25.3. Green Methanol 170
25.4. Green Hydrogen as a Marine Fuel 171

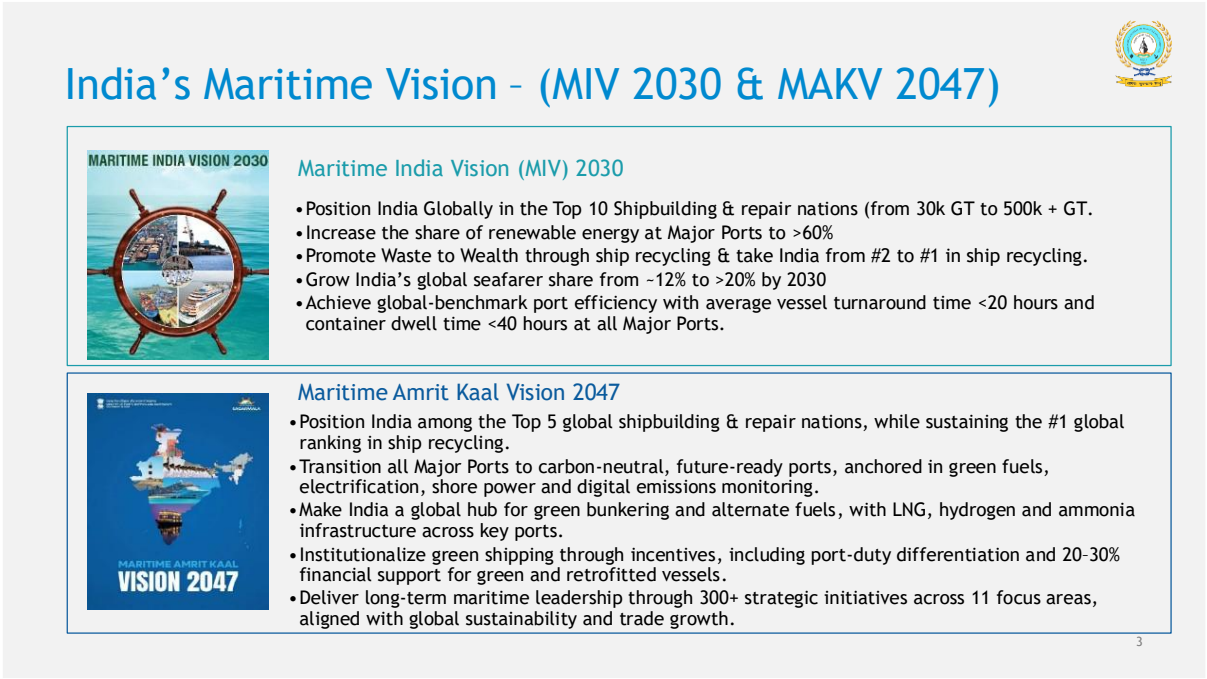
25.5. Battery Electric Energy 173
25.6. National Green Hydrogen Mission – Enabling Ecosystem 173
25.7. Alternative Fuels Properties Comparison 174
26. Alternative Fuel Transition : Challenges and Safety Considerations 175
27. National Green Hydrogen Mission – Green Hydrogen Hubs 180
India as a Net Green Energy Exporter & Bunkering Destination 184
28. Green Maritime Corridors 185
29. Study on Potential Demand and Pricing of Alternative Marine Fuels in India 186
30. Green Corridor Pre-Feasibility Study under the Indo-Danish Centre of Excellence 187
31. Nuclear Propulsion for Merchant Shipping 190
32. Strategic Rationale for Nuclear Marine Propulsion 191
32.1. Near-Zero Operational Emissions 191
32.2. Exceptional Energy Density 192
32.3. Long Endurance 192
32.4. Continuous High-Power Availability 193
Reduced Dependence on Bunkering Networks 193
Greater Predictability of Energy Costs 193
Nuclear Reactor Technology Options 195
Pressurised Water Reactors 195
Small Modular Reactors (SMR) 196
High-Temperature Gas-Cooled Reactors 197
Liquid Metal-Cooled Reactors 198
Molten Salt Reactors 199
India's Strength for Nuclear Marine Propulsion 200
Strategic Thorium Resource Base 204
India's Strategic Strength for Nuclear Marine Propulsion 210
Established Nuclear Programme 210
Advanced Fast-Reactor Development 210
Strategic Thorium Resource Base 210
Thorium Fuel-Cycle Research 210
Advanced Reactor Design Capability 211

National SMR Mission 211
Marine Nuclear Experience 211
Indigenous Manufacturing Base 211
Evolving Governance Framework 211
International Engagement 211
Priority Areas for Future Development 212
Small Modular Reactors (SMRs): Emerging Pathway for Maritime Applications 213
Evolution of Small Modular Reactors 214
Key Characteristics of SMRs 215
Compact and Modular Design 215
Factory-Based Manufacturing 215
Flexible Deployment 215
Enhanced Safety Features 215
Long Operating Cycles 216
Multi-Purpose Applications 216
Types of SMRs 216
Indian Context 217
Potential Maritime Applications of SMRs 218
Merchant Ship Propulsion 218
Floating Nuclear Power Plants 218
Port and Offshore Power Supply 218
Remote Coastal and Island Energy Systems 218
Desalination 219
Hydrogen, Ammonia and Synthetic Fuel Production 219
Integrated Maritime Energy Systems 219
Molten-Metal-Based Reactors (Liquid Metal-Cooled Reactors) 219
Working Principle 220
Principal Types of Liquid Metal-Cooled Reactors 221
Sodium-Cooled Fast Reactors (SFR) 221
Lead-Cooled Fast Reactors (LFR) 221
Lead-Bismuth Eutectic Reactors (LBE) 221
Key Features 221

High Heat-Transfer Capability 222
High-Temperature, Low-Pressure Operation 222
High Power Density 222
Long Fuel Cycles 222
Efficient Fuel Utilisation 222
Indian Context 222
Potential Maritime Applications 223
Engineering Considerations for Marine Deployment 224
Floating Nuclear Power Platforms (Floating Nuclear Power Plants – FNPPs) 225
Evolution of Floating Nuclear Power Plants 226
Basic Configuration and Working Principle 226
Key Characteristics and Advantages 227
Demonstrated Commercial Example – Akademik Lomonosov 227
Global Development Trends 229
Potential Applications 229
Challenges 230
Relevance for India 231
Nuclear Power Applications for Port Decarbonization 232
Nuclear Energy and Port Decarbonization 232
Contribution towards Scope 1 Emission Reduction 233
Contribution towards Scope 2 Emission Reduction 233
Contribution towards Scope 3 Emission Reduction 234
Integrated Maritime Energy Hubs 235
Relevance for India 235
Green Ports 236
Sustainable Indicators Framework for Indian Ports 243
GHG Emission Scopes 245
Gujarat's Green Ports Journey – Engagement with India's National Maritime Decarbonisation Policy Framework (NMDP) 248
National Port Sustainability Council (NPSC) – Proposed 254
Harit Sagar – Green Port Guidelines 259
Green Tug Transition Program (GTTP) 265

Integrated Vessel Traffic Management System (iVTMS) 268
Just-in-Time Arrival and Digital Twin for Ports 271
Digital Twin Pilot – VOCPA Tuticorin 273
Shore-to-Ship Power (SPS) – Decarbonising Emissions at Berth 276
Swachh Sagar Portal 279
Just Transition in Maritime 280

1.MIV-2030 & MAKV 2047 Vision



India's maritime transformation journey is guided by two interconnected strategic frameworks: Maritime India Vision (MIV) 2030 and Maritime Amrit Kaal Vision (MAKV) 2047. Together, these visions provide a comprehensive roadmap for positioning India as a leading global maritime nation by enhancing port infrastructure, shipping, shipbuilding, maritime manpower, sustainability, and technology-driven governance. MIV 2030 serves as the medium-term blueprint with over 150 initiatives aimed at accelerating growth, improving efficiency, and strengthening India's maritime competitiveness, while MAKV 2047 builds upon this foundation through more than 300 strategic initiatives across 11 focus areas aligned with the national aspiration of *Viksit Bharat 2047*.

1.1. Maritime India Vision (MIV) 2030

MIV 2030 seeks to transform India into a globally competitive maritime power by improving operational efficiency, increasing domestic manufacturing capability, and promoting sustainable growth. A key objective is to position India among the top 10 shipbuilding and ship repair nations, increasing annual production capacity from approximately 30,000 GT to over 500,000 GT. The vision also aims to strengthen India's leadership in ship recycling by enabling the country to move from the world's second-largest ship recycling destination to the leading position globally.

The vision emphasizes development of a future-ready maritime workforce. India currently contributes approximately 12% of the global seafaring workforce, and MIV 2030 targets increasing this share to more than 20% by 2030, supported by expanded maritime

training capacity, enhanced employability, digital certification, welfare initiatives, and greater participation of women seafarers

Sustainability is another key pillar of MIV 2030. The vision aims to increase the share of renewable energy at major ports to over 60%, promote circular economy principles through environmentally compliant ship recycling, and achieve globally benchmarked operational efficiency, including average vessel turnaround times below 20 hours and container dwell times below 40 hours. These initiatives contribute directly to reducing logistics costs and improving India's competitiveness in global trade.

1.2. Maritime Amrit Kaal Vision (MAKV) 2047

Building on MIV 2030, MAKV 2047 represents India's long-term maritime strategy for achieving global leadership by the centenary of independence. The vision aims to position India among the top five shipbuilding and repair nations globally, while maintaining the country's leadership in ship recycling. It seeks to create a resilient maritime ecosystem that supports economic growth, energy security, supply chain resilience, and the Blue Economy.

A defining feature of MAKV 2047 is its strong emphasis on sustainability and decarbonization. The vision envisages all major ports becoming carbon-neutral, future-ready ports, supported by renewable power, shore electricity, green fuels, digital emissions monitoring, and low-carbon maritime infrastructure. India is also expected to emerge as a global hub for green bunkering and alternate fuels, including LNG, hydrogen, ammonia, methanol and other next-generation fuels. Financial incentives and targeted support for green and retrofitted vessels will accelerate the transition toward environmentally sustainable shipping.

The MAKV 2047 framework encompasses 11 strategic themes, including green shipping, shipbuilding and repair, maritime clusters, coastal shipping, inland waterways, education and research, maritime professional services, technology and innovation, global maritime presence, next-generation ports, and enhancement of Indian tonnage. Through these initiatives, India seeks to establish itself as a globally respected maritime hub characterized by innovation, sustainability, efficiency, and strategic leadership.

Together, MIV 2030 and MAKV 2047 provide a phased roadmap for transforming India's maritime sector into a globally competitive, technologically advanced, environmentally sustainable, and growth-oriented ecosystem that supports national development, trade expansion, employment generation, and the vision of Viksit Bharat 2047

2. Maritime National Games 2027

2.1. Strengthening Maritime Community Engagement Through Sports

Introduction

The Maritime National Games 2027, scheduled to be held in Mehsana, Gujarat from 5-12 January 2027, represents a unique initiative aimed at fostering unity, wellbeing and engagement across India's maritime ecosystem. Conceived as a national platform for sports and community participation, the event brings together stakeholders from across the maritime sector, including seafarers, ports, shipping companies, public sector undertakings, shipyards, maritime training institutes, RPSLs, logistics organizations, universities, research institutions and maritime families.

The Games are being organized with the support of Ganpat University, which is serving as a strategic partner and host institution. The initiative aligns with the broader objective of strengthening the human element of the maritime sector by promoting physical fitness, teamwork, inclusivity and professional camaraderie among diverse maritime stakeholders.

Vision and Key Features

The vision of the Maritime National Games is to establish a trusted biennial platform that promotes sporting excellence, maritime unity, workforce wellbeing, family participation, para-sport inclusion and youth engagement. The event seeks to strengthen connections across various segments of the maritime industry while creating opportunities for interaction beyond professional and organizational boundaries.

The 2027 edition is expected to attract approximately 5,000 participants from across the country and provide outreach to around 265 maritime organizations. The programme will feature 28 sporting disciplines spanning team sports, racquet sports, aquatic events, indoor competitions and endurance activities. Participation is envisaged from a broad spectrum of the maritime community, including seafarers, ports, maritime companies, shipyards, training institutes, veterans and para-athletes.

The official opening ceremony is proposed for 9 January 2027, with the closing and medal ceremony scheduled for 12 January 2027. Through its scale and diversity of participation, the Maritime National Games aims to strengthen the sense of community within India's maritime sector while supporting the development of a healthier, more inclusive and socially connected maritime workforce.Legislative Reforms: Establishing a Modern Regulatory Framework

The first pillar of reform focuses on strengthening the legal and policy foundation of the maritime sector through comprehensive legislative modernization. Historically, several maritime laws were based on legacy provisions that no longer reflected emerging industry requirements, technological advancements and international best practices.

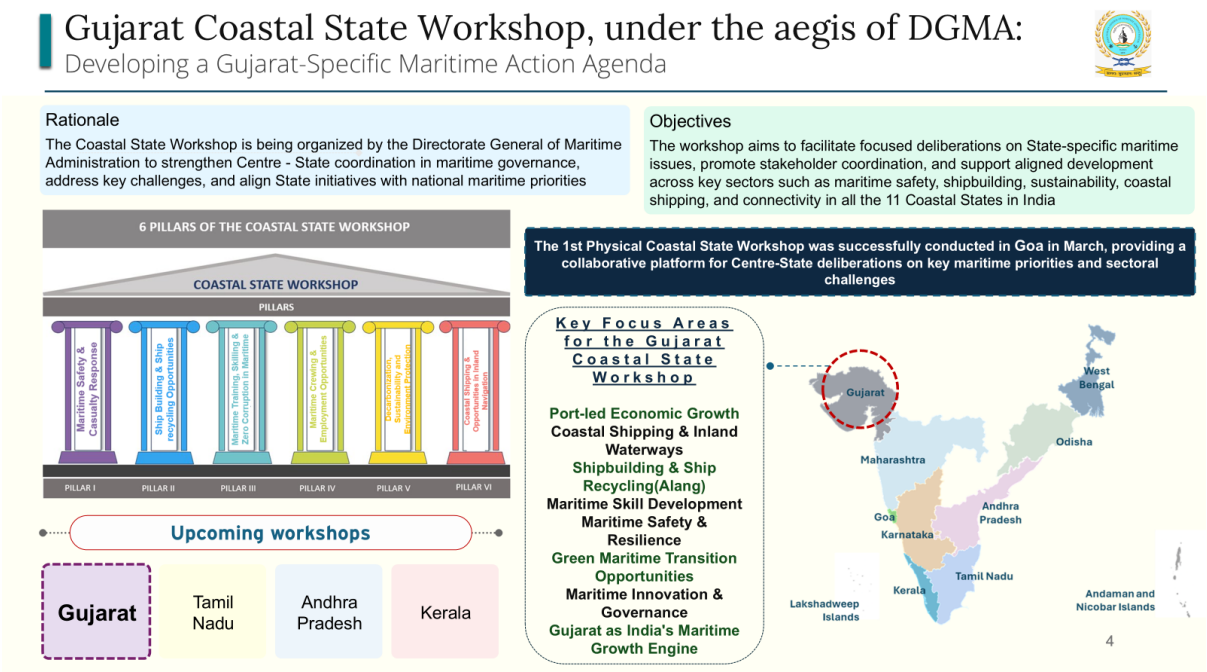
To address these challenges, the Government enacted the Merchant Shipping Act, 2025 and the Coastal Shipping Act, 2025. These landmark legislations represent a major step towards modernizing India's maritime governance framework.

The Merchant Shipping Act, 2025 seeks to provide a contemporary legal structure aligned with evolving international maritime conventions, modern shipping practices and advancements in maritime technology. The legislation aims to promote regulatory clarity, improve compliance mechanisms and facilitate the growth of India's shipping sector while maintaining high standards of safety, security and environmental protection.

Similarly, the Coastal Shipping Act, 2025 establishes a dedicated legal framework for the promotion and regulation of coastal shipping activities. By providing greater policy certainty and operational clarity, the Act is expected to strengthen coastal cargo movement, encourage modal shift from road and rail transport and support the development of a more efficient and environmentally sustainable logistics network.

Together, these legislative reforms provide the regulatory foundation necessary for achieving long-term maritime growth while improving investor confidence and facilitating business operations across the sector.

3. Gujarat Coastal State Workshop, under the aegis of DGMA



3.1. Developing a Gujarat-Specific Maritime Action Agenda

Introduction

The Gujarat Coastal State Workshop, being organized under the aegis of the Directorate General of Maritime Administration, aims to strengthen Centre-State coordination in maritime governance and develop a focused action agenda aligned with Gujarat's maritime priorities. The initiative forms part of a wider engagement across India's eleven coastal States to identify State-specific challenges, promote stakeholder coordination and align regional initiatives with national maritime development objectives.

The workshop framework is structured around six pillars covering maritime safety and casualty response; shipbuilding and ship-recycling opportunities; maritime training, skilling and prevention of corruption; maritime crewing and employment opportunities; sustainability, green transition and environmental protection; and coastal shipping and inland navigation. These pillars provide a comprehensive basis for deliberations on the

regulatory, operational, environmental and human-resource dimensions of maritime development.

Gujarat-Specific Priorities

The Gujarat workshop will focus on the State's distinctive maritime strengths and development requirements, including port-led economic growth, coastal shipping and inland waterways, shipbuilding and ship recycling at Alang, maritime skill development, maritime safety and resilience, green maritime transition, and innovation in maritime governance. The discussions will also examine how Gujarat's established port network, industrial base and maritime institutions can contribute more effectively to national maritime growth.

The initiative builds upon the first physical Coastal State Workshop conducted in Goa, which provided a collaborative platform for Centre-State deliberations on key maritime priorities and sectoral challenges. Gujarat is among the identified workshops alongside Tamil Nadu, Andhra Pradesh and Kerala. The Gujarat engagement is intended to translate broad national priorities into practical, State-specific interventions and strengthen the State's role as a major driver of India's maritime economy.The map also indicates major logistics corridors, including the Western Dedicated Freight Corridor, the Delhi-Mumbai Industrial Corridor and other key rail connectivity. These corridors provide Gujarat's ports with hinterland access to Delhi, Mumbai and other major economic centres. This connectivity is a critical factor in enabling efficient cargo evacuation, reducing logistics costs and improving the competitiveness of Indian exports and imports.

4. GIFT City as a Catalyst for an India International Ship Registry and Maritime Financing Ecosystem

4.1. Strengthening India's Maritime Financial Competitiveness

GIFT City has emerged as an important platform for developing internationally competitive maritime financing, leasing and ship-owning structures in India. Recent reforms have focused on creating greater flexibility for entities operating within the International Financial Services Centre (IFSC), with the objective of attracting maritime capital, expanding Indian-linked tonnage and supporting global shipping operations from India.

The notification issued on 7 July 2026 provides additional regulatory flexibility by enabling eligible GIFT-IFSC entities to charter foreign vessels for EXIM and international trade without requiring a separate licence under Section 11. The reforms are intended to simplify operational procedures, reduce compliance burdens and improve the ease of doing business for maritime enterprises operating through GIFT City.

4.2. Licensing and Flagging Reforms

The proposed framework combines licensing flexibility with provisions for overseas vessel registration and operation. While maintaining the existing cabotage framework

and safeguards applicable to coastal trade, the reforms seek to provide internationally aligned structures for ship ownership, leasing and vessel deployment.

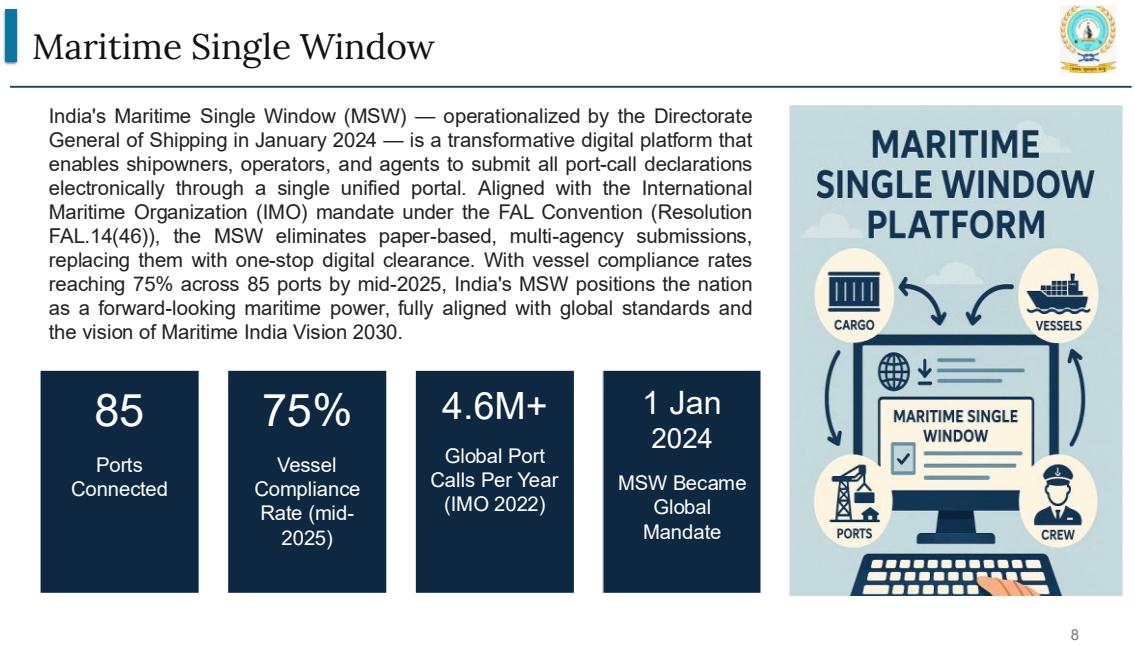
The overseas flagging framework is expected to allow IFSC-based entities to register and operate vessels under foreign flags, thereby providing greater operational flexibility and enhancing India's attractiveness as a maritime business jurisdiction. Such measures can facilitate participation by global ship owners, leasing entities and maritime service providers while strengthening India's integration with international shipping markets.

4.3. Expected Impact on the Maritime Ecosystem

The combined effect of these reforms is expected to support the growth of India-linked tonnage and deepen the country's maritime financial ecosystem. Greater flexibility in ownership and leasing structures can help attract maritime investments, increase participation of international capital and expand the range of maritime services anchored in India.

The development of a stronger maritime financing ecosystem through GIFT City has the potential to complement India's broader maritime ambitions by supporting ship acquisition, leasing, financing and international shipping operations. Over time, such initiatives could contribute to establishing GIFT City as a key hub for maritime finance and a potential foundation for an India International Ship Registry.

5. Maritime Single Window



5.1. Digital Integration of Port-Clearance Processes

India’s Maritime Single Window (MSW) represents an important step towards digital transformation and process simplification in the maritime sector. Operationalized by the Directorate General of Shipping in January 2024, the platform enables shipowners, operators and agents to submit port-call declarations electronically through a single

unified portal. This replaces multiple paper-based and agency-wise submissions with a more integrated and transparent digital clearance mechanism.

The MSW is aligned with the International Maritime Organization's mandate under the FAL Convention, which requires member countries to adopt electronic information exchange for ship arrival, stay and departure formalities. With global shipping handling millions of port calls annually, the move towards a single-window system is essential for reducing procedural delays, improving data consistency and enhancing the ease of doing business in maritime operations.

India's MSW has achieved connectivity across 85 ports, with vessel compliance reaching around 75% by mid-2025. This indicates a significant shift towards digital adoption across the port ecosystem. By enabling online submission, faster processing and better coordination among stakeholders, the platform strengthens India's capacity to meet international standards in maritime governance.

5.2. Significance

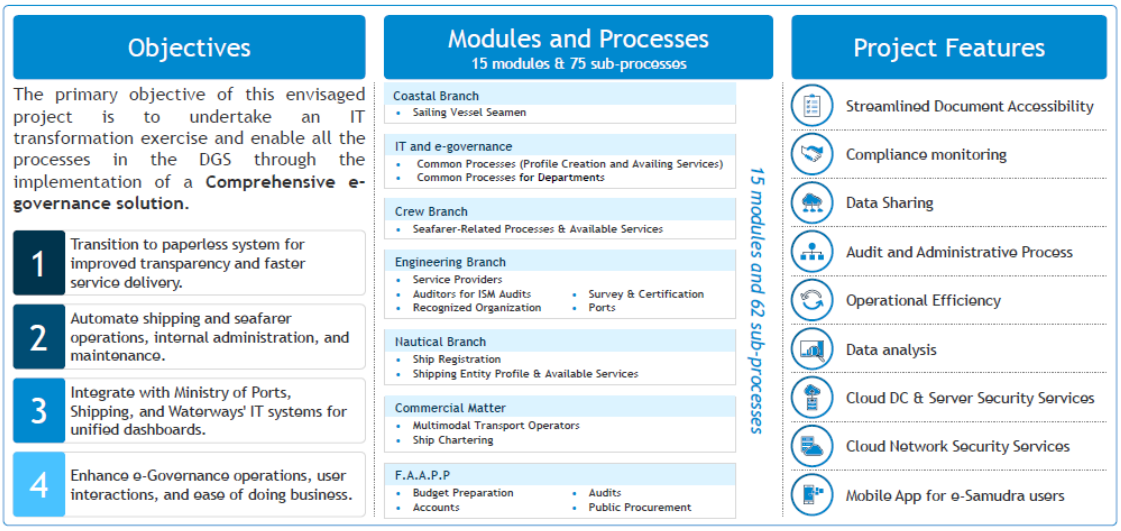
The Maritime Single Window supports the broader objectives of Maritime India Vision 2030 by promoting paperless clearance, reducing administrative duplication and improving efficiency in port-call management. It also enhances transparency by creating a unified digital record of vessel-related declarations and approvals.

By integrating port authorities, shipping agents, vessels, cargo interests and government agencies through a common platform, MSW contributes to faster turnaround, improved compliance monitoring and more predictable maritime operations. Its implementation marks a major transition from conventional documentation-based procedures to a modern digital governance framework for Indian ports.

6. Digitalisation

6.1. E-Samudra

E-Samudra



The Directorate General of Shipping has initiated the e-Samudra programme as a comprehensive digital governance platform aimed at transforming maritime administration through end-to-end digitisation of regulatory processes, stakeholder services and internal workflows. The initiative is designed to support the transition from fragmented and paper-based systems to an integrated digital ecosystem capable of providing seamless service delivery, improving transparency and strengthening regulatory oversight. As the maritime sector continues to expand in scale and complexity, there is an increasing need for technology-enabled governance frameworks that can efficiently support shipping operations, seafarer services, vessel administration and maritime regulatory functions. The e-Samudra platform has therefore been conceptualised as a foundational pillar of maritime digital transformation within the Directorate General of Shipping.

The primary objective of the initiative is to create a comprehensive e-governance solution that integrates multiple functions and processes under a unified digital architecture. The platform seeks to enable paperless processing, automated workflows, secure data management and improved service delivery across the maritime administration. By digitising regulatory and administrative functions, e-Samudra aims to reduce processing timelines, improve stakeholder convenience and enhance transparency in service delivery. The shift towards digital governance also aligns with broader national objectives relating to digital transformation, ease of doing business and efficient public service delivery.

A significant feature of the platform is its extensive coverage of maritime regulatory functions through multiple digital modules and sub-processes. The system is designed to support activities across various branches including coastal shipping administration, seafarer services, engineering and survey functions, ship registration, certification, commercial shipping matters and internal administrative processes. By integrating these diverse functions within a common digital environment, the platform facilitates

seamless information flow and reduces dependency on isolated systems. The resulting interoperability is expected to improve efficiency while enabling better coordination across different departments and functional areas.

The implementation of e-Samudra will support complete transition towards paperless operations for a wide range of maritime services. Digital submission of applications, electronic processing of records and online issuance of approvals and certificates will significantly reduce physical documentation requirements. In addition to improving convenience for stakeholders, paperless processing enhances traceability, reduces administrative burden and contributes towards more environmentally sustainable governance practices. Greater transparency in workflows can also improve accountability and strengthen confidence among maritime stakeholders interacting with the administration.

Another important objective of the platform is the automation of shipping and seafarer-related processes. Automation of routine activities enables more efficient management of applications, approvals, records and regulatory transactions while reducing the possibility of manual errors and process delays. The initiative also seeks to strengthen integration with digital systems maintained by the Ministry of Ports, Shipping and Waterways and other government entities, thereby facilitating exchange of information and creation of unified monitoring frameworks. Such integration will support data-driven decision-making and improve visibility across various maritime functions.

The platform incorporates several features aimed at strengthening governance, compliance monitoring and operational efficiency. Enhanced document accessibility, digital record management and data-sharing capabilities will facilitate easier access to information while maintaining appropriate security and governance safeguards. Integrated compliance monitoring functions will improve regulatory oversight and support timely identification of non-compliance issues. The platform also enables structured audit and administrative processes, thereby strengthening institutional governance and improving overall effectiveness of maritime administration.

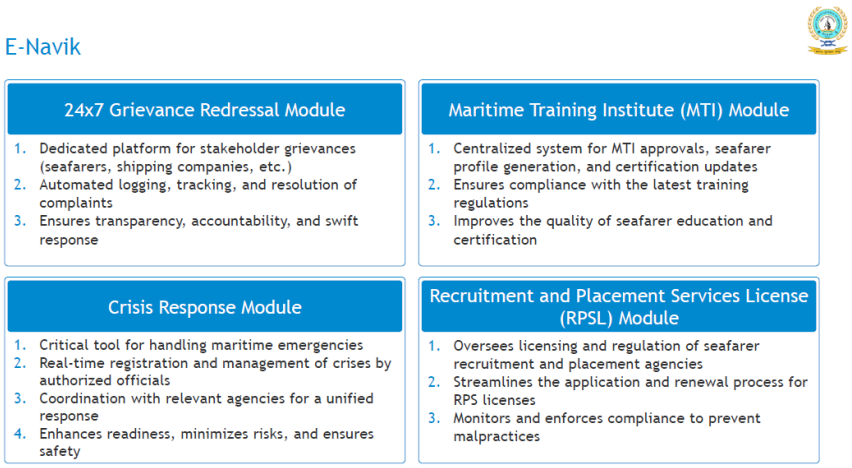
Technology-enabled data analysis forms an important component of the e-Samudra framework. The availability of consolidated data across multiple functions provides opportunities for generating insights that can support policy development, operational planning and performance monitoring. Analytical capabilities can assist administrators in identifying trends, monitoring service delivery performance and evaluating the effectiveness of regulatory interventions. Such data-driven governance approaches contribute towards more informed decision-making and continuous improvement in administrative processes.

Given the critical nature of maritime regulatory information, the platform has also been designed with strong emphasis on digital security and system resilience. Cloud infrastructure, network security measures and secure data management practices are intended to support business continuity, protect sensitive information and ensure reliability of digital services. The inclusion of mobile application support further improves

accessibility by enabling stakeholders to access services and information through multiple digital channels. This enhances user experience and facilitates greater adoption of digital services across the maritime community.

Through the implementation of e-Samudra, the Directorate General of Shipping seeks to establish a modern digital governance ecosystem capable of supporting future maritime growth while improving service delivery, compliance management and ease of doing business. The platform represents a major step towards creating a transparent, efficient and stakeholder-centric maritime administration aligned with the objectives of Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047. By integrating regulatory functions, automating processes and enabling data-driven governance, e-Samudra is expected to significantly strengthen the effectiveness and responsiveness of maritime administration in India.

6.2. E-Navik



The e-Navik platform represents a major component of the Directorate General of Maritime Administration's digital transformation agenda and is designed to function as an integrated digital ecosystem for seafarer services, stakeholder engagement, regulatory oversight and emergency response. As the maritime sector becomes increasingly digitised, there is a growing need for centralized platforms capable of delivering efficient services, strengthening governance and improving interaction between the maritime administration and stakeholders. The e-Navik initiative seeks to address these requirements by bringing together multiple operational and welfare-related functions within a unified digital framework.

A key component of the platform is the 24x7 Grievance Redressal Module, which is intended to provide a dedicated mechanism for receiving, tracking and resolving grievances raised by maritime stakeholders, including seafarers, shipping companies and other users of maritime services. The module seeks to improve transparency, accountability and responsiveness by enabling digital registration and monitoring of complaints throughout the resolution lifecycle. Automated workflows and tracking mechanisms will facilitate timely action on grievances while providing stakeholders with greater visibility regarding the status of their submissions. The initiative is expected to

strengthen confidence in administrative processes and ensure more efficient handling of stakeholder concerns.

The platform also incorporates a dedicated Maritime Training Institute (MTI) Module aimed at streamlining administration and oversight of maritime training institutions. The module is designed to support functions such as institute approvals, seafarer profile management, certification updates and regulatory compliance monitoring. By centralizing information relating to maritime education and training, the system enhances transparency and facilitates more effective supervision of training activities. The module is expected to improve adherence to evolving training standards while supporting consistent delivery of maritime education and certification services across approved training institutions.

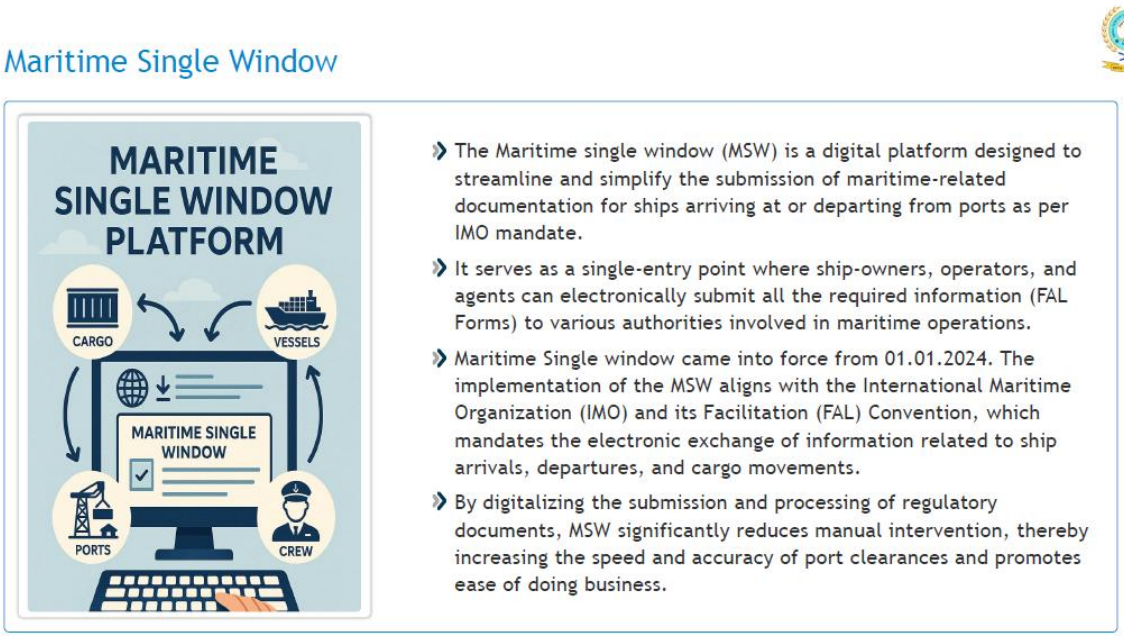
Another significant component is the Recruitment and Placement Services License (RPSL) Module, which focuses on regulation and monitoring of recruitment and placement agencies operating within the maritime sector. Recruitment agencies play a critical role in connecting seafarers with employment opportunities, and effective oversight is essential for protecting seafarers from fraudulent practices and ensuring compliance with applicable regulations. The module digitises licensing, renewal and compliance-related processes, enabling improved monitoring and more efficient administration of recruitment agencies. Enhanced regulatory oversight through the platform is expected to strengthen transparency and contribute towards prevention of malpractice within the crewing ecosystem.

The Crisis Response Module represents an important welfare and emergency management tool within the e-Navik framework. Maritime operations frequently involve situations requiring coordinated response across multiple agencies, including accidents, emergencies, abandonment cases, welfare incidents and other crisis situations affecting seafarers and vessels. The module is designed to facilitate real-time registration, monitoring and management of crisis events by authorised officials. By establishing a digital mechanism for coordination and information sharing, the system supports timely intervention and strengthens preparedness for handling maritime emergencies. Improved coordination among relevant agencies can enhance the effectiveness of response measures while helping minimise risks and safeguard the welfare of affected personnel.

Collectively, the various modules within e-Navik contribute towards creating a more responsive, transparent and digitally enabled maritime administration. The platform strengthens service delivery by integrating welfare functions, regulatory oversight, training governance, grievance handling and crisis management within a common digital environment. Such integration improves operational efficiency, reduces administrative delays and facilitates data-driven decision-making across multiple areas of maritime administration. The initiative also aligns with broader objectives relating to ease of doing business, seafarer welfare and digital governance under Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047.

The implementation of e-Navik is expected to significantly improve stakeholder experience while strengthening institutional capacity within the maritime administration. By providing digital access to services, improving monitoring capabilities and enhancing coordination across different functional areas, the platform establishes a modern governance framework capable of supporting the evolving needs of India's maritime sector. The initiative represents a key step towards creating a more efficient, transparent and stakeholder-centric maritime ecosystem supported by technology-enabled governance and service delivery.

6.3. Maritime Single Window



The Maritime Single Window (MSW) represents one of the most significant digital reforms undertaken in the maritime sector to facilitate paperless and seamless exchange of information relating to ship arrivals, departures and cargo operations. The platform has been developed in accordance with the International Maritime Organization's Facilitation (FAL) Convention, which mandates electronic transmission and exchange of information between ships and shore authorities. Traditionally, shipowners, operators and agents were required to submit similar information separately to multiple regulatory agencies, resulting in duplication of effort, increased compliance burden and delays in processing. The Maritime Single Window seeks to eliminate these inefficiencies by providing a unified digital interface through which all required information can be submitted once and shared electronically with relevant authorities.

The platform functions as a single-entry digital gateway for stakeholders involved in maritime transport and port operations. Through the system, shipowners, operators, masters and shipping agents can electronically submit mandatory information and FAL forms required by various government agencies. The digital integration of multiple authorities into a common platform reduces the need for repetitive submissions and manual document handling while ensuring greater consistency and accuracy of

information. This approach aligns with international best practices and supports the global trend towards digitalisation of maritime logistics and port clearance processes.

The implementation of the Maritime Single Window marks a major step towards compliance with international facilitation requirements and strengthening India's position as a modern maritime nation. By aligning domestic procedures with IMO standards, the platform facilitates smoother interaction between ships and regulatory authorities while enhancing operational efficiency within the port ecosystem. The initiative also supports international shipping companies operating in Indian waters by providing standardised and predictable digital processes consistent with global maritime practices. Such alignment is important for improving stakeholder confidence and strengthening India's attractiveness as a maritime and logistics destination.

A major advantage of the system lies in its ability to significantly reduce manual intervention in regulatory and administrative processes. Digital submission and processing of information eliminates dependence on physical documentation and enables faster transmission of data across agencies. Reduction in manual processing not only improves speed but also enhances data quality, minimises errors and strengthens transparency. Automated workflows facilitate quicker review and approval processes, thereby contributing to more efficient port clearances and reduced vessel turnaround times. These improvements directly support operational efficiency within ports and shipping operations.

The platform also contributes to enhanced coordination among various authorities involved in maritime operations. Multiple government departments and regulatory entities require information relating to vessel arrivals, cargo movements, crew details and operational clearances. The Maritime Single Window enables these agencies to access and utilise information from a common digital source, thereby improving coordination and reducing delays caused by fragmented communication channels. Better information sharing supports faster decision-making and strengthens the overall effectiveness of maritime administration.

From an ease-of-doing-business perspective, the introduction of the Maritime Single Window is expected to generate substantial benefits for the shipping and logistics sector. Simplification of documentation requirements, reduction of administrative burden and faster processing timelines help reduce compliance costs and improve predictability of port-related procedures. These improvements are particularly important for supporting trade facilitation, enhancing logistics competitiveness and creating a more efficient environment for shipping operators and maritime stakeholders. The initiative therefore contributes not only to regulatory modernisation but also to broader economic objectives relating to trade and logistics efficiency.

The Maritime Single Window forms an integral part of India's broader digital transformation agenda within the maritime sector. Together with initiatives such as e-Samudra, e-Navik and other digital governance platforms, the system supports the creation of an integrated and technology-enabled maritime ecosystem. By facilitating

seamless exchange of information, enhancing transparency and improving service delivery, the platform contributes towards strengthening maritime governance while supporting the objectives of Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047. The initiative represents an important milestone in the development of a modern, efficient and globally aligned maritime administration capable of supporting the future growth of India's maritime economy.

6.4. Shipbuilding scheme portal

The Directorate General of Maritime Administration is increasingly leveraging digital technologies to improve governance, transparency and service delivery across various segments of the maritime sector. While significant progress has been achieved through initiatives such as e-Samudra, e-Navik and the Maritime Single Window, the shipbuilding sector also requires a dedicated digital ecosystem capable of supporting efficient implementation of government support schemes and facilitating stakeholder interaction. In response to this requirement, a dedicated DGS Shipbuilding Portal has been developed to provide an end-to-end digital platform for administration of shipbuilding-related schemes and initiatives.

The portal has been designed to digitise the complete lifecycle of scheme administration and stakeholder interactions, thereby eliminating dependency on manual processes and physical documentation. Traditionally, applicants seeking benefits under shipbuilding incentive schemes were required to submit documents through multiple stages involving manual scrutiny, physical correspondence and extensive follow-up. Such processes often resulted in administrative delays and limited visibility regarding the status of applications. The digital platform addresses these challenges by providing a single integrated interface for application submission, processing, tracking and management. This contributes to greater transparency while significantly improving ease of doing business for stakeholders engaged in the shipbuilding sector.

A key feature of the portal is the ability to facilitate online submission of applications relating to various shipbuilding support measures and incentive schemes. Through a structured digital workflow, applicants can upload required documents, complete prescribed forms and submit requests electronically without physical interaction with multiple offices. Standardisation of the application process improves consistency, reduces administrative burden and supports faster processing of requests. The digital platform also enables easier record management and creates an auditable trail of all transactions undertaken through the system.

The portal further introduces real-time tracking and monitoring capabilities, allowing applicants and administrators to monitor the progress of applications through different stages of evaluation and approval. Improved visibility of application status enhances transparency and reduces uncertainty often associated with manual processing systems. Stakeholders are able to track developments electronically while administrators can monitor workflow efficiency and identify bottlenecks requiring intervention. Such transparency contributes towards greater accountability and improves confidence in scheme administration processes.

Digital issuance of approvals, certificates and related documentation represents another important component of the platform. By replacing traditional paper-based processes with electronically generated approvals and records, the portal improves operational efficiency while reducing processing timelines. Digital issuance also strengthens authenticity, improves accessibility and facilitates easier retrieval of records when required. The resulting reduction in paperwork and administrative effort contributes towards a more efficient and user-friendly regulatory environment.

The portal also supports digital management of redemption and benefit disbursement processes associated with government support schemes. Effective management of incentive claims requires accurate tracking, verification and documentation of eligibility conditions. Integration of these activities within the digital platform enables more efficient administration, improves traceability and supports timely processing of eligible claims. Such capabilities are particularly important for schemes aimed at promoting domestic shipbuilding, fleet modernisation and maritime industrial development.

The implementation of the DGS Shipbuilding Portal aligns with broader national objectives relating to ease of doing business, digital governance and promotion of maritime manufacturing capabilities. Government initiatives such as the Shipbuilding Financial Assistance Scheme, Ship Recycling Credit Note Scheme and other shipbuilding support measures require efficient and transparent administrative mechanisms to maximise their effectiveness. A dedicated digital platform strengthens implementation capacity while improving accessibility and convenience for industry stakeholders seeking to participate in these programmes.

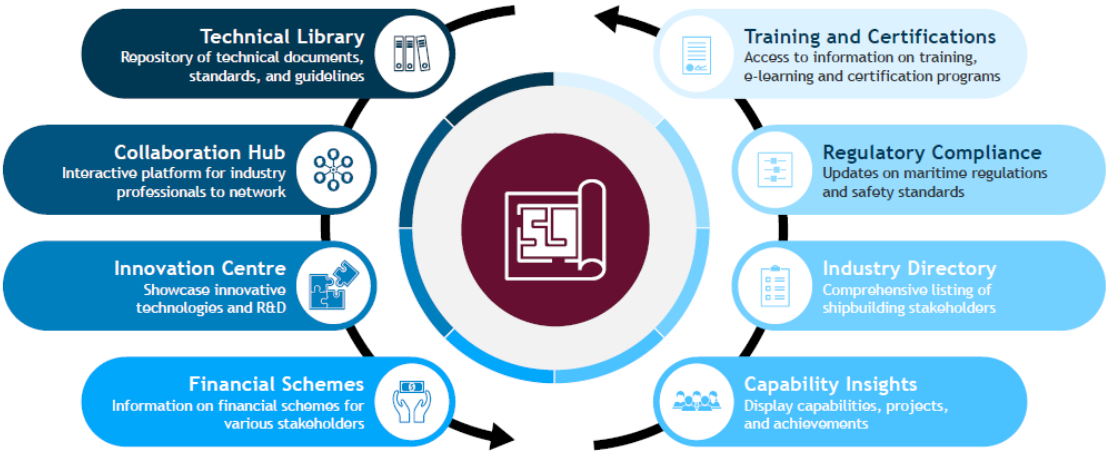
The portal also supports the long-term objective of creating a more competitive and investment-friendly shipbuilding ecosystem in India. By reducing administrative complexity, improving transparency and providing a predictable digital interface for

interactions with the maritime administration, the platform contributes towards a more enabling business environment. Enhanced digital governance can encourage greater participation by shipyards, vessel owners and investors while supporting the broader objectives of Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047 relating to domestic shipbuilding capacity enhancement and maritime industrial development.

Through end-to-end digitisation of application processing, tracking, approvals and benefit administration, the DGS Shipbuilding Portal represents an important step towards modernising governance within the shipbuilding sector. The platform reinforces the commitment of the maritime administration towards technology-enabled service delivery and provides a transparent, efficient and stakeholder-centric mechanism for implementation of shipbuilding support initiatives.

6.5. Comprehensive shipbuilding portal

Comprehensive Shipbuilding portal development underway as a single digital gateway to integrate India's entire shipbuilding ecosystem



India's shipbuilding ecosystem is characterised by the participation of multiple stakeholders including shipyards, vessel owners, equipment manufacturers, classification societies, training institutions, financial institutions, technology providers and government agencies. While several policy initiatives have been introduced to support sectoral growth, information relating to schemes, regulations, technical standards, research activities and stakeholder capabilities often remains distributed across multiple sources. The absence of a unified digital platform limits collaboration, increases information asymmetry and creates challenges for industry participants seeking access to opportunities, guidance and institutional support. To address these challenges, a comprehensive Shipbuilding Portal is being developed as a single digital gateway to integrate and strengthen India's entire shipbuilding ecosystem.

The proposed platform is intended to function as a central repository of information and services relevant to all stakeholders across the shipbuilding value chain. By bringing together technical resources, regulatory information, industry databases, training opportunities, financial assistance schemes and collaboration tools within a single

digital environment, the portal seeks to improve accessibility and reduce fragmentation of information. The initiative aligns with the broader objectives of creating a modern, technology-enabled and industry-focused maritime ecosystem capable of supporting long-term growth in domestic shipbuilding and ship repair activities.

A key component of the portal is the development of a Technical Library that will provide access to technical documents, design standards, guidelines, regulations and reference materials relevant to shipbuilding and related maritime industries. Easy access to updated technical information is critical for improving industry knowledge, strengthening compliance and facilitating adoption of best practices. The Technical Library is expected to serve as an important knowledge resource for shipyards, designers, engineers, researchers and regulators while supporting standardisation and quality enhancement across the sector.

The platform also envisages establishment of a Collaboration Hub to facilitate interaction among industry stakeholders. Shipbuilding projects often require close coordination among multiple participants including shipyards, designers, equipment suppliers, classification societies, academic institutions and research organisations. The proposed collaboration framework will provide opportunities for networking, knowledge sharing and partnership development, thereby strengthening industry linkages and supporting collective capacity building. Improved stakeholder connectivity can contribute significantly towards innovation, project execution and long-term sectoral growth.

Innovation and technology development form another important pillar of the proposed portal. Through a dedicated Innovation Centre, the platform seeks to showcase emerging technologies, research initiatives and indigenous innovations relevant to shipbuilding and marine engineering. The initiative will promote greater visibility of research and development activities while encouraging adoption of advanced technologies and innovative solutions across the industry. By creating a forum for exchanging ideas and disseminating technological advancements, the portal can support competitiveness and facilitate development of a stronger domestic marine technology ecosystem.

The portal will further provide information relating to various Financial Schemes and support mechanisms available to industry participants. Access to funding support, incentive programmes and financial assistance schemes remains an important factor influencing investment decisions and sectoral growth. Consolidation of information relating to such schemes within a single platform will improve awareness among stakeholders and facilitate more effective utilisation of available government support measures. Enhanced visibility of financial assistance opportunities is expected to support expansion of domestic shipbuilding capacity and encourage greater industry participation.

Human resource development and regulatory awareness are also integral components of the proposed ecosystem. Dedicated sections relating to Training and Certifications will provide information on relevant courses, skill development programmes,

certification pathways and e-learning opportunities. Simultaneously, the Regulatory Compliance component will keep stakeholders informed regarding maritime regulations, safety requirements and evolving compliance standards applicable to shipbuilding and ship repair activities. Improved access to training and regulatory information will contribute towards workforce development and strengthen overall industry compliance.

To improve visibility across the industry, the platform also proposes creation of an Industry Directory and Capability Insights framework. The Industry Directory will provide a structured listing of shipbuilding stakeholders, while the Capability Insights module will showcase projects, facilities, achievements and technical capabilities of participating organisations. Such features can facilitate business development, enhance transparency regarding available capacities and support collaboration among industry participants. Increased visibility of domestic capabilities will also help promote Indian shipyards and service providers before potential customers and investors.

The comprehensive Shipbuilding Portal represents a strategic step towards creating an integrated and digitally connected shipbuilding ecosystem in India. By combining technical resources, industry networking, innovation promotion, financial support information, training opportunities and regulatory guidance within a single platform, the initiative seeks to create a collaborative environment capable of supporting growth across the shipbuilding value chain. The proposed framework will contribute towards strengthening domestic capabilities, improving ease of doing business and advancing the objectives of Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047 relating to shipbuilding, maritime industrial development and global competitiveness.

6.6. Training Ecosystem

Training Ecosystem Vision

The Training Ecosystem envisions the creation of a unified, cloud-based digital platform to regulate, monitor, and modernize maritime training, certification, and skill development. The objective is to bring all stakeholders—training institutes, faculty, trainees, regulators, and certifying authorities—onto a single integrated system, ensuring consistency, compliance, transparency, and quality enhancement across the maritime training landscape.

2. Key Features

The proposed ecosystem integrates seven critical modules, including Learning Management Systems (LMS), Faculty Development, Web-Based Simulators, AR/VR-based training, centralized attendance, certificate validation, and digital training & assessment records, into one cohesive digital framework. The platform enables real-time oversight, data-driven decision-making, and secure, transparent operational processes through advanced technology and centralized governance.

LMS-The LMS is a secure, DGS-compliant e-learning platform for standardized maritime training which ensures training integrity through real-time tracking, anti-cheating controls, and assessment access only after full course completion.

Web Based Simulation-A web-based simulator provides an immersive, interactive platform that replicates real-world maritime scenarios for effective learning and assessment.

Digital Tar-The Training and Assessment Record (TAR) Book is a mandatory document that records and verifies a seafarer's structured onboard training and practical competencies.

CAS 2.0-The Centralized Attendance System (CAS) uses facial biometrics to securely verify the presence of candidates, faculty, and administrators across Maritime Training Institutes.

OMCV-Online Marine Certificates Verification (OMCV) is a digital platform that enables secure upload, verification, and digital stamping of maritime certificates to ensure authenticity.

FDP-A Faculty Development Program (FDP) is a structured initiative designed to upgrade teaching skills, subject expertise, and professional competencies of faculty members through continuous learning and assessment.

AR/VR-Augmented Reality (AR) and Virtual Reality (VR) are immersive digital technologies designed to deliver realistic, interactive experiences for training, learning, and operational simulation. These technologies enhance engagement, situational awareness, and skill development.

Outcome of the Training Ecosystem RFP

The RFP aims to facilitate the selection of a **Master System Integrator** responsible for designing, developing, and implementing the integrated Training Ecosystem. The successful implementation is expected to enhance maritime training quality, enable

standardized skilling and certification, improve regulatory oversight, and significantly increase overall system efficiency.

6.7. E-Pariksha

The Examination, Assessment, and Certification reforms for Certificates of Competency (CoC), covering both written and oral examinations, establish a fully digitized and integrated system that encompasses the entire examination lifecycle. The framework operates as an end-to-end digital process beginning with user registration, followed by eligibility assessment, seat booking, monitoring of misconduct, conduct of examinations, evaluation and re-evaluation, data storage, and management of the question bank and question paper generation. Each stage is structured within a unified digital platform, ensuring continuity, traceability, and standardization across all examination-related activities.

The system initiates with user registration, where candidates are onboarded into the digital platform. This is followed by eligibility assessment based on predefined regulatory criteria, ensuring that only qualified candidates proceed to the examination stage. Seat booking is managed digitally, enabling candidates to select examination slots in a structured and transparent manner. The framework also incorporates mechanisms to detect and address misconduct during the examination process, ensuring adherence to rules and maintaining the integrity of assessments.

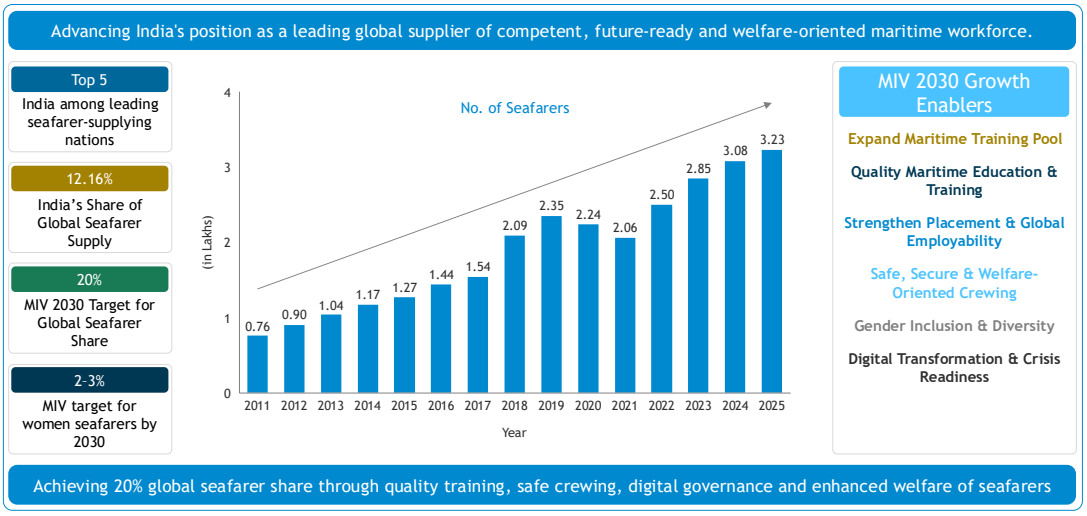
The conduct of examinations is managed through digital and hybrid modes, including Computer-Based Testing and structured oral examinations. The evaluation process is also digitized, with provisions for re-evaluation to ensure fairness and accuracy in results. All examination data is stored in a centralized system, enabling secure record-keeping, data retrieval, and audit capabilities. The question bank and question paper generation are integrated into the system, ensuring controlled access, standardization, and security in the preparation and distribution of examination content.

The objective of the reform is to create a secure, transparent, and fully digital examination system for the competency assessment and certification of seafarers. This objective is achieved through the implementation of technology-driven processes that eliminate manual inefficiencies and introduce consistent standards across all stages of examination and certification.

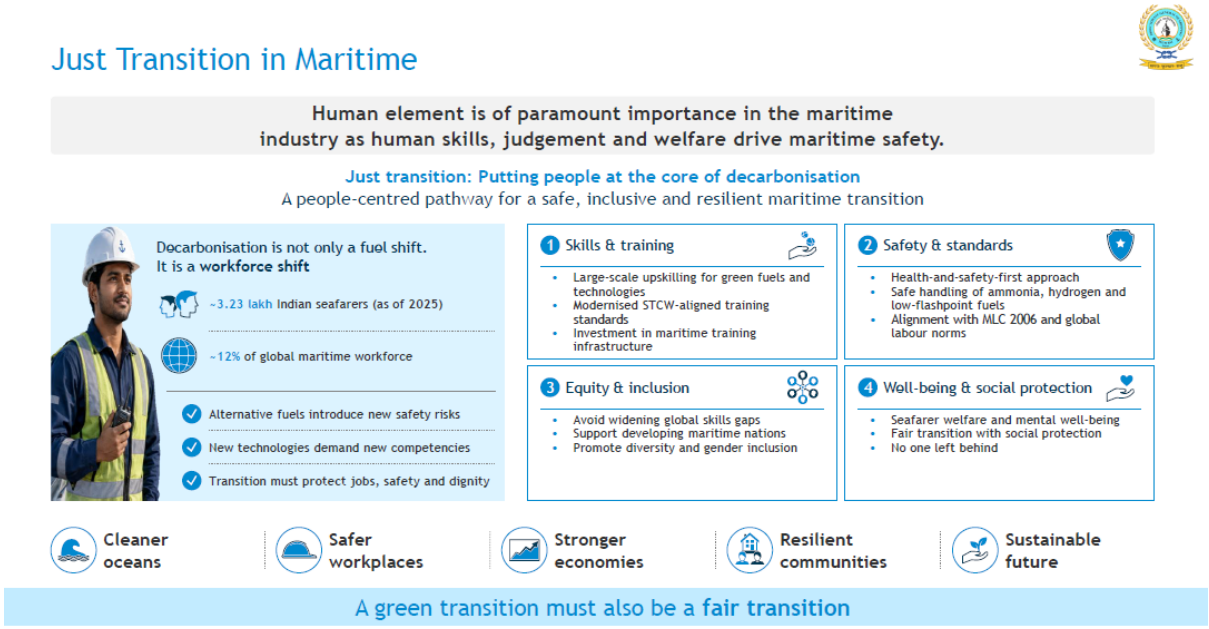
The scope of the system extends across the entire examination lifecycle, from initial registration to the issuance of certificates. It includes both written and oral examinations, conducted through hybrid or computer-based modes, ensuring flexibility while maintaining uniform standards. The system is designed to function across all Maritime Mercantile Departments (MMDs), ensuring nationwide consistency in examination practices.

Core features of the system include biometric verification for candidate authentication, CCTV surveillance, and online proctoring to monitor examination conduct. Question papers are encrypted to ensure confidentiality, while answer scripts are digitized through scanning for secure evaluation. The system also includes mechanisms for grievance redressal and feedback from candidates, ensuring that concerns are addressed within the same digital ecosystem.

The impact of these reforms is reflected in the creation of a uniform candidate experience across all examination centres, reducing regional variations in procedures. The integration of digital tools enhances examination integrity by minimizing the risk of malpractices, while also improving operational efficiency through automated processes. Transparency is strengthened through real-time monitoring, secure data handling, and traceable workflows, ensuring accountability at each stage of the examination and certification process.



6.8. Just Transition in Maritime



The maritime sector is entering a period of significant transformation driven by global decarbonisation objectives, adoption of alternative fuels and the emergence of new operational technologies. While much of the international discourse on maritime transition focuses on vessel technology, fuel pathways and emission reduction targets, the success of this transition will ultimately depend on the readiness, competence and welfare of seafarers and other maritime professionals who are responsible for operating these systems safely and effectively. Human skills, judgment and welfare remain the foundation of maritime safety, and therefore the transition towards low-carbon shipping must be pursued as a people-centric transformation rather than merely a technological shift.

India currently contributes a significant share of the global seafaring workforce and is recognised as one of the leading maritime manpower-supplying nations. As the shipping industry moves towards alternative fuels such as ammonia, hydrogen, methanol and other emerging energy solutions, there will be a corresponding requirement for new competencies, specialised training and enhanced safety awareness among maritime personnel. Unlike conventional fuels, many emerging fuel types involve unique handling procedures, storage arrangements and operational risks that require additional knowledge and skills. The workforce transition therefore becomes an essential element of maritime decarbonisation, with training and continuous professional development serving as critical enablers for safe adoption of future technologies.

A key component of a just transition framework is the creation of a comprehensive skills and training ecosystem capable of preparing maritime personnel for the evolving requirements of green shipping. Existing training standards will need to be continuously updated to reflect emerging industry practices, technological developments and international regulatory requirements. The introduction of specialised training programmes, simulator-based learning environments and updated competency standards will be necessary to equip seafarers with the skills required to operate vessels using alternative fuels and advanced digital systems. Continued investment in maritime training infrastructure, faculty development and research capabilities will therefore play an important role in ensuring that India remains a leading provider of highly skilled maritime professionals during the transition period.

Safety considerations assume even greater importance as the industry adopts new technologies and fuel systems. Alternative fuels introduce operational characteristics and hazards that differ from traditional marine fuels and therefore require enhanced risk management measures. A successful transition will require a proactive safety-first approach supported by robust training, updated operational procedures, specialised emergency response capabilities and strengthening of international safety standards. Alignment with the Maritime Labour Convention, 2006 and other international instruments will remain essential to ensure that technological advancement is accompanied by continued protection of seafarer rights, living conditions and occupational safety standards.

The transition must also be inclusive and equitable. There is a risk that rapid technological change may create disparities in access to skills, employment opportunities and training resources across different segments of the maritime workforce and among maritime nations. A just transition framework therefore seeks to ensure that the benefits of decarbonisation are widely shared and that no group is disproportionately disadvantaged during the transition process. Particular emphasis is required on supporting developing maritime nations, expanding access to training opportunities, promoting diversity within the maritime workforce and encouraging greater participation of women and underrepresented groups in maritime careers. Such measures will help create a resilient and inclusive maritime ecosystem capable of adapting to long-term industry transformation.

Equally important is the need to strengthen social protection and welfare mechanisms for maritime personnel. The transition towards greener shipping should not be achieved at the cost of workforce well-being. Seafarers will be required to operate increasingly sophisticated equipment while simultaneously adapting to new operational practices and regulatory obligations. Enhanced welfare measures, mental health support systems, fair employment practices and adequate social protection mechanisms will therefore be critical components of the transition process. Protecting livelihoods and ensuring workforce resilience will help maintain confidence among maritime professionals and support long-term sustainability of the sector.

A people-centred approach to maritime decarbonisation provides benefits extending beyond environmental outcomes alone. Investment in skills, safety, inclusion and welfare contributes to cleaner oceans through adoption of sustainable technologies, safer workplaces through enhanced competency and risk management, stronger economies through creation of high-skilled employment opportunities and resilient communities through long-term workforce development. By placing people at the centre of maritime transformation, the sector can ensure that environmental objectives are achieved while simultaneously strengthening safety, competitiveness and social sustainability. The concept of a just transition therefore recognises that successful decarbonisation is not solely about reducing emissions but also about creating a fair, inclusive and future-ready maritime ecosystem capable of supporting sustainable growth for generations to come.

6.9. Abandonment Scenario in India

Abandonment Scenario in India

SUMMARY AS ON DATE		Vessels (Nos.)	Seafarers (Nos.)
16.07.2026			
Cases Resolved (Seafarers Repatriated)	01.01.25 to 31.12.25	108	988
	01.01.26 to till date	56	473

Key Challenges

- Large number of fraudulent and illegal agents are operating, and this leads to illicit extraction of money from seafarers, illegal deployment on vessels, fake CDC endorsement etc.
- Many agents often disappear after receiving the money
- Many seafarers are often left abandoned. India tops the nations with the highest number of seafarer abandonments.

Active Cases Details	Vessels (Nos.)	Seafarers (Nos.)	Stage 1		Stage 2		Stage 3		Stage 4		Stage 5		Stage 6	
			Vls	Seafarer	Vls	Seafarer	Vls	Seafarer	Vls	Seafarer	Vls	Seafarer	Vls	Seafarer
Cat. 1: P&I Valid	20	159	0	0	0	0	1	21	2	3	11	65	6	70
Cat. 2: P&I Expired	15	139	0	0	0	0	1	3	1	26	7	68	6	42
Cat. 3: Disputed	25	169	0	0	0	0	0	0	0	0	18	136	7	33
Cat. 4: Arrest/ Jail/Detention	20	45	1	5	0	0	2	3	6	6	11	31	0	0
TOTAL	80	512	1	5	0	0	4	27	9	35	47	300	19	145

Seafarer abandonment continues to remain one of the most significant welfare and regulatory challenges facing the global maritime industry. Cases of abandonment arise when shipowners fail to fulfil their obligations towards crew members, including payment of wages, provision of essential supplies, repatriation arrangements and

maintenance of safe living conditions on board vessels. Such situations often leave seafarers stranded for extended periods without financial resources, adequate support systems or means of returning to their home countries. The issue has become increasingly complex due to the involvement of multiple jurisdictions, distressed shipowners, vessel detentions, legal disputes and the activities of unauthorised recruitment and placement agents.

India has witnessed a substantial number of abandonment-related cases involving both Indian seafarers and vessels connected to Indian operations. A significant share of these cases involve fraudulent and illegal recruitment agents who collect money from aspiring seafarers through unauthorised channels and subsequently arrange deployment on vessels without proper contractual protections or verification of shipowner credentials. In many instances, such agents disappear after receiving payments, leaving seafarers exposed to exploitation and increased vulnerability. The problem is compounded by the issuance of fraudulent documentation and misleading employment arrangements that make it difficult for seafarers to verify the authenticity of operators and recruitment agencies before joining a vessel.

The growing incidence of seafarer abandonment highlights the need for stronger oversight of recruitment and placement services, enhanced monitoring of vessel compliance and improved mechanisms for early identification of potential distress situations. Many abandonment cases emerge gradually through delays in payment of wages, deterioration of vessel maintenance standards, depletion of onboard supplies or prolonged detention of vessels in ports. Timely intervention by maritime authorities, port administrations and welfare organisations is therefore critical to prevent such situations from escalating into full abandonment cases. Strengthening information-sharing frameworks, improving reporting mechanisms and enhancing coordination between domestic and international stakeholders can significantly improve the effectiveness of response measures.

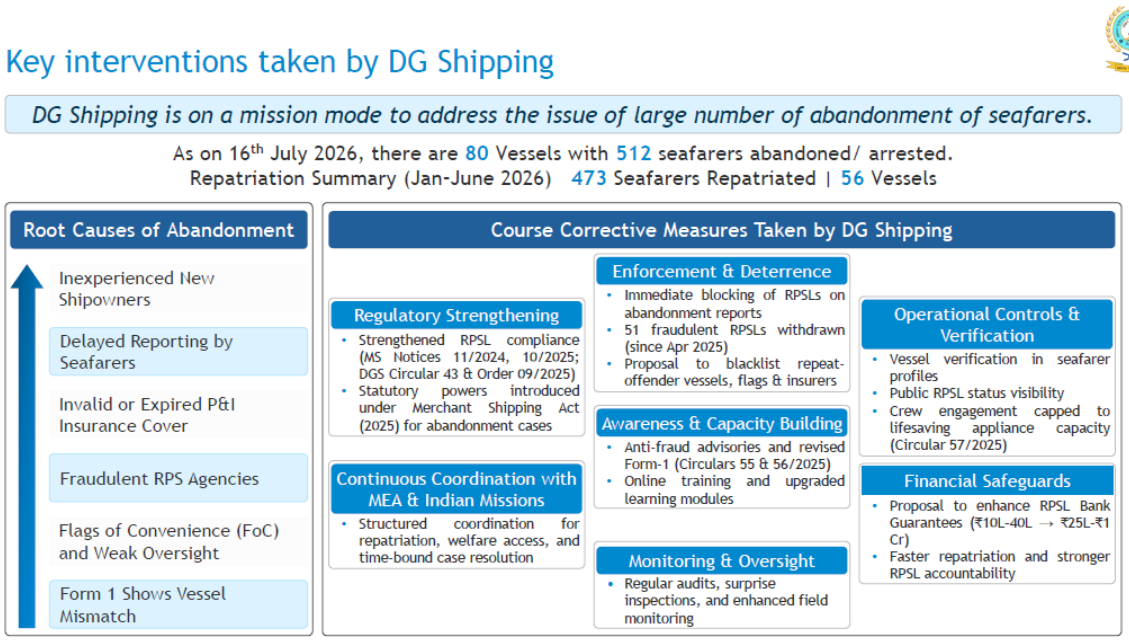
A key challenge in abandonment cases arises from the diverse legal and operational circumstances under which vessels become distressed. Cases may involve vessels with valid documentation but financially distressed owners, vessels with expired certifications, vessels involved in commercial disputes, or vessels under arrest and detention proceedings. Each category presents unique regulatory and welfare challenges requiring coordinated action by maritime administrations, port authorities, insurers, shipowners, flag States and labour welfare organisations. Effective management of abandonment cases therefore requires not only welfare support for affected crew members but also structured mechanisms for resolution of legal, operational and financial issues associated with the vessel.

The protection of seafarers affected by abandonment remains a central objective of international maritime labour standards, particularly under the Maritime Labour Convention, 2006. The Convention places obligations on shipowners and flag States to ensure repatriation, financial security and welfare protection of seafarers serving on board vessels. Strengthening implementation of these protections through domestic

legislation, improved enforcement and enhanced monitoring mechanisms is essential for safeguarding the rights and welfare of maritime personnel. Recent legislative reforms under the Merchant Shipping Act, 2025 further strengthen the Government's ability to intervene in abandonment situations by providing statutory mechanisms for protection of seafarers, including arrangements relating to crew replacement and recovery of associated costs from responsible shipowners.

Addressing the challenge of seafarer abandonment requires a multi-dimensional approach encompassing stronger regulation of recruitment agencies, improved monitoring of vessel operators, enhanced international cooperation and effective welfare support frameworks. Greater awareness among seafarers regarding authorised recruitment channels, stronger enforcement against fraudulent agents and continued alignment with international labour standards will be critical in reducing the incidence of abandonment cases. Such measures will contribute towards strengthening confidence in the maritime profession, protecting the rights and dignity of seafarers and ensuring that India's growing maritime workforce continues to operate within a safe, fair and internationally compliant employment environment.

6.10. Key interventions taken by DG Shipping



The issue of seafarer abandonment has emerged as a priority area for the Directorate General of Shipping due to the increasing number of cases involving distressed vessels, abandoned crews and fraudulent recruitment practices. As of July 2026, a significant number of vessels and seafarers continue to require regulatory intervention, monitoring and welfare assistance, highlighting the need for a coordinated and multi-pronged response. DG Shipping has therefore adopted a mission-mode approach focused not only on repatriation and welfare support but also on addressing the systemic causes that contribute to abandonment cases.

Analysis of abandonment cases indicates that several structural challenges continue to drive the problem. A considerable proportion of cases involve inexperienced shipowners operating vessels with weak financial and operational capability. Delayed reporting by seafarers often allows problems to escalate before authorities are able to intervene. In several instances, vessels are found operating without valid or adequate Protection and Indemnity (P&I) insurance cover, thereby limiting financial security available for repatriation and crew welfare obligations. Fraudulent Recruitment and Placement Service Licensees (RPSLs) and unauthorised recruitment agencies have also contributed to cases of illegal deployment, inadequate contractual protections and misinformation provided to seafarers. In addition, certain vessels operating under flags of convenience and weak oversight regimes present increased risks relating to compliance, welfare protection and enforcement of maritime labour standards. Collectively, these factors increase the vulnerability of seafarers and contribute to the occurrence of abandonment situations requiring intervention by maritime authorities.

To address these challenges, DG Shipping has undertaken a series of regulatory strengthening measures. Various circulars, notices and administrative directions have been issued to tighten oversight of recruitment and placement practices, improve verification mechanisms and strengthen compliance monitoring. Further support has been provided through statutory provisions introduced under the Merchant Shipping Act, 2025, which establish a stronger legal framework for dealing with abandonment cases and protecting affected seafarers. These measures are intended to create a more robust regulatory environment capable of identifying risks at an early stage and facilitating timely intervention where necessary.

Enforcement and deterrence have formed another key pillar of DG Shipping's response. Immediate action has been taken against recruitment agencies linked to abandonment complaints and fraudulent activities, including suspension and withdrawal of licences. Enhanced scrutiny of repeat offenders and stronger enforcement measures have been proposed to discourage non-compliance and improve accountability across the maritime recruitment ecosystem. The objective is to create a strong deterrent against practices that expose seafarers to exploitation and increase the likelihood of abandonment situations.

Recognising that abandonment cases frequently involve foreign jurisdictions, DG Shipping has strengthened coordination mechanisms with the Ministry of External Affairs and Indian Missions abroad. Structured engagement with diplomatic missions has facilitated repatriation efforts, welfare assistance, communication with local authorities and time-bound resolution of cases involving Indian seafarers serving overseas. This coordinated approach has enabled more effective management of complex cases where assistance is required across multiple jurisdictions and regulatory authorities.

Operational controls and verification mechanisms have also been enhanced to reduce opportunities for fraudulent deployment and improve transparency. Measures have been introduced to strengthen vessel verification processes and improve visibility regarding the status of licensed recruitment agencies. Additional safeguards have been

incorporated to ensure that crew engagement processes are aligned with vessel safety and operational requirements. These interventions are expected to improve compliance assurance and provide greater confidence to seafarers seeking employment opportunities through authorised channels.

DG Shipping has also placed significant emphasis on awareness generation and capacity building. Revised documentation requirements, awareness campaigns and training initiatives have been introduced to improve understanding among seafarers regarding recruitment procedures, contractual safeguards, complaint mechanisms and welfare protections. Strengthening awareness at the seafarer level is considered essential for reducing vulnerability to fraudulent operators and ensuring that potential risks are identified and reported at an early stage.

Continuous monitoring and oversight remain central to the overall strategy. Regular audits, inspections and field-level monitoring activities are being undertaken to identify emerging risks and ensure compliance with regulatory requirements. Alongside these efforts, proposals have been developed to strengthen financial safeguards available within the recruitment ecosystem, including enhancement of financial security mechanisms and greater accountability of recruitment agencies. These measures aim to ensure availability of resources for repatriation, welfare support and timely resolution of abandonment cases while reinforcing compliance across the sector.

The combined effect of these interventions is expected to create a stronger preventive framework capable of addressing the root causes of abandonment while simultaneously improving response mechanisms when cases arise. Through regulatory reforms, stronger enforcement, international coordination, enhanced oversight and welfare-focused interventions, DG Shipping is working towards reducing the incidence of abandonment cases and strengthening protection available to Indian seafarers operating across the global maritime industry.

Challenges of life at sea lead to many death cases (including natural death) as well as missing cases

Death Cases

	2012 - 17	2018	2019	2020	2021	2022	2023	2024	2025	2026	TOTAL
Closed	0	0	0	0	0	5	3	3	0	0	11
Pending	5	1	3	6	6	4	3	2	12	25	67
Settled	1	6	6	33	61	48	58	49	55	13	330
TOTAL	6	7	9	39	67	57	64	54	67	38	408

Missing Cases

	2015 - 17	2018	2019	2020	2021	2022	2023	2024	2025	2026	TOTAL
Closed	0	0	1	0	1	0	0	6	1	0	9
Desertion	1	2	7	2	4	2	2	5	0	0	25
Pending	0	6	0	6	2	11	13	4	4	9	55
Settled	18	6	10	6	10	16	9	15	11	2	103
TOTAL	19	14	18	14	17	29	24	30	16	11	192

Closed — Closed from ship-owners / P&I without compensations

Pending — Under progress and pending

Settled — Case settled by ship-owners / P&I with compensations

Life at sea continues to expose seafarers to unique occupational, environmental and operational risks that are significantly different from those experienced in shore-based professions. Long periods away from home, demanding work schedules, exposure to harsh weather conditions, isolation, fatigue, medical emergencies and limited access to specialised healthcare facilities can increase vulnerability to accidents, illnesses and other welfare-related incidents. While maritime safety standards and regulatory oversight have improved substantially over the years, fatalities and missing seafarer cases continue to be reported across the global shipping industry, requiring sustained attention from regulators, shipowners and welfare organisations.

Analysis of reported cases indicates that seafarer deaths arise from a variety of causes including natural medical conditions, accidents on board, occupational incidents, health emergencies and other operational circumstances. The nature of maritime employment often means that immediate access to advanced medical care may not always be readily available, particularly during long international voyages. Ageing crew profiles in certain segments, increasing operational demands and extended sea service periods further underline the importance of preventive healthcare, medical screening and onboard welfare measures. Effective implementation of health management systems, improved medical preparedness and timely telemedical assistance have therefore become important components of modern maritime safety management.

Cases involving missing seafarers present an additional challenge due to the operational complexity associated with investigations conducted across different jurisdictions and maritime environments. Such cases may arise from accidents, adverse weather conditions, operational incidents or other circumstances requiring extensive search, investigation and verification efforts. Resolution of these cases often involves cooperation among flag States, coastal States, shipowners, insurers, maritime administrations and law enforcement authorities. Given the complexity of maritime operations and evidentiary requirements, investigations and settlement processes associated with missing seafarer cases can often take considerable time before final closure is achieved.

The available case trends indicate that while a significant number of cases have been resolved and compensation mechanisms activated, several matters remain under investigation or pending completion. Resolution typically involves coordination among shipowners, Protection and Indemnity (P&I) insurers, maritime administrations and affected families to determine liability, verify circumstances and process applicable welfare and compensation claims. The role of financial security mechanisms provided under international maritime conventions has become increasingly important in ensuring timely support to affected families and facilitating settlement of claims arising from maritime casualties.

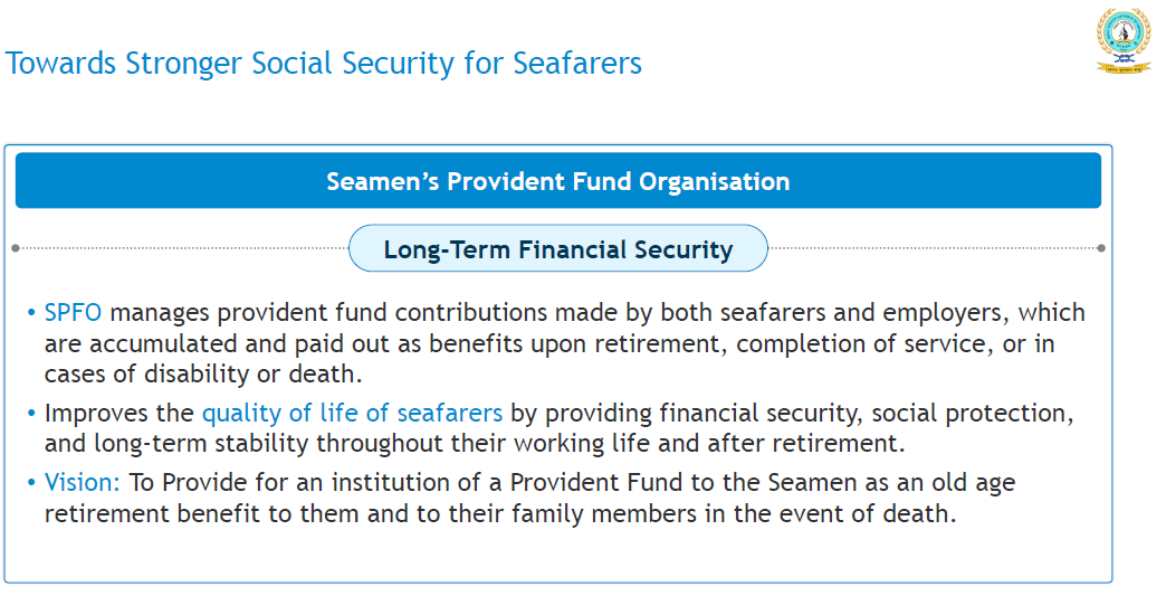
Recognising these challenges, international instruments such as the Maritime Labour Convention, 2006, the STCW Convention and various IMO safety regulations place considerable emphasis on seafarer welfare, occupational safety and emergency preparedness. Shipowners are required to maintain safe working environments,

implement safety management systems, provide adequate medical facilities and ensure compliance with internationally prescribed welfare standards. Continuous improvements in vessel design, onboard monitoring systems, emergency response procedures and crew training have contributed towards reducing risks; however, the inherently demanding nature of maritime operations necessitates ongoing vigilance and continuous improvement.

The growing focus on seafarer well-being has also highlighted the importance of mental health, fatigue management and social support systems. Extended contracts, social isolation and operational pressures can have adverse impacts on the overall welfare of seafarers, making preventive welfare measures an integral part of maritime safety. Strengthening welfare frameworks, enhancing access to counselling and support services, improving onboard living conditions and promoting a safety culture across the industry can play a significant role in reducing incidents and improving quality of life at sea.

Continued collaboration among maritime administrations, shipowners, welfare organisations, insurers and international bodies remains essential for addressing fatalities and missing seafarer cases effectively. Strengthening reporting mechanisms, improving data collection, enhancing accident investigation capabilities and ensuring timely settlement of claims can help provide greater protection to seafarers and their families. As India continues to expand its role as a major maritime manpower-supplying nation, sustained focus on health, safety, welfare and social protection measures will remain critical in safeguarding the interests of Indian seafarers serving across the global shipping industry.

6.11. Towards Stronger social security for seafarers



The maritime profession is characterised by unique employment patterns, prolonged periods at sea, international mobility and exposure to occupational risks that differ

significantly from those faced in shore-based sectors. While seafarers play a critical role in facilitating global trade and ensuring uninterrupted movement of goods, their access to long-term social security and retirement benefits has historically remained a matter of concern across many maritime jurisdictions. Strengthening social protection mechanisms is therefore an important component of seafarer welfare and forms an integral part of the broader objective of creating a safe, secure and welfare-oriented maritime workforce.

The Seamen's Provident Fund Organisation (SPFO) serves as a dedicated institutional mechanism for providing long-term financial security to seafarers and their families. The organisation administers provident fund contributions made jointly by seafarers and employers during the course of employment. These contributions are accumulated over time and become available as financial benefits upon retirement, completion of service, disability or other eligible circumstances prescribed under the applicable framework. By creating a structured savings mechanism linked to maritime employment, the SPFO contributes towards income security and financial resilience throughout a seafarer's professional life.

The importance of social security within the maritime sector extends beyond retirement planning alone. Seafarers frequently spend extended periods away from their families and often face uncertainties arising from fluctuating employment cycles, evolving industry conditions and occupational risks associated with maritime operations. Access to a stable social protection mechanism therefore plays an important role in improving overall quality of life and providing financial confidence during active service as well as after retirement. A structured provident fund framework helps create a long-term savings culture while ensuring that maritime professionals have access to financial support at critical stages of their lives.

The SPFO framework also carries significant welfare implications for the families of seafarers. Maritime employment frequently involves service in international waters and exposure to circumstances beyond the control of the individual seafarer. In situations involving disability, permanent incapacity or death, the availability of accumulated provident fund benefits can provide important financial assistance to dependents and family members. Such support mechanisms strengthen social protection and help mitigate the economic impact of unforeseen events affecting maritime personnel.

The broader vision underpinning the provident fund framework is the establishment of a robust social security system that supports seafarers throughout their professional and post-retirement years. In addition to providing financial benefits, the framework contributes towards enhancing the attractiveness of maritime careers by offering greater economic security and welfare assurance. Strong social protection mechanisms also support workforce retention by improving confidence among maritime professionals and reinforcing the perception of shipping as a stable and sustainable long-term career option.

As India seeks to expand its position as a leading provider of maritime manpower and increase its share of the global seafaring workforce, strengthening welfare and social security frameworks remains a key policy priority. Measures aimed at enhancing financial security, improving retirement benefits and extending social protection are consistent with the objectives of creating a future-ready maritime workforce supported by strong welfare institutions. The continued evolution of the SPFO framework therefore represents an important step towards ensuring that seafarers not only contribute to maritime growth during their working years but also benefit from long-term economic security and welfare protection throughout their lives and beyond.

6.12. Towards stronger welfare for seafarers

The welfare of seafarers extends beyond employment conditions and occupational safety and encompasses the broader objective of ensuring timely support, financial assistance and welfare protection during various stages of a seafarer's life and career. Given the unique nature of maritime employment, seafarers and their families often require support mechanisms that address health emergencies, educational needs, welfare-related contingencies and financial hardships that may arise during active service or after retirement. Strengthening welfare support systems is therefore an essential component of a resilient maritime ecosystem and contributes directly to improving the quality of life of maritime professionals.

The Seafarer Welfare Fund Society (SWFS) functions as a dedicated welfare institution focused on providing immediate assistance and welfare support to seafarers and their families. Unlike long-term social security mechanisms that primarily address retirement and pension-related needs, the SWFS is designed to provide direct welfare interventions covering health, education, welfare infrastructure and various forms of financial assistance. Through targeted welfare programmes, the organisation seeks to support serving seafarers, retired maritime personnel, women seafarers, dependents of deceased seafarers and children of maritime professionals. The welfare framework

reflects the recognition that effective maritime development requires not only skilled manpower but also strong support systems capable of addressing the social and welfare needs of those employed in the sector.

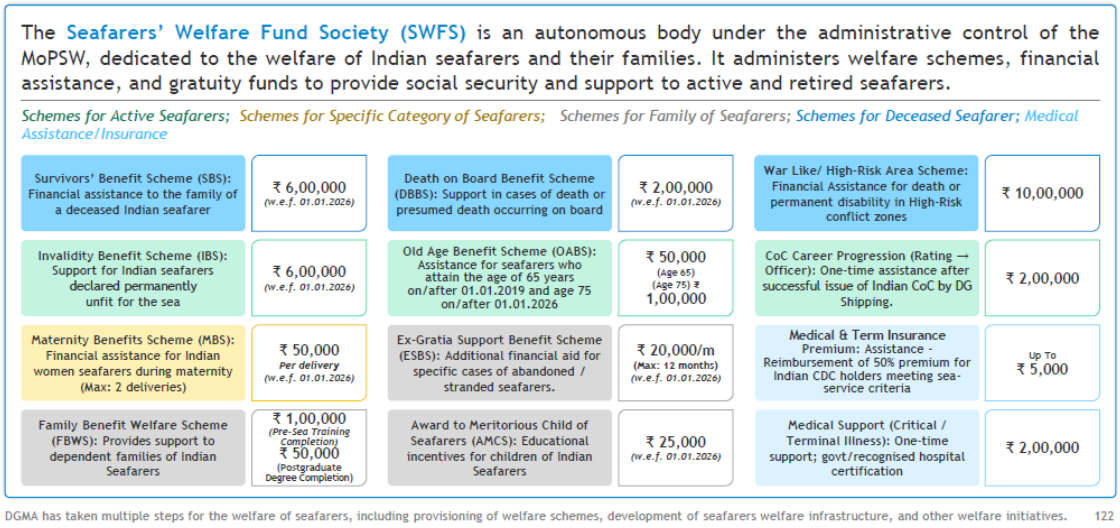
The range of welfare schemes administered under the SWFS framework is intended to provide comprehensive support across different stages of a seafarer's life cycle. Assistance is extended through multiple schemes covering education support, welfare grants, family assistance measures and other welfare-oriented interventions aimed at improving the socio-economic well-being of beneficiaries. Such support mechanisms help reduce financial vulnerability and provide an additional layer of protection for seafarers and their families against unforeseen circumstances. By addressing welfare requirements beyond traditional employment-related benefits, the SWFS contributes towards strengthening social resilience within the maritime community.

A significant component of the welfare programme is the development of welfare infrastructure aimed at enhancing the quality and reach of services available to seafarers. Investments in welfare-related infrastructure enable better delivery of support services, improve accessibility and strengthen institutional capacity for addressing welfare concerns. Such infrastructure plays an important role in ensuring that welfare initiatives are not limited to financial assistance alone but are supported by sustainable systems and facilities capable of serving the long-term needs of maritime stakeholders.

The welfare framework also recognises the importance of insurance and financial risk mitigation as essential elements of seafarer protection. Maritime employment often involves exposure to occupational risks, health contingencies and uncertainties associated with international deployment. Support for insurance coverage through structured assistance mechanisms helps ensure that seafarers and their families have access to financial protection when required. Strengthening insurance accessibility improves overall welfare outcomes and complements existing social security and provident fund arrangements available within the maritime sector.

The continued strengthening of the Seafarer Welfare Fund Society aligns with broader national objectives of creating a welfare-oriented and future-ready maritime workforce. As India seeks to expand its global presence as a leading provider of maritime manpower, welfare and social protection measures assume increasing importance in attracting, retaining and supporting skilled professionals. Comprehensive welfare mechanisms help create confidence among seafarers, improve career attractiveness and ensure that maritime growth is accompanied by adequate social support systems. The SWFS framework therefore represents an important pillar of India's maritime welfare architecture by providing timely assistance, targeted support and enhanced welfare protection for seafarers and their families throughout their professional and personal lives.

6.13. Steps are being taken by the DG Shipping for the welfare of seafarers



The Seafarers' Welfare Fund Society (SWFS) serves as the principal welfare institution dedicated to supporting Indian seafarers and their families through a wide range of social welfare, financial assistance and support programmes. Functioning under the administrative control of the Ministry of Ports, Shipping and Waterways, the Society has been established to address welfare requirements that extend beyond employment-related benefits and to provide assistance during circumstances involving illness, disability, retirement, family hardship, death or other welfare contingencies. Through a structured framework of welfare schemes and financial assistance programmes, SWFS contributes towards strengthening social security and enhancing the overall well-being of the maritime workforce.

The welfare framework administered by the Society encompasses multiple schemes targeted at different categories of beneficiaries, including active seafarers, retired maritime personnel, women seafarers, children of seafarers and families of deceased seafarers. This broad coverage recognises the diverse welfare needs that arise throughout the lifecycle of maritime employment and ensures that support mechanisms remain accessible to seafarers at various stages of their professional and personal lives. By adopting a comprehensive and inclusive approach, the Society seeks to provide meaningful assistance to beneficiaries facing different forms of financial, medical and social challenges.

A key focus area of the welfare framework is the provision of financial assistance to families affected by the death of a seafarer. Special benefit schemes have been instituted to provide support in circumstances involving death on board, presumed death at sea and other casualty-related situations. Such measures are intended to

provide immediate economic assistance to dependents and reduce financial distress for affected families. Similarly, dedicated schemes support seafarers who suffer permanent disability or are declared medically unfit for sea service, thereby ensuring that individuals whose maritime careers are curtailed due to health-related reasons receive an additional layer of financial protection.

The welfare architecture also provides support to elderly maritime professionals through old-age assistance programmes aimed at enhancing financial security after retirement. Given the unique employment characteristics of the maritime profession and the absence of continuous shore-based employment opportunities for many seafarers during later stages of life, retirement-related support remains an important component of welfare policy. Such assistance complements other social security mechanisms and contributes towards improving the long-term economic well-being of retired seafarers.

Recognising the increasing participation of women within the maritime sector, the welfare framework includes dedicated support measures tailored to their specific requirements. Assistance mechanisms have been developed to provide support during maternity and other welfare-related contingencies, thereby promoting greater inclusivity within the maritime profession. Additional welfare measures are also extended to stranded and abandoned seafarers who may require urgent assistance due to unforeseen operational or employment-related challenges. These interventions reinforce the principle that welfare protection should remain available whenever seafarers face circumstances beyond their control.

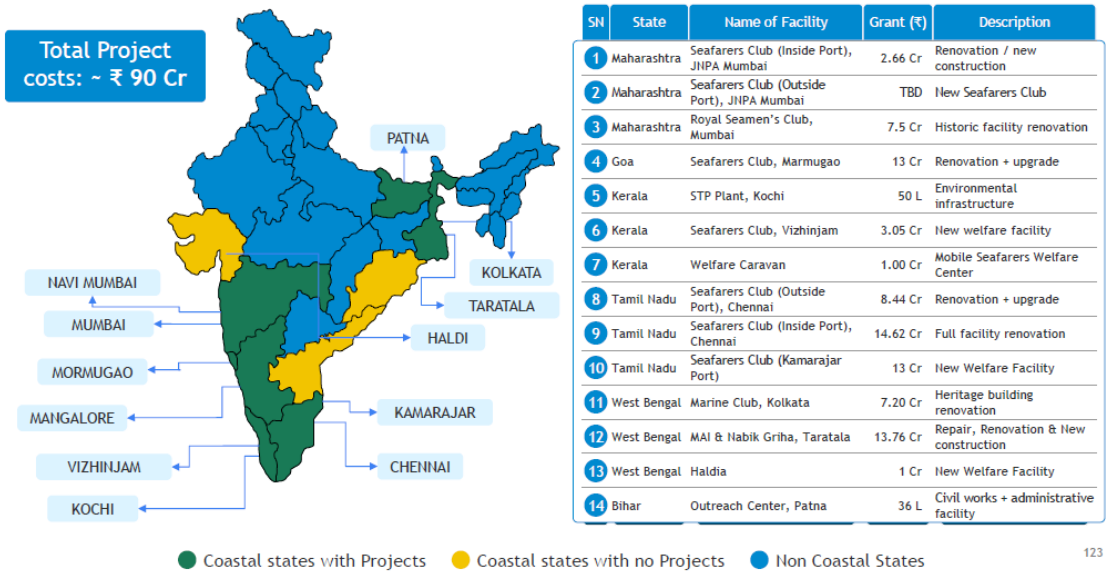
Education support forms another important pillar of the welfare framework. Financial assistance and scholarship-type benefits are extended to children of seafarers in recognition of the contribution made by maritime professionals to the national economy and global trade. Such initiatives help strengthen family welfare, encourage educational advancement and contribute towards improving long-term socio-economic outcomes for seafaring families. Measures supporting career progression and professional development have also been introduced to encourage skill enhancement and facilitate upward mobility within the maritime profession.

Healthcare and insurance assistance constitute a further area of intervention under the SWFS framework. Medical emergencies, critical illnesses and healthcare-related expenses can impose significant financial burdens on seafarers and their families. To address these concerns, various assistance mechanisms have been introduced to support medical treatment, hospitalisation and insurance premium payments. These provisions complement existing employer obligations and social protection arrangements while enhancing the overall welfare and financial resilience of maritime personnel.

The continued expansion and strengthening of welfare measures through the Seafarers' Welfare Fund Society reflects the Government's commitment towards creating a welfare-oriented maritime ecosystem. As India seeks to enhance its global standing as a leading maritime manpower nation, comprehensive welfare support becomes

increasingly important for attracting, retaining and protecting skilled maritime professionals. By addressing financial security, healthcare, education, family welfare and emergency assistance requirements through a structured institutional framework, the SWFS contributes significantly towards improving the quality of life of Indian seafarers and ensuring that maritime growth is accompanied by strong social and welfare safeguards.

6.14. Seafarer welfare infrastructure - SWBAT



SN	State	Name of Facility	Grant (₹)	Description
1	Maharashtra	Seafarers Club (Inside Port), JNPA Mumbai	2.66 Cr	Renovation / new construction
2	Maharashtra	Seafarers Club (Outside Port), JNPA Mumbai	TBD	New Seafarers Club
3	Maharashtra	Royal Seamen's Club, Mumbai	7.5 Cr	Historic facility renovation
4	Goa	Seafarers Club, Marmugao	13 Cr	Renovation + upgrade
5	Kerala	STP Plant, Kochi	50 L	Environmental infrastructure
6	Kerala	Seafarers Club, Vizhinjam	3.05 Cr	New welfare facility
7	Kerala	Welfare Caravan	1.00 Cr	Mobile Seafarers Welfare Center
8	Tamil Nadu	Seafarers Club (Outside Port), Chennai	8.44 Cr	Renovation + upgrade
9	Tamil Nadu	Seafarers Club (Inside Port), Chennai	14.62 Cr	Full facility renovation
10	Tamil Nadu	Seafarers Club (Kamarajar Port)	13 Cr	New Welfare Facility
11	West Bengal	Marine Club, Kolkata	7.20 Cr	Heritage building renovation
12	West Bengal	MAI & Nabik Griha, Taratala	13.76 Cr	Repair, Renovation & New construction
13	West Bengal	Haldia	1 Cr	New Welfare Facility
14	Bihar	Outreach Center, Patna	36 L	Civil works + administrative facility

The Seafarers Welfare Board and Trust (SWBAT) has undertaken a comprehensive programme for creation, modernisation and expansion of welfare infrastructure for seafarers across India. Recognising that the welfare requirements of seafarers extend beyond financial assistance and social security measures, the programme focuses on developing dedicated welfare facilities that can provide accommodation, recreation, support services, outreach activities and welfare assistance to maritime personnel and their families. With projects spread across major maritime locations and strategic coastal centres, the initiative seeks to strengthen the institutional infrastructure available to seafarers and improve access to welfare services throughout the country.

The infrastructure development programme represents a significant long-term investment in seafarer welfare and has been conceptualised to support the growing size and geographical distribution of India's maritime workforce. Welfare infrastructure projects have been planned and implemented across major maritime hubs including Mumbai, Mormugao, Kochi, Vizhinjam, Chennai, Kamarajar Port, Kolkata, Haldia and Taratala, among others. By establishing and upgrading welfare facilities in locations where seafarers frequently embark, disembark or access maritime services, the programme seeks to enhance convenience, improve service delivery and create dedicated spaces tailored to the needs of maritime professionals.

A significant component of the programme involves renovation, restoration and modernisation of existing seafarers' clubs and welfare establishments. Many of these facilities have historically served as important centres for seafarer welfare, providing accommodation, recreational amenities and support services. The ongoing infrastructure initiative focuses on upgrading these facilities to contemporary standards through modernisation of buildings, improvement of available services and enhancement of overall user experience. In several locations, new welfare infrastructure is also being developed to address increasing demand and support future growth in maritime activity.

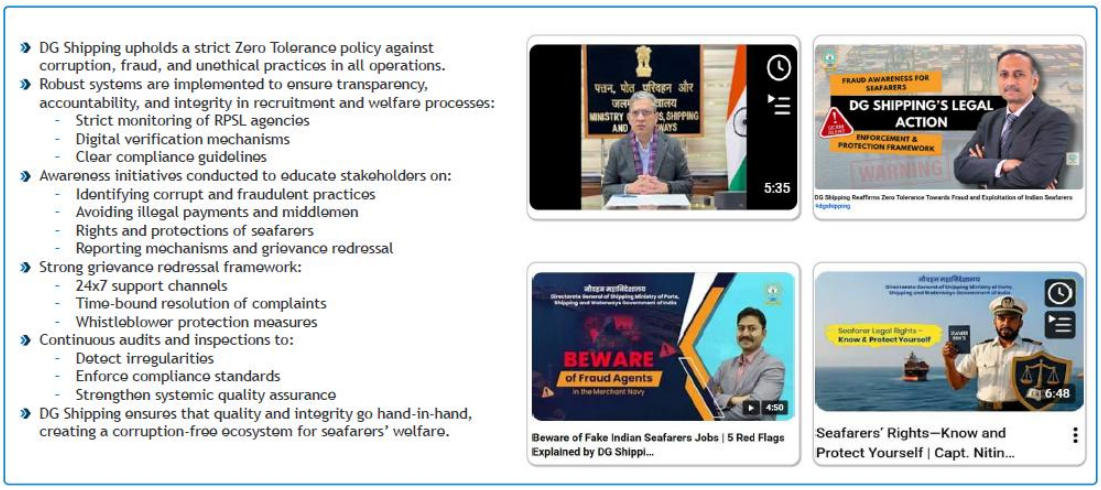
The programme also incorporates region-specific projects designed to address local welfare and operational requirements. In addition to seafarers' clubs and welfare centres, investments have been made in supporting infrastructure and outreach initiatives intended to improve accessibility of welfare services. Mobile welfare facilities and outreach centres have been included to ensure that welfare support can be extended beyond traditional port locations and reach a wider segment of the seafaring community. Such initiatives contribute towards creating a more inclusive welfare ecosystem capable of supporting seafarers regardless of their location or stage of service.

Environmental and sustainability considerations have also been integrated within specific infrastructure projects. Investments in supporting facilities and associated infrastructure improvements seek to ensure that welfare centres are developed in a sustainable and operationally efficient manner. The emphasis on modern infrastructure complements broader efforts towards improving living conditions, promoting welfare and strengthening service delivery standards within the maritime sector.

The creation of a nationwide network of welfare facilities also supports broader objectives relating to seafarer welfare, community development and workforce sustainability. Dedicated welfare infrastructure provides a platform for delivery of educational programmes, counselling services, welfare assistance, skill development initiatives and community engagement activities. These facilities help strengthen social support systems available to seafarers and their families while creating opportunities for enhanced interaction between maritime stakeholders and welfare institutions.

The SWBAT infrastructure initiative forms an important pillar of India's maritime welfare framework and complements other welfare measures implemented through the Seafarers' Welfare Fund Society, social security institutions and regulatory initiatives. By investing in permanent welfare infrastructure across major maritime centres, the programme aims to improve quality of life for seafarers, strengthen welfare delivery mechanisms and ensure that India's growing maritime workforce is supported by modern, accessible and sustainable welfare facilities. The initiative reflects a long-term commitment to creating a welfare-oriented maritime ecosystem in which seafarers and their families have access to the institutional support necessary for their well-being and professional development.

6.15. Ensuring zero tolerance for corruption in crewing



The Directorate General of Shipping has adopted a policy of zero tolerance towards corruption, fraud and unethical practices within the maritime recruitment and crewing ecosystem. The integrity of the recruitment process has a direct bearing on seafarer welfare, safety and employment opportunities, and therefore ensuring transparency and accountability across recruitment channels has emerged as a key regulatory priority. Fraudulent recruitment practices not only result in financial losses for seafarers but also expose them to risks such as illegal deployment, non-compliant employment contracts, abandonment and exploitation. In response, DG Shipping has undertaken a series of institutional, technological and awareness-based interventions aimed at strengthening governance within the crewing sector.

A central component of this initiative has been the strengthening of oversight mechanisms applicable to Recruitment and Placement Service Licensees (RPSLs). Regulatory supervision has been enhanced through stricter monitoring, periodic inspections and improved compliance verification processes. Digital verification mechanisms have been introduced to promote transparency and facilitate authentication of recruitment-related information. These reforms enable seafarers to verify the legitimacy of recruitment agencies and reduce the possibility of engagement through unauthorised intermediaries. Enhanced compliance requirements and monitoring systems also assist the maritime administration in identifying irregularities at an early stage and taking corrective action where necessary.

Recognising that prevention is as important as enforcement, DG Shipping has also placed considerable emphasis on awareness generation and stakeholder education. Various outreach initiatives have been conducted to educate seafarers regarding fraudulent recruitment practices, illegal fee demands and risks associated with unauthorised agents. Awareness programmes focus on strengthening understanding of

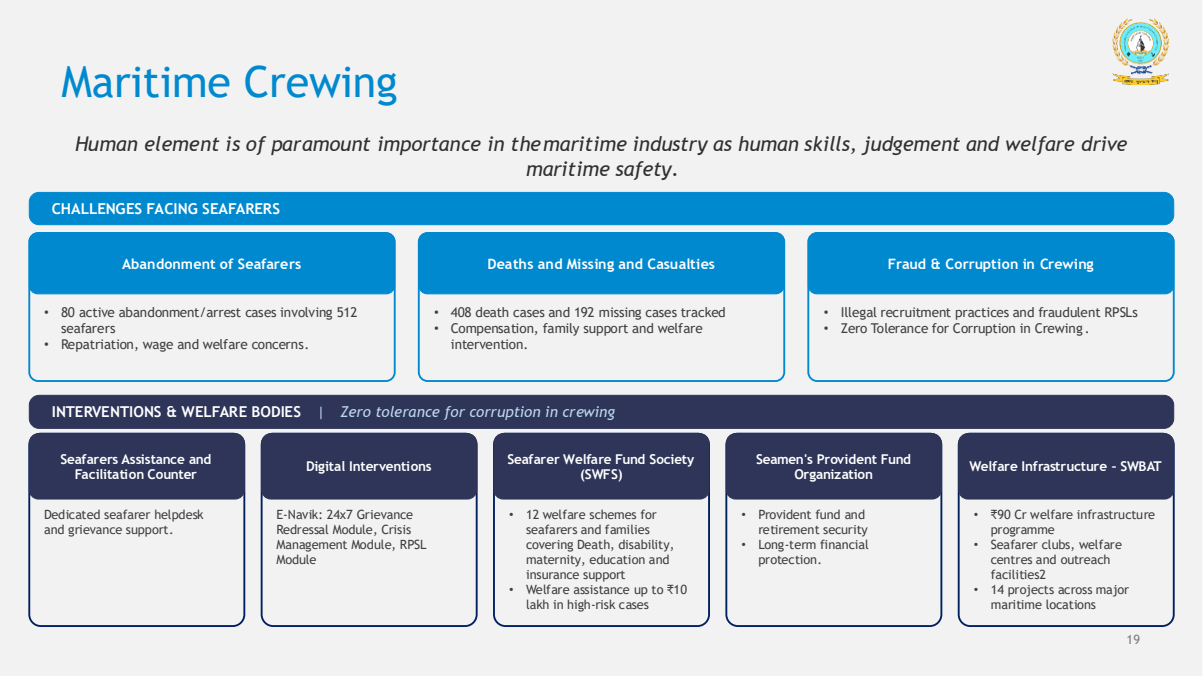
recruitment procedures, employment rights, grievance mechanisms and available protections under Indian and international maritime regulations. By improving awareness among seafarers, the administration seeks to reduce vulnerability to exploitation and encourage informed decision-making while seeking employment opportunities.

An effective grievance redressal framework has been developed to ensure timely assistance and corrective action in cases involving complaints against recruitment agencies or related stakeholders. Dedicated support mechanisms, structured complaint handling procedures and time-bound resolution processes contribute towards improving confidence within the maritime workforce. Such mechanisms enable seafarers to report suspected irregularities and seek assistance without undue delay. Strengthening grievance redressal systems also promotes accountability among recruitment agencies and supports a more responsive regulatory environment capable of addressing emerging concerns in a timely manner.

Continuous audits and inspections form another important pillar of the overall strategy. Regular compliance assessments allow regulators to identify operational deficiencies, evaluate adherence to prescribed standards and verify implementation of regulatory requirements. Inspections also serve as an important quality assurance mechanism by ensuring that recruitment practices remain aligned with legal and ethical standards. Through sustained monitoring and enforcement, DG Shipping seeks to create a culture of compliance that discourages unethical practices and promotes professionalism across the maritime recruitment ecosystem.

The strengthening of recruitment governance is also linked to broader objectives relating to seafarer welfare and maritime safety. Recruitment irregularities can have far-reaching consequences extending beyond employment-related issues and may contribute to abandonment cases, contractual disputes, welfare concerns and operational safety risks. Ensuring that seafarers are recruited through authorised channels and deployed on compliant vessels is therefore an important element of safeguarding the overall integrity of the maritime sector. Increased transparency within recruitment processes supports not only seafarer welfare but also enhances confidence among shipowners, international employers and other maritime stakeholders.

The combined approach of regulatory oversight, digital verification, stakeholder awareness, grievance handling and continuous monitoring reflects the commitment of DG Shipping to establishing a corruption-free, transparent and accountable maritime recruitment system. By strengthening governance across the crewing value chain and promoting ethical recruitment practices, the administration seeks to protect the rights and interests of Indian seafarers while creating a safer and more trustworthy maritime employment environment. These initiatives contribute towards the broader objective of building a welfare-oriented maritime ecosystem founded on integrity, compliance and responsible governance.



6.16. Mission 20

The most important message from the file is that India's active seafarer base has grown from 62,267 in 2010 to 323,429 in 2025, which means the active workforce has expanded by about 419% over fifteen years. In CAGR terms, this is roughly 11.6% annual growth across the period. This is not a marginal increase; it reflects a structural scaling of India's maritime labour pool. The growth is especially notable because it was not entirely linear. The data shows a long upward arc from 2010 to 2019, a visible disruption around 2020–2021, and then a strong rebound from 2022 onward, culminating in the highest level yet in 2025. The composition of this growth is equally important. Based on the DGMA data, the ratings segment has expanded much faster than the officer segment. Active ratings increased from 26,711 in 2010 to 209,436 in 2025, which is roughly a 684% increase over the period and about 14.7% annualized growth. Officers, by comparison, increased from 35,556 in 2010 to 113,993 in 2025, which is still a strong increase of around 221%, but far slower than ratings growth, with CAGR of roughly 8.1%. This means that the overall expansion of India's active seafarer base has been driven disproportionately by ratings rather than officers. Over time, the workforce mix has tilted more strongly toward ratings, with ratings accounting for around 42.9% of active seafarers in 2010 and about 64.8% by 2025, while the officer share has fallen from roughly 57.1% to 35.2% over the same period. Page 145 of 412 Indian Seafarer Competitiveness Strategy - PwC The data also shows that the nautical side has grown faster than the engineering side. Active nautical seafarers increased from 36,423 in 2010 to 217,654 in 2025, which represents nearly 498% growth, while engineering seafarers increased from 25,844 to 105,775, which is around 309% growth. In CAGR terms, nautical grew at roughly 12.7% annually, compared with 9.9% for engineering. This has changed the internal structure of the maritime

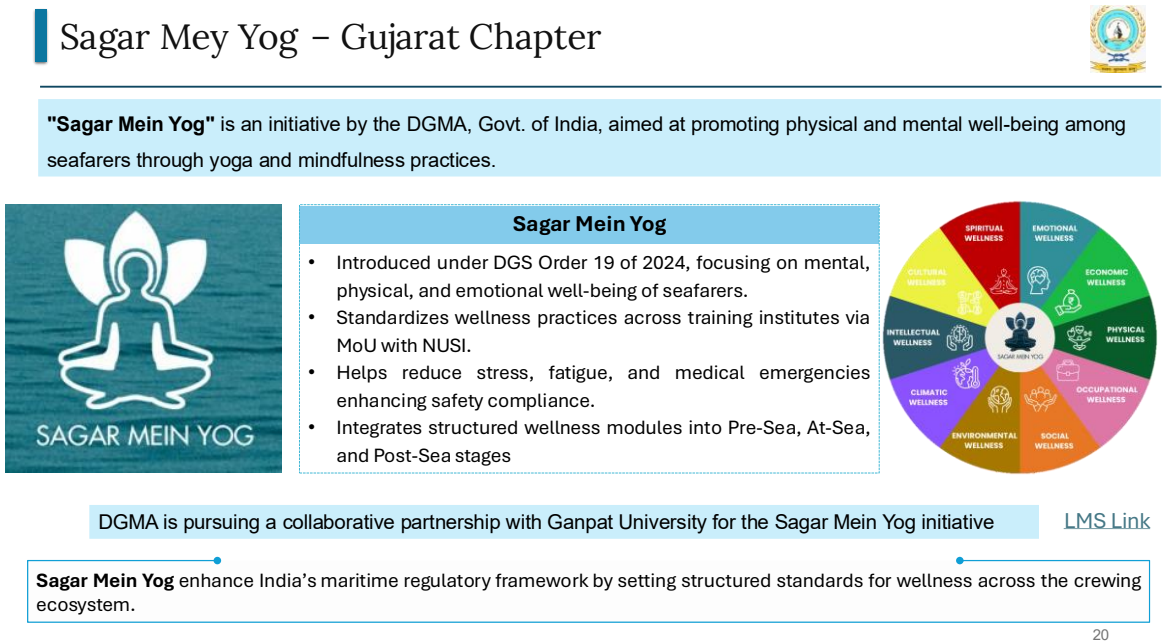
workforce. In 2010, nautical personnel accounted for about 58.5% of active seafarers, while engineering accounted for 41.5%. By 2025, nautical had increased to roughly 67.3%, while engineering had fallen to about 32.7% of the total. This indicates that the strongest expansion has occurred in nautical tracks, especially among ratings and seafarer-facing vessel roles. One of the most useful features of the data is that it clearly captures the pandemic-era disruption and post pandemic rebound. Active seafarers increased consistently until 2019, reaching 234,886, but then dropped to 224,478 in 2020 and further to 205,787 in 2021. This means the total active seafarer base contracted by roughly 12.4% between 2019 and 2021. The disruption was sharper on the ratings side than the officer side. Ratings fell from 144,930 in 2019 to 116,262 in 2021, a reduction of nearly 19.8%, while officers remained comparatively resilient, decreasing only marginally from 89,959 to 89,525. This is a crucial point because it suggests that lower and mid-rank labour-market exposure was more vulnerable during the disruption period, while the officer base held up better. From 2021 to 2025, however, the system recovered strongly, with the total active workforce increasing by roughly 57.2%, showing that the contraction was temporary rather than structural. The rank-wise structure gives further depth to this story. On the nautical side, the single largest category by 2025 is Cruise Vessel Employees, at 39,266, followed by A B at 18,318, Crew (Others) at 13,741, Hospitality Staff at 13,677, Second Officer at 12,925, Cook at 12,672, and Ordinary Seaman at 12,433. This is highly significant because it shows that the modern Indian seafaring profile is no longer confined only to traditional cargo-vessel hierarchies. The scale of cruise-related roles, saloon, hospitality, and broad service side categories has become too large to treat as peripheral. In fact, the Cruise Vessel Employees category is now the single largest nautical rank block in the file, which signals an important shift in the structure of opportunity and labour deployment. The growth within nautical ranks also shows where momentum has been strongest. The biggest absolute increase is in Cruise Vessel Employees, rising from just 27 in 2010 to 39,266 in 2025. Other major gainers include A B, Hospitality Staff, Crew (Others), Ordinary Seaman, Trainee Deck Rating, and Cook. This indicates that the widening of the nautical labour base is being driven by both conventional deck pathways and newer service-intensive segments, especially cruise and hospitality-linked employment. It also suggests that policy discussions around the Indian seafaring workforce should no longer treat cruise and service-side roles as niche segments; they are now central to workforce growth. At the same time, the nautical data also reveals where stress appeared during the 2019–2021 period. The sharpest declines in that phase were visible in Cruise Vessel Employees, Crew (Others), Trainee Deck Rating, Hospitality Staff, and Deck Rating. This is consistent with what would be expected during a disruption period that hit cruise, hospitality, and internationally mobile labour particularly hard. The decline in these segments does not change the longer-term growth story, but it does show that parts of the seafaring workforce are more exposed to cyclical and global disruptions than others. On the engineering side, the largest category by 2025 is 3rd Engineer, at 12,095, followed very closely by Oiler at 11,893, Engine Petty Officer at

11,539, 2nd Engineer at 10,403, Chief Engineer at 9,023, and Watch Keeping Engineer Officer OICEW at 8,918. This means the engineering workforce remains much more rank-structured around the formal engine-room ladder than the nautical side, which has seen broader diversification across cruise, hospitality, and service categories. Engineering therefore appears more traditional in its composition, even though it too shows important new technical streams. The strongest growth engines in engineering are Oiler, Engine Petty Officer, 3rd Engineer, Watch Keeping Engineer Officer, 2nd Engineer, Electro Technical Officer, Trainee Engine Rating, Motorman, and Trainee Page 146 of 412 Indian Seafarer Competitiveness Strategy - PwC Marine Engineer. These trends are especially important because they show that both classical engine-room roles and newer technical categories are expanding together. The rise of Electro Technical Officer, from 322 in 2010 to 5,082 in 2025, is particularly significant because it reflects the broader technological complexity of ships and the increasing importance of automation, electrical systems, and digitally integrated vessel operations. The 2019–2021 dip on the engineering side shows a different pattern from nautical. The largest engineering declines in that period were visible in Trainee Engine Rating, Watch Keeping Motor Man, Trainee Marine Engineer, Electrical/ Electronic Officer, Watch Keeping Engineer Officer, and Engineer Cadet. This again suggests that junior and trainee categories were hit first and hardest by labour-market disruption, while the fully established officer base remained comparatively more stable. The female seafarer trend in the workbook is also important, though it requires careful handling because the female breakdown tables contain some internal inconsistencies in the nautical subcomponents for later years. What is reliable in the data is the total female count by year. Based on the DGMA data, female active seafarers increased from 1,599 in 2021 to 7,033 in 2025. This means the female active seafarer base has expanded by around 340% in just four years. As a share of total active seafarers, women increased from roughly 0.78% in 2021 to about 2.17% in 2025. This is a meaningful shift, even though the base remains small. The high-level split also shows that the large majority of women in the file are on the nautical side, with a much smaller engineering representation. That means inclusion is improving, but the growth is still concentrated more in selected tracks than across the whole maritime labour base. The rank-level female data supports the view that female seafaring growth is highly segmented. On the nautical side, major visible female categories include Cruise Vessel Employees, Hospitality Staff, Deck Rating, and cadet or junior officer pathways, while on the engineering side female participation remains concentrated in officer and cadet-level technical roles rather than broad-based ratings growth. This suggests that women's participation is increasing but is doing so unevenly and likely through a combination of cadet pipelines, cruise-linked employment, hospitality tracks, and specific officer channels rather than through full-spectrum sectoral integration. The Indian-flag versus foreign-flag split is one of the clearest strategic signals in the workbook. From 2016 to 2025, the overwhelming majority of active Indian seafarers are employed on foreign-flag vessels rather than Indian-flag vessels. In 2025, out of 323,429 active seafarers, only

30,558 are shown under Indian-flag employment, while 292,871 are shown under foreign-flag employment. That means roughly 90.6% of active Indian seafarers are on foreign-flag vessels, and only about 9.4% are on Indian-flag vessels. This foreign dominant structure is not new, but it is becoming even more visible and more deeply embedded over time. The same foreign-dominant pattern holds separately for both officers and ratings. In 2025, only 12,952 officers are on Indian-flag vessels, compared with 101,040 officers on foreign-flag vessels. Similarly, only 17,606 ratings are on Indian-flag vessels, compared with 191,831 ratings on foreign-flag vessels. This means that nearly 88.6% of officers and about 91.6% of ratings are sailing under foreign flags. The implication is straightforward: India is now primarily a global maritime labour supplier, not a flag-contained national labour market. That is why international competitiveness, foreign-carrier access, global recognition, and market linkage matter so much for the future of Indian seafaring. The trend over time also suggests that Indian-flag employment has remained comparatively flat, while foreign-flag employment has done most of the expansion work. Indian-flag seafarers increased only modestly from around 20,211 in 2016 to 30,558 in 2025, while foreign-flag seafarers grew far more strongly, from 123,729 to 292,871 over the same period. In other words, most of the growth in India's active seafarer base is being generated by the foreign-flag labour market, not by domestic-flag fleet expansion. This has major strategic implications. It means the future of Indian seafaring is tied much more closely to global shipping demand and international hiring networks than to Indian-flag fleet size alone. Page 147 of 412 Indian Seafarer Competitiveness Strategy - PwC The projection sheet extends this pattern forward. Based on the DGMA projected trend, the active seafarer base is expected to increase from 3.234 lakh in 2025 to about 4.328 lakh by 2030. That implies an increase of roughly 1.094 lakh over five years, or around 34% growth from the 2025 base. The annual pace implied by the projection is lower than the strong historic surge seen in some of the rebound years after 2021, which suggests a more moderated but still healthy growth trajectory going forward. This indicates that the system is expected to keep expanding, but perhaps on a more stable slope rather than through another step-jump. A very important structural conclusion emerges when these pieces are read together. The Indian active seafarer base is not just getting larger; it is becoming more rating-heavy, more nautical-heavy, more foreign flag dependent, and more diversified in role composition, especially through cruise, hospitality, service, and broad support categories. At the same time, the officer segment continues to grow, but not as quickly as ratings. Engineering remains strong, but is growing more slowly than nautical. Women's participation is increasing, but from a low base and with uneven distribution across categories. This has direct strategic implications for policy and workforce planning. First, if India wants to move from being a large supplier to becoming a stronger strategic maritime workforce power, then the officer pipeline needs focused strengthening. The data makes it clear that ratings growth has carried much of the headline expansion, but officer depth remains critical for long-term competitiveness, command capability, and higher value deployment. Second, the extreme dependence on

foreign-flag employment means labour-market trust, documentation quality, international recognition, and direct employer linkage are far more important than domestic fleet size alone. Third, the rise of cruise and hospitality-linked roles suggests that the definition of "seafarer strategy" must widen beyond the traditional cargo-vessel frame. A further implication is that volatility affects different segments. The disruption around 2020–2021 hit cruise, hospitality, ratings, and junior or trainee categories much harder than it hit the established officer core. This means the resilience of the maritime labour market is uneven. The most vulnerable segments are often those with less bargaining power, lower sea-time accumulation, or greater reliance on rapidly shifting international service patterns. A more resilient ecosystem would therefore need better transition support for junior entrants, better placement continuity, and stronger market-linkage mechanisms for segments most exposed to disruption. Overall, based on the DGMA active seafarer data, India's maritime workforce story is one of rapid structural rise with clear internal imbalances. The country's active seafarer base has reached a scale where it can no longer be understood as just an output of training institutions. It is now a large labour-market system shaped by foreign-flag demand, ratings-led expansion, nautical-sector dominance, and growing role diversification. The next phase of strategy should therefore focus not only on expanding numbers further, but on improving the composition, quality, and resilience of that growth—especially by accelerating officer development, protecting and formalizing higher-growth segments, improving the international employability architecture, and ensuring that inclusion and diversification are backed by real institutional support rather than by raw expansion alone.

6.1. Sagar Mein Yog



Sagar Mein Yog is an initiative of the Directorate General of Maritime Administration (DGMA), Government of India, aimed at promoting the physical, mental, and emotional

well-being of seafarers through yoga and mindfulness practices. The initiative seeks to integrate wellness into the maritime ecosystem and establish structured practices that support the overall health and resilience of seafarers throughout their careers.

Introduced under DGMA Order 19 of 2024, the initiative focuses on improving the mental, physical, and emotional well-being of seafarers through a standardized wellness framework. To facilitate consistent implementation across the maritime training ecosystem, DGMA has entered into an MoU with NUSI for the standardization of wellness practices and programmes.

The initiative is intended to address challenges such as stress, fatigue, and health-related concerns commonly associated with seafaring life. By promoting wellness and mindfulness practices, the programme aims to contribute to improved well-being while supporting safety compliance and operational readiness within the maritime sector.

A key feature of Sagar Mein Yog is the integration of structured wellness modules across the entire seafarer lifecycle. The programme incorporates wellness interventions during the Pre-Sea, At-Sea, and Post-Sea stages, ensuring that support mechanisms remain available throughout training and professional service.

The wellness framework adopts a holistic approach encompassing multiple dimensions of well-being, including physical wellness, emotional wellness, social wellness, occupational wellness, intellectual wellness, environmental wellness, spiritual wellness, economic wellness, cultural wellness, and climatic wellness. This broad-based approach seeks to promote overall quality of life and resilience among maritime professionals.

The initiative is expected to strengthen India's maritime regulatory framework by establishing structured wellness standards across the crewing ecosystem. Through the incorporation of yoga, mindfulness, and organized wellness practices into maritime training and professional development, Sagar Mein Yog aims to foster a healthier, safer, and more sustainable maritime workforce while supporting the long-term welfare of Indian seafarers.

DGMA is pursuing a collaborative partnership with Ganpat University for the Sagar Mein Yog initiative

6.2. Sagar Mein Samman

Sagar Mein Samman – Gujarat Chapter

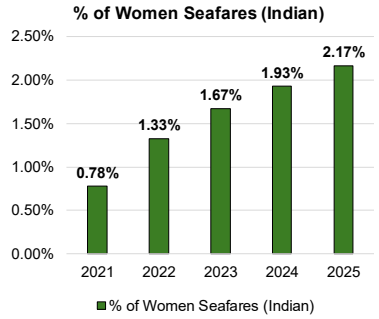
"Honour at Sea"

Flagship Initiative of DGMA to promote gender inclusion, equality and welfare in the maritime sector.

- **The Sagar Mein Samman (SMS)** Initiative underscores the need to promote gender inclusivity and equal opportunities for women seafarers in the Indian maritime industry.
- Establishes policy-backed norms for women's safety, equal opportunity, and career advancement.
- **₹1,00,000** is offered through the Maritime Training Trust (MTT) to encourage women cadets and ratings to enroll in pre-sea courses.
- **DGMA is pursuing a collaborative partnership with Ganpat University for the Sagar Mein Samman initiative**

4 Strategic Pillers

Empowerment & Leadership	Inclusivity & Equal Opportunity	Safety & Well-being	Skill Development & Training
01	02	03	04



The share of women seafarers increased from **0.78% in 2021 to 2.17% in 2025**, marking a nearly **178%** growth over just four years, reflecting a strong and accelerating upward trend.

Objective: Create an Inclusive, equitable and safe maritime ecosystem for women

Sagar Mein Samman (SMS), meaning "Honour at Sea", is a flagship initiative of DGMA aimed at promoting gender inclusion, equality, and welfare within the maritime sector. The initiative recognizes the need to create a more inclusive maritime ecosystem by encouraging greater participation of women in seafaring careers and strengthening institutional support for their professional growth and well-being.

The initiative seeks to promote gender inclusivity and equal opportunities for women seafarers across the Indian maritime industry. It establishes policy-backed norms focused on safety, equal opportunity, and career advancement, with the objective of creating an enabling environment for women at all stages of their maritime careers.

As part of the initiative, financial assistance of ₹1,00,000 is provided through the Maritime Training Trust (MTT) to encourage women cadets and ratings to enroll in pre-sea training courses. The support is intended to improve accessibility to maritime education and encourage greater participation of women in the seafaring profession.

The programme is built around four strategic pillars: Empowerment and Leadership, Inclusivity and Equal Opportunity, Safety and Well-being, and Skill Development and Training. Together, these pillars provide the framework for advancing gender inclusion and strengthening support mechanisms for women seafarers within the maritime ecosystem.

The initiative is being implemented against a backdrop of increasing participation of women in the Indian seafaring workforce. The share of Indian women seafarers increased from 0.78% in 2021 to 1.33% in 2022, 1.67% in 2023, 1.93% in 2024, and 2.17% in 2025. This represents a growth of nearly 178% over a four-year period, indicating a sustained upward trend in the participation of women in maritime careers.

The overarching objective of Sagar Mein Samman is to create an inclusive, equitable, and safe maritime ecosystem for women. Through policy interventions, financial support, safety measures, leadership development, and capacity-building initiatives, the programme seeks to strengthen the participation and long-term career progression of women within India's maritime sector.

DGMA is pursuing a collaborative partnership with Ganpat University for the Sagar Mein Samman initiative.

6.3. Zero Tolerance for Fraud in Training

The proposed social media campaign on “Zero Tolerance to Maritime Fraud in Training and Crewing” seeks to build awareness, promote verification, and encourage reporting of fraudulent practices affecting cadets, seafarers, and their families. The campaign is intended to strengthen vigilance against fraudulent training providers, unauthorized recruitment practices, and misleading placement claims while promoting the use of official DGMA/DGMA verification mechanisms.

Under the training-focused component of the campaign, prospective cadets are encouraged to choose only DGMA/DGMA-approved Maritime Training Institutes and approved courses. Candidates are advised to verify institutional approvals, course validity, available seats, and CIP or institutional performance status prior to admission. The campaign also seeks to raise awareness regarding fake institutes, invalid certificates, and false promises relating to guaranteed placements or shipboard training opportunities. In addition, stakeholders are encouraged to report instances of cheating, misinformation, or misleading admission and training claims.

The crewing-focused component emphasizes verification of Recruitment and Placement Service Licence (RPSL) status exclusively through official DGMA/DGMA platforms. The campaign advises seafarers not to make payments towards agent fees, placement fees, or other informal charges. It also seeks to caution candidates against fake job offers, contract substitution practices, and engagement with unlicensed sub-agents. Reporting of suspected fraud is encouraged to facilitate enforcement action and enable authorities to take appropriate regulatory and blacklisting measures against offenders.

Maritime Training Institutes have been identified as important partners in campaign implementation. Institutes are expected to display advisories, incorporate fraud awareness messages during induction programmes, guide prospective students to undertake verification before admission or payment, and disseminate official campaign material through their communication channels.

The campaign is proposed to be delivered through a combination of short videos, digital carousels, WhatsApp awareness cards, website updates, posters, multilingual content, and other awareness materials targeting cadets, seafarers, and their families. The objective is to ensure broad outreach and improve awareness across different stakeholder groups.

The rollout is proposed to be aligned with the implementation of the MTI Module and RPSL Module, creating direct pathways for verification and reporting. This integration is expected to strengthen transparency, improve access to authentic information, and contribute to a more secure maritime training and recruitment ecosystem.

7. Ship Building and Repairs

7.1. Introduction

Shipbuilding has returned to the centre of India's maritime agenda, and it has done so at a moment of rare opportunity. The world's leading yards are committed three to five years forward, the global fleet is entering a replacement cycle weighted decisively towards larger tonnage, and owners are actively seeking capacity beyond the three nations that have long dominated the industry. India meets this moment with a coastline of over 11,000 kilometres, deep-water sites available at scale, an established steel industry, a leading global position in ship recycling and a maritime workforce recognised across the world's fleets. In September 2025 the Government of India matched that endowment with commitment, approving a programme of approximately $7.8 Bn across four pillars to build shipbuilding capacity, capability and demand over the decade to 31 March 2036.

Section 2 establishes the demand context: the size and trajectory of the global market, the order backlog now held by the leading shipbuilding nations, the structural shift towards larger vessels, and the vessel mix through which scale and margin can both be secured. Section 3 sets out the four-pillar architecture and the incentives available at each stage of a shipbuilding investment. Sections 4 to 6 examine the three funded pillars in turn: the Shipbuilding Financial Assistance Scheme at $2.7 Bn, the Maritime Development Fund at $2.8 Bn, and the Shipbuilding Development Scheme at $2.2 Bn, the last comprising greenfield cluster development and brownfield capacity expansion. Section 7 addresses the aggregation of public sector demand into a visible order pipeline, Section 8 the component manufacturing agenda on which domestic value addition depends, and Section 9 the Container Manufacturing Promotion Scheme. Section 10 draws the argument together as the conclusion.

7.2. The Global Shipbuilding Market: Demand Context

India is entering shipbuilding at a favourable point in the global cycle. Three propositions support this: the market is growing at a healthy rate after a prolonged period of stagnation, existing yards are already committed several years forward and cannot readily absorb incremental demand, and the composition of demand is shifting towards vessel classes that reward new, purpose-built capacity rather than incumbency in legacy facilities. Each is examined in turn.

Market size and the growth outlook to 2030

The global shipbuilding and repair market, measured across both commercial and defence vessels, stood at approximately $158 Bn in 2018 and expanded to approximately $205 Bn by 2023. It then plateaued, easing marginally to approximately $204 Bn in 2024 before recovering to approximately $215 Bn in 2025, which represents compound growth of only about 2 per cent a year across those two years. The market is projected to reach approximately $262 Bn by 2030, implying compound growth of 4 to 5 per cent a year over the forecast period.

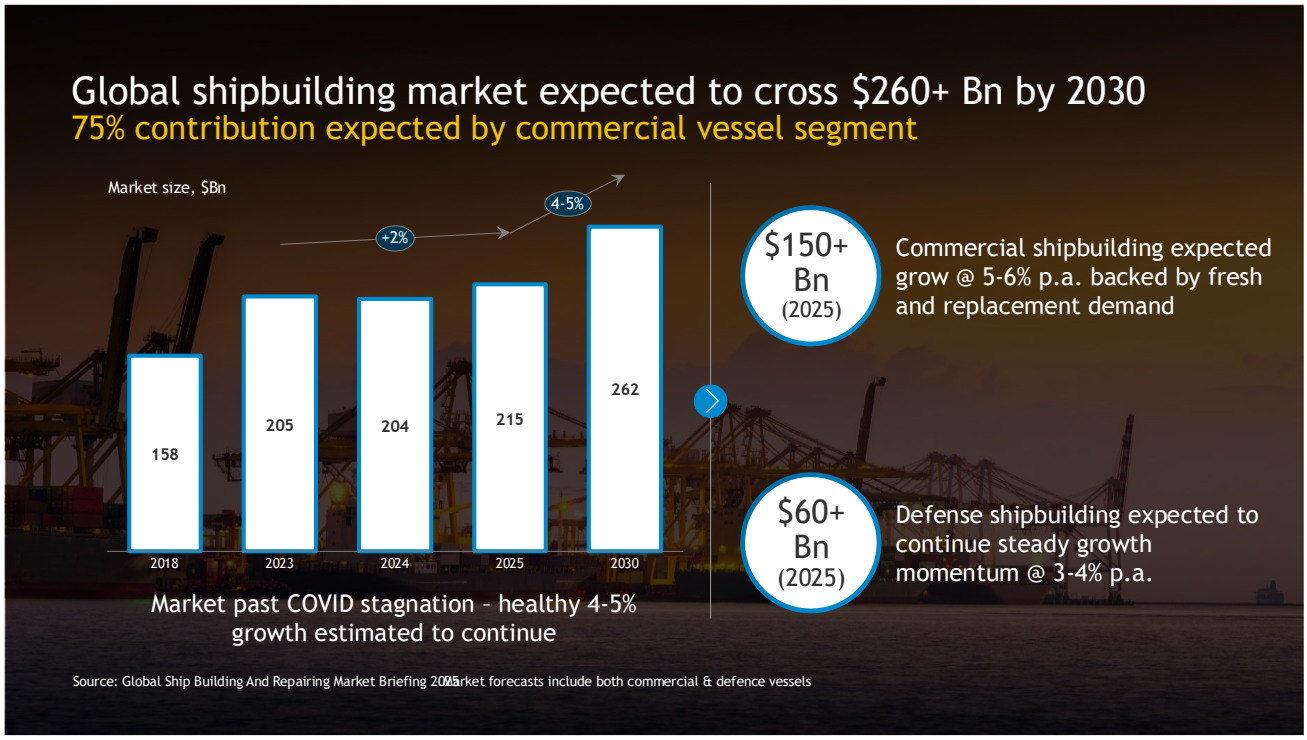


Exhibit 2.1: Global shipbuilding and repair market size, 2018 to 2030

Two features of this trajectory deserve emphasis. The first is the inflection in the growth rate. The two years from 2023 to 2025 delivered compound growth of only about 2 per cent a year and included an absolute contraction in 2024. The forward projection to 2030 assumes 4 to 5 per cent compound growth, roughly double that recent rate. The presentation characterizes this as the market having moved past COVID stagnation, with healthy growth of 4 to 5 per cent now estimated to continue. The projection therefore

embeds an assumption of renewed expansion rather than a simple extrapolation of the immediately preceding period.

The second feature is the divergence between the two constituent segments. Commercial shipbuilding accounted for over $150 Bn of the 2025 total and is expected to grow at 5 to 6 per cent a year, driven by a combination of fresh demand and replacement of ageing tonnage. Defence shipbuilding accounted for over $60 Bn and is expected to grow more slowly, at 3 to 4 per cent a year, though from a base of considerable stability. Because the commercial segment is both larger and faster growing, its share of the total rises over the forecast period, and the commercial vessel segment is expected to account for approximately 75 per cent of the market by 2030.

For India, the practical significance is that the addressable opportunity is concentrated in commercial tonnage. Defence shipbuilding in India is already established, with capable public and private yards and a settled procurement relationship with the Indian Navy and Coast Guard. The commercial segment, by contrast, is where Indian participation is negligible relative to market size, and it is also the segment where growth is fastest. The policy instruments described in later sections are accordingly weighed towards commercial vessel construction, with specialised and defence-adjacent tonnage treated as a margin-enhancing complement rather than the primary target.

The shipbuilding Supercycle and order backlog

Market growth alone would not create an opening for a new entrant if existing yards had spare capacity to absorb it. The second element of the argument is therefore that the global yard base is already heavily committed. The conventional measure of this commitment is backlog duration, expressed as the ratio of the order book to the volume delivered in the most recent full year, and therefore readable as the number of years of work a yard has already secured.

Exhibit 2.2: Global shipyard backlog duration and country order books

Global backlog duration currently stands at 3.2 years, against a long-run average of approximately 2.2 years. The measure is therefore running about one full year above its historical mean. The historical series makes the significance of this clearer: backlog duration collapsed in the years following the 2008 financial crisis, falling well below one year in the middle of the last decade as the industry worked through a severe demand contraction, and has recovered steadily since. The present position is among the strongest in the period observed.

Disaggregating the order book by the three dominant shipbuilding nations, measured on compensated gross tonnage as of 30 June 2026 against deliveries in the last full year, produces the following picture. China holds an order book of 4,679 vessels with an average backlog of 5.1 years. South Korea holds 722 vessels at an average of 3.0 years. Japan holds 755 vessels at an average of 2.8 years. Across the leading global yards, the backlog therefore runs to approximately 3 to 5 years.

The implication is direct. A shipowner placing an order at a leading Chinese yard today is negotiating for delivery around five years hence. Owners who require tonnage earlier than that, or who wish to diversify their supplier base for commercial or strategic reasons, must look beyond the incumbent three. This is the specific commercial opening that Indian capacity is intended to address. The window is, however, time bound. Backlog duration is cyclical, and the same series that shows the current elevation also shows how rapidly it can unwind. Capacity that comes on stream after the cycle turns will face materially harder market conditions than capacity that is available while owners are still

queuing. The urgency embedded in the scheme timelines described in later sections follows from this.

The structural shift towards larger vessels

The third element of the demand argument concerns the composition rather than the volume of future orders. The global fleet totals 116,041 vessels. Distributed by age, 28,089 vessels or 24 per cent are under ten years old, 39,761 vessels or 34 per cent are between eleven and twenty years, 17,408 vessels or 15 per cent are between twenty-one and thirty years, 11,120 vessels or 10 per cent are between thirty-one and forty years, and 19,663 vessels or 17 per cent are over forty years old.

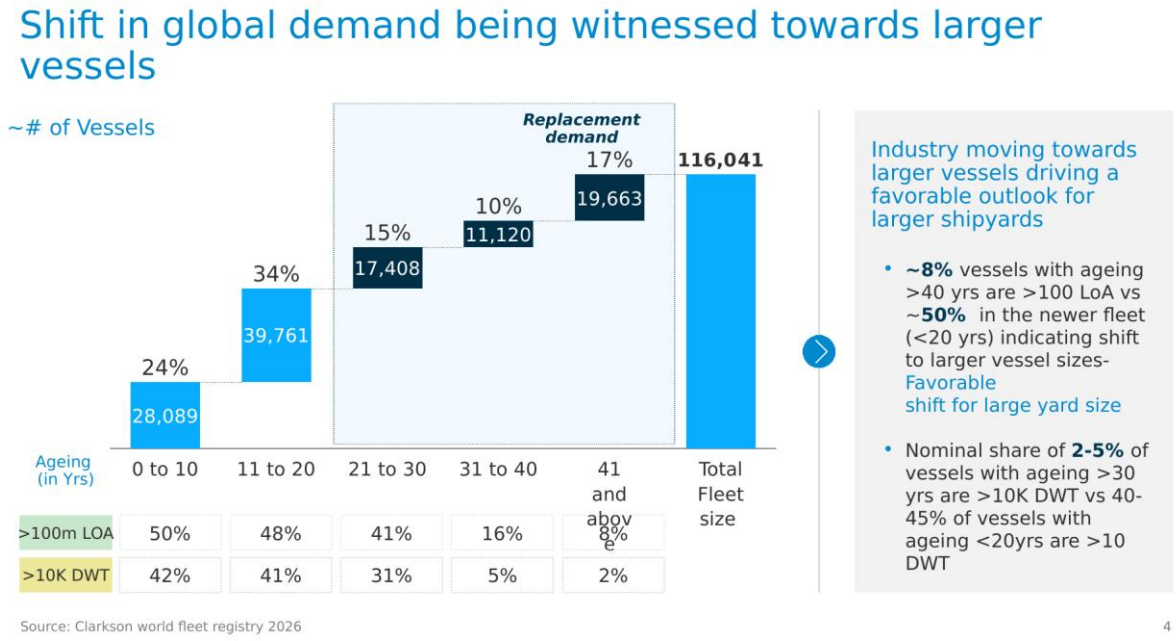


Exhibit 2.3: Global fleet by age band, with vessel size characteristics

The vessels in the older age bands constitute the replacement demand pool. What makes this pool analytically interesting is not its size but the contrast between the vessels leaving the fleet and those entering it. Among vessels over forty years old, only about 8 per cent exceed 100 metres in length overall, and only about 2 per cent exceed 10,000 deadweight tonnes. Among vessels under ten years old, approximately 50 per cent exceed 100 metres in length overall and approximately 42 per cent exceed 10,000 deadweight tonnes. The pattern holds across the intermediate bands: 48 per cent of vessels aged eleven to twenty years exceed 100 metres, falling to 41 per cent for those aged twenty-one to thirty and 16 per cent for those aged thirty-one to forty.

The fleet is therefore not simply being replaced; it is being replaced with substantially larger units. A small ageing vessel is not typically succeeded by another small vessel but is absorbed into the capacity of a larger one. This has a direct bearing on what kind of yard

India should build. Capacity designed around the dimensions of the vessels now being retired would be capacity designed for a market that is contracting. The favorable configuration is a large yard, with dock and berth dimensions, craneage and outfitting capacity suited to vessels above 100 metres in length overall and above 10,000 deadweight tonnes.

This conclusion is reflected directly in the design parameters of the greenfield clusters described in section 6.4, where the sites under development offer post-dredging depths of 10 to 16 metres and waterfronts of 1.8 to 3 kilometres. Those specifications are not incidental; they are what the size profile of future replacement demand requires.

Composition of the ageing fleet by vessel category

Having established that replacement demand favors larger vessels, the next question is which vessel categories that demand will fall into. The ageing fleet, comprising vessels in the older age bands, totals 48,191 units. Its composition by category is set out below.

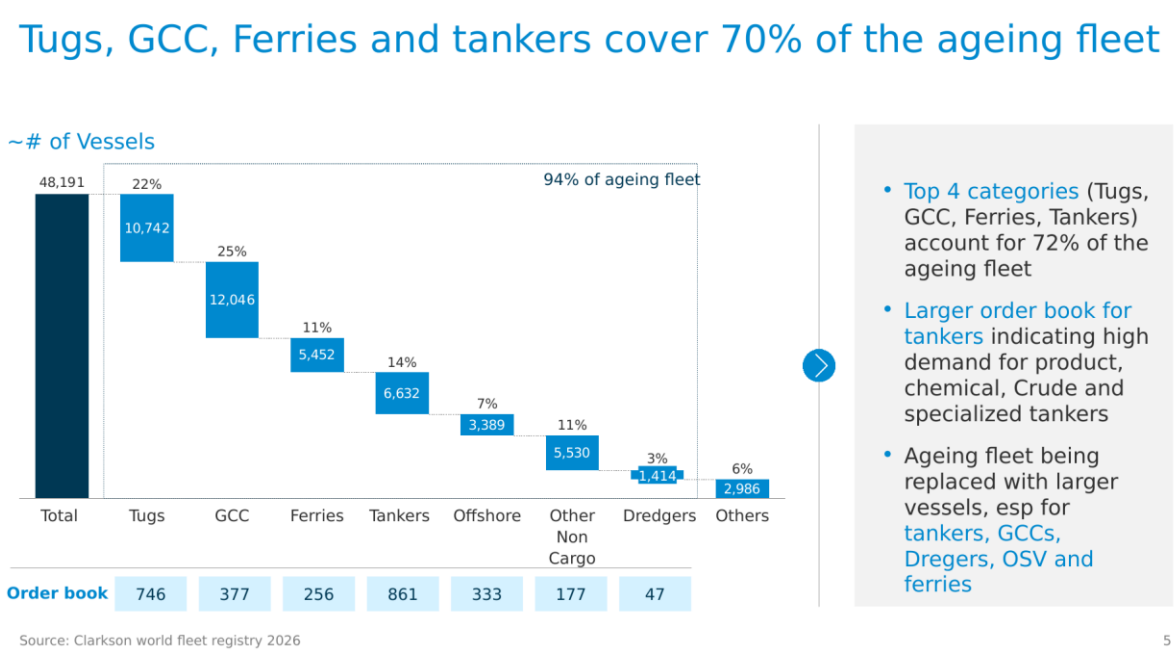


Exhibit 2.4: Ageing fleet and order book by vessel category

Vessel category	Ageing fleet (vessels)	Share of ageing fleet
General cargo carriers	12,046	25%
Tugs	10,742	22%
Tankers	6,632	14%
Other non-cargo	5,530	11%

Vessel category	Ageing fleet (vessels)	Share of ageing fleet
Ferries	5,452	11%
Offshore	3,389	7%
Dredgers	1,414	3%
Others	2,986	6%
Total	48,191	100%

Table 2.1: Composition of the ageing fleet by vessel category

Four categories, namely tugs, general cargo carriers, ferries and tankers, together account for 72 per cent of the ageing fleet. Extending the list to include offshore vessels, other non-cargo vessels and dredgers brings the coverage to approximately 94 per cent. Replacement demand is therefore concentrated rather than dispersed, which is favourable for a new entrant: a yard need not develop competence across the full spectrum of vessel types to address the bulk of the opportunity.

The order book provides a forward reading of where that demand is being placed, and it does not simply mirror the ageing fleet. The largest order book among these categories is for tankers, at 861 vessels, notwithstanding that tankers represent 14 per cent of the ageing fleet rather than the largest share. This indicates demand running ahead of pure replacement, reflecting requirements for product tankers, chemical tankers, crude carriers and specialised tanker tonnage. Order books across the remaining categories range from 47 vessels at the lower end to 746 vessels, with tugs, general cargo carriers, ferries and offshore vessels all represented.

Read together with the size analysis in section 2.3, the pattern is one of ageing tonnage being replaced by larger tonnage within the same broad categories, and this effect is most pronounced for tankers, general cargo carriers, dredgers, offshore support vessels and ferries. For Indian yards, the practical reading is that tankers and general cargo carriers offer the largest addressable volumes, while dredgers, offshore support vessels and ferries offer more specialised opportunities where domestic demand from public sector programmes, discussed in section 7, can provide an initial order base.

Balancing scale against margin in the vessel mix

The final element of the demand analysis addresses a tension in the strategy. The tonnage targets that India has set require volume, and volume is most readily achieved through large conventional vessels. Those vessels, however, are also the most price-competitive segment of the market, where established yards in China, South Korea and Japan

compete on cost at scale. Building only conventional tonnage would deliver gross tonnage but compress margins.

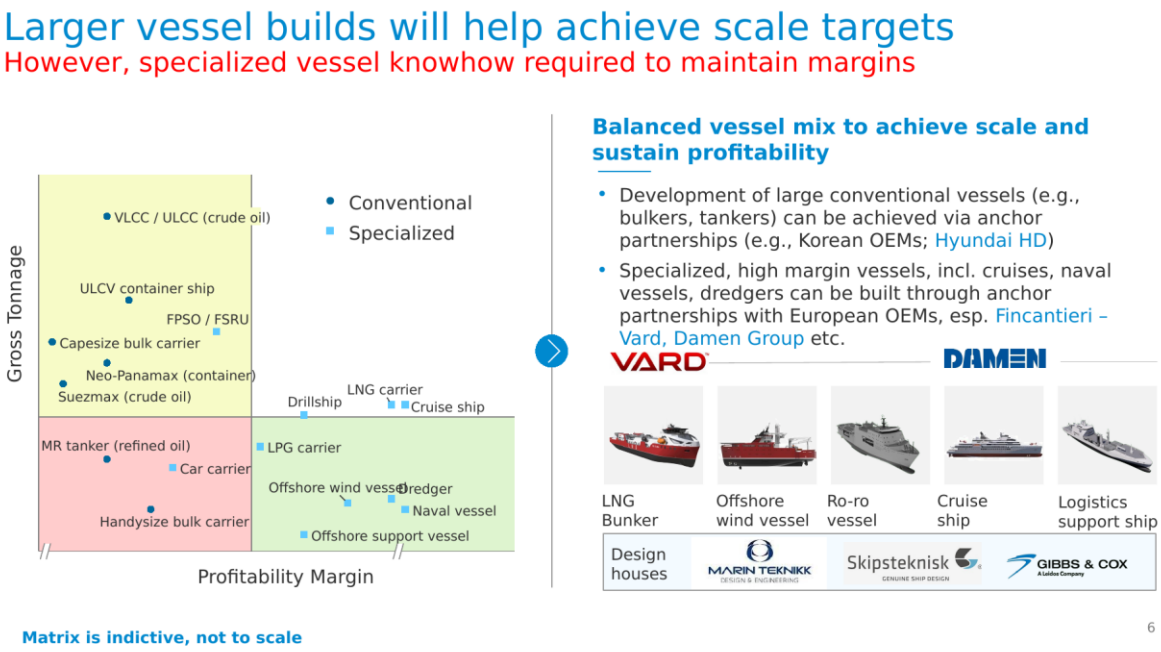


Exhibit 2.5: Indicative positioning of vessel types by gross tonnage and profitability margin

The exhibit positions vessel types along two axes: gross tonnage, which stands as a proxy for the contribution a vessel makes to scale targets, and profitability margin. The conventional group occupies the high-tonnage, lower-margin region and includes very large and ultra large crude carriers at around 80,000 gross tonnes, ultra large container vessels at around 60,000, Capesize bulk carriers at around 50,000, Neo-Panamax container vessels at around 45,000, Suezmax crude tankers at around 40,000, medium range refined product tankers at around 22,000, and Handysize bulk carriers at around 10,000.

The specialised group occupies the higher-margin region across a wider tonnage spread and includes floating production and storage units and floating storage and regasification units at around 52,500 gross tonnes, liquefied natural gas carriers and cruise ships at around 35,000, drillships at around 32,500, liquefied petroleum gas carriers at around 25,000, car carriers at around 20,000, dredgers at around 12,500, offshore wind installation vessels at around 11,500, naval vessels at around 10,000, and offshore support vessels at around 4,000. The matrix is indicative and is not drawn to scale.

The conclusion drawn in the address is that a balanced vessel mix is required, and that the route to both halves of that mix runs through anchor partnerships with established international builders and design houses. For large conventional vessels, the partners identified are Korean original equipment manufacturers, with HD Hyundai named specifically. For specialised, higher-margin tonnage including cruise vessels, naval

vessels and dredgers, the partners identified are European original equipment manufacturers, with Fincantieri and its Vard subsidiary and the Damen Group named specifically. Within the specialised category, five vessel types are highlighted as immediate priorities: liquefied natural gas bunkering vessels, offshore wind vessels, roll-on roll-off vessels, logistics support ships and cruise ships.

The reliance on anchor partnerships is deliberate and reflects a realistic assessment of where Indian capability currently stands. Neither large conventional nor specialised construction can be established from a standing start on domestic know-how alone. Design capability, production engineering and supply chain qualification all require transfer from builders who already possess them. This is why HD Hyundai appears not only in this analysis but also as the anchor investor in the Thoothukudi cluster discussed in section 6.4, and why the anchor shipyard requirement is written into the greenfield cluster conditions described in section 6.2.

7.3. India's Policy Architecture for Shipbuilding

The four pillars and the total outlay of approximately $7.8 Bn

The Government of India has organised its response to the opportunity described in section 2 around four pillars, with a combined approved outlay of approximately $7.8 Bn. Three of the four carry a specific financial allocation; the fourth is a programme of legal, policy and process reform which enables the others rather than disbursing funds itself.

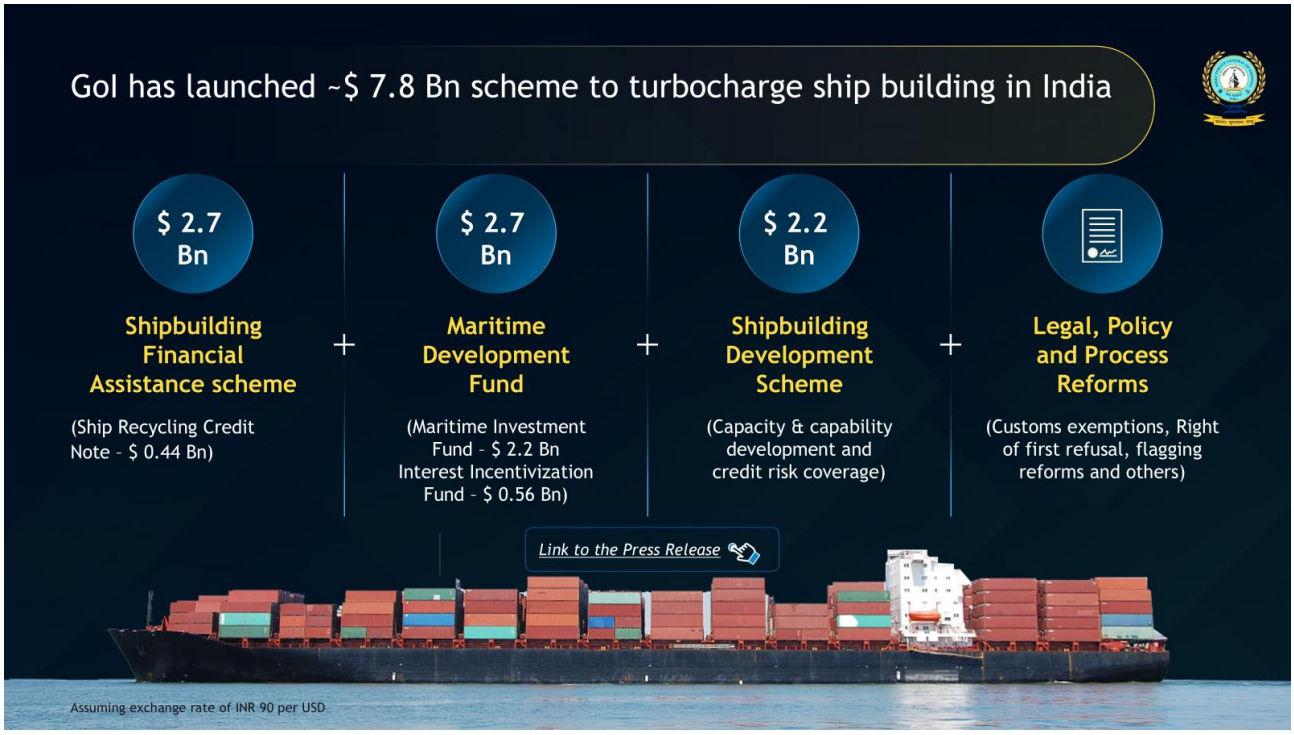


Exhibit 3.1: The four pillars of the shipbuilding programme and their outlays

Pillar	Instrument	Outlay	Composition
1	Shipbuilding Financial Assistance Scheme	$2.7 Bn	Includes the Ship Recycling Credit Note of $0.44 Bn
2	Maritime Development Fund	$2.8 Bn	Maritime Investment Fund $2.2 Bn and Interest Incentivization Fund $0.56 Bn
3	Shipbuilding Development Scheme	$2.2 Bn	Capacity and capability development, and credit risk coverage
4	Legal, Policy and Process Reforms	-	Customs exemptions, right of first refusal, flagging reforms and related measures
	Total	Approximately $7.8 Bn	

Table 3.1: The four pillars and their approved outlays

The three funded pillars are close to equal in scale, at approximately $2.8 Bn, $2.8 Bn and $2.2 Bn respectively, and this near-parity is itself informative. It indicates that the programme does not rest on a single dominant instrument but distributes support across three distinct functions. The Shipbuilding Financial Assistance Scheme addresses the unit economics of each vessel constructed. The Maritime Development Fund addresses the availability and cost of capital. The Shipbuilding Development Scheme addresses the physical capacity to build at all. A shipyard that received only one of the three would still face a binding constraint from the other two.

The fourth pillar carries no outlay but should not be read as secondary. Customs exemptions determine the landed cost of imported components, which matters directly given the import dependence documented in section 8. The right of first refusal determines whether Indian-built and Indian-flagged tonnage has preferential access to domestic cargo. Flagging reforms determine the administrative cost of registering and operating a vessel under the Indian flag. These measures shape the commercial environment within which the funded instruments operate, and their absence would blunt the effect of the funded pillars considerably.

All dollar figures follow the denomination used in the presentation, with rupee equivalents converted at the exchange rate of Rs. 90 per dollar stated on the same slide.

Financial incentives across the shipbuilding lifecycle

The four pillars are more usefully understood not as parallel schemes but as a sequence of interventions aligned to the stages at which a shipbuilding enterprise incurs cost and faces risk. Slide 74 presents the same architecture organised along this lifecycle.

Exhibit 3.2: Financial incentives mapped across the shipbuilding lifecycle

At the pre-operations stage, before a yard has built anything, the binding constraints are land and marine access. Under the Shipbuilding Development Scheme, a yard entering a greenfield cluster obtains land parcels together with ready plug-and-play infrastructure at nominal lease rental, and the common marine infrastructure on which its operations depend, including breakwaters, dredging and reclamation and internal infrastructure, is provided rather than financed by the yard. This removes from the yard the single largest and least bankable element of shipbuilding capital cost.

At the post-operations stage, once the yard is building, four instruments apply. The Shipbuilding Financial Assistance Scheme provides 15 to 25 per cent financial assistance on every ship built. The Shipbuilding Development Scheme provides risk cover through pre-shipment insurance, post-shipment insurance and vendor default insurance, addressing the counterparty and execution risks that make shipbuilding difficult to finance conventionally. For existing yards, the same scheme provides 25 per cent capital assistance towards brownfield expansion of production capacity. The Maritime Development Fund provides loans through the Maritime Investment Fund for long-term capital deployment across shipbuilding, port modernisation and green shipping, together with an interest incentive of up to 3 per cent.

Three further elements sit outside the four pillars but materially affect project economics. The first is additional outlay by the Government of India to stimulate demand, covering approximately 437 vessels, which is the demand aggregation programme examined in section 7. The second is additional incentive from state governments, estimated at 15 to 25 per cent of capital expenditure through mechanisms including

capital subsidy and reimbursement of state goods and services tax. The third is the extension of infrastructure status to ships, which enables a ten-year tax holiday through GIFT City.

Taken together, these interact multiplicatively rather than additively. A yard in a greenfield cluster receives infrastructure at nominal cost from the Centre, capital subsidy from the state, concessional debt and interest support from the Maritime Development Fund, per-vessel assistance under the Shipbuilding Financial Assistance Scheme, insurance cover against execution risk, a visible order pipeline through demand aggregation, and favourable tax treatment on the resulting asset. It is the combination, rather than any single instrument, that is intended to close the competitiveness gap against established yards operating at far greater scale.

7.4. Pillar 1: Shipbuilding Financial Assistance Scheme

Scheme composition and the assistance rate structure

The Shipbuilding Financial Assistance Scheme is the instrument that addresses the unit economics of vessel construction. Its purpose is to bridge the cost differential between an Indian yard and an established international competitor on each individual vessel, rather than to subsidise the yard as an enterprise. The approved outlay of $2.7 Bn comprises three components: approximately $2.3 Bn for the extension of the financial assistance scheme itself, $0.44 Bn for the Ship Recycling Credit Note, and approximately $0.02 Bn for the establishment of the National Shipbuilding Mission.

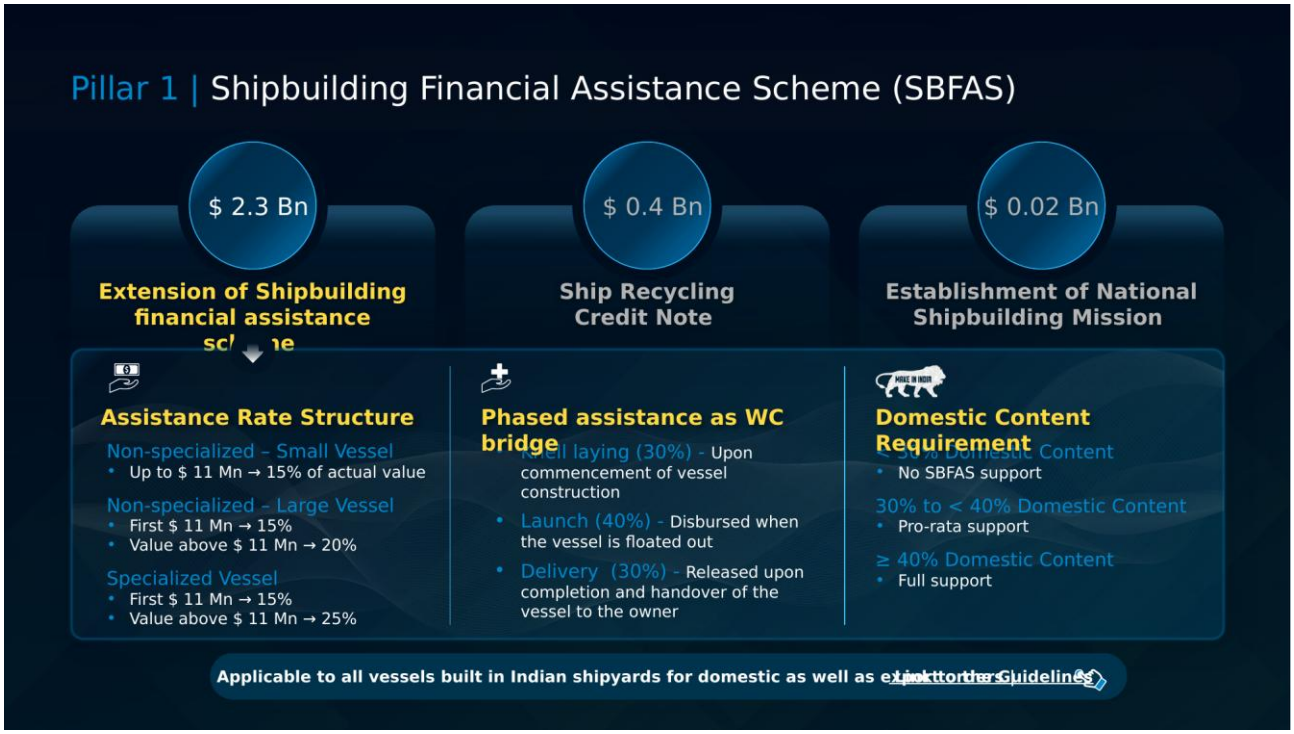


Exhibit 4.1: Shipbuilding Financial Assistance Scheme: composition and assistance structure

The assistance rate structure is tiered by vessel type and by contract value, and is deliberately weighted towards larger and more specialised vessels.

Vessel category	First $11 Mn of value	Value above $11 Mn
Non-specialised, small vessel (up to $11 Mn)	15% of actual value	Not applicable
Non-specialised, large vessel	15%	20%
Specialised vessel	15%	25%

Table 4.1: Assistance rate structure under the Shipbuilding Financial Assistance Scheme

The structure carries a clear intent. A small non-specialised vessel attracts 15 per cent. A large non-specialised vessel attracts 15 per cent on the first $11 Mn and 20 per cent thereafter. A specialised vessel attracts 15 per cent on the first tranche and 25 per cent on the balance. The marginal rate therefore rises with both size and specialisation, which aligns the incentive precisely with the demand analysis in sections 2.3 and 2.5: larger vessels are where replacement demand is concentrated, and specialised vessels are where margin is available. A yard that responds rationally to this rate structure will build the vessels that the market analysis indicates it should build.

Disbursement is phased against construction milestones, with 30 per cent released on keel laying when vessel construction commences, 40 per cent on launch when the vessel is floated out, and 30 per cent on delivery when the completed vessel is handed over to the owner. The phasing is significant beyond its administrative function. Shipbuilding is working capital intensive, with expenditure incurred across a multi-year build against payment terms that are typically back-loaded. By releasing 70 per cent of assistance before delivery, the scheme functions as a working capital bridge rather than solely as a terminal subsidy, which improves the financing profile of each contract.

Assistance is conditioned on domestic content. A vessel with less than 30 per cent domestic content receives no support. Between 30 per cent and 40 per cent, support is pro-rated. At 40 per cent or above, full support applies. This condition is the mechanism by which the scheme guards against a superficial form of success in which Indian yards become assembly points for imported packages, generating tonnage and employment at the yard while leaving the value chain offshore. The threshold connects this pillar directly to the component manufacturing agenda in section 8: unless domestic component capability develops, yards will struggle to clear the 40 per cent threshold and will receive only pro-rated support.

The scheme applies to all vessels built in Indian shipyards, for domestic and export orders alike. This is a material design choice. Restricting assistance to domestic orders would have tied Indian yards to the scale of Indian demand; extending it to exports

permits yards to compete for the international backlog identified in section 2.2, which is where the volume lies.

The Ship Recycling Credit Note: a global first

Within the Shipbuilding Financial Assistance Scheme, the Ship Recycling Credit Note is a distinct instrument and is described in the address as a global first. $0.44 Bn has been allocated to it, with validity of ten years running from 24 September 2025 to 31 March 2036.

Exhibit 4.3: Structure of the Ship Recycling Credit Note

The mechanism links two activities that have historically been treated as unrelated. When a vessel is recycled at a Hong Kong Convention compliant ship recycling yard in India, the owner becomes entitled to a credit note valued at 40 per cent of the fair scrap value of that vessel. The credit note may then be applied as an offset against the cost of a new vessel built at an Indian shipyard, up to a limit of 5 per cent of the new vessel value.

The instrument carries five design features that materially widen its usefulness. It is valid for three years from the date of completion of recycling, which allows the owner time to place a newbuild order rather than requiring simultaneous transactions. It is stackable, so credit notes from multiple recycled vessels may be combined against a single newbuild. It permits partial utilisation, so a credit note need not be exhausted in one transaction. It is transferable, so an owner who recycles but does not intend to order a new vessel may transfer the entitlement to one who does. And its valuation is market-driven, being derived from published scrap prices rather than from an administratively fixed figure.

The strategic reasoning behind the instrument rests on India's position at both ends of the vessel lifecycle. India is already a leading global destination for ship recycling. It is not yet a significant shipbuilding nation. The credit note converts the established position into support for the aspirational one, by giving the owner of a vessel reaching the end of its life a financial reason to route both the disposal and the replacement through India. The transferability provision is what makes this work in practice, because the population of owners recycling tonnage and the population ordering new tonnage do not fully overlap; without transferability the instrument would only assist owners who happened to be doing both at once.

The requirement that recycling take place at a Hong Kong Convention compliant yard adds a second policy objective. It converts the credit note into an incentive for continued upgrading of Indian recycling yards to international environmental and safety standards, since only compliant yards can generate the entitlement. The instrument therefore advances shipbuilding capacity, recycling standards and lifecycle retention of value within India simultaneously.

Eligibility, valuation and redemption under the SRCN

The operating rules of the credit note are set out across three dimensions: which vessels qualify, how the credit is valued, and on what conditions it may be redeemed.

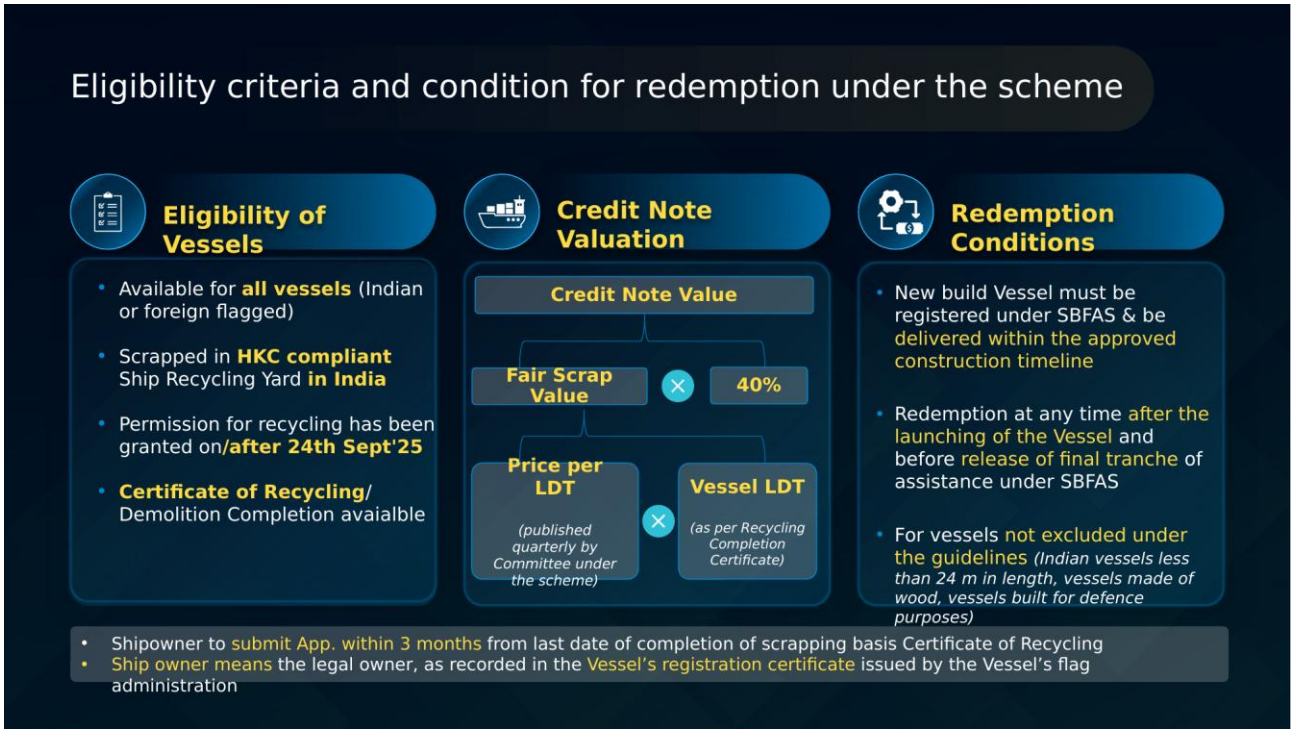


Exhibit 4.4: Eligibility, valuation and redemption conditions under the SRCN

Eligibility on the recycling side. The credit note is available in respect of all vessels, whether Indian or foreign flagged. The vessel must be scrapped at a Hong Kong Convention compliant ship recycling yard in India, permission for recycling must have

been granted on or after 24 September 2025, and a certificate of recycling or demolition completion must be available. The extension to foreign flagged vessels is a significant widening of scope, since it allows the instrument to draw international recycling volumes into Indian yards rather than merely redistributing domestic tonnage.

Eligibility on the newbuild side. The new vessel against which the credit is applied must be registered under the Shipbuilding Financial Assistance Scheme and must be delivered within the approved construction timeline. Certain vessels are excluded, namely Indian vessels of less than 24 metres in length, vessels constructed of wood, and vessels built for defence purposes.

Valuation. The credit note value is 40 per cent of the fair scrap value of the recycled vessel. Fair scrap value is itself the product of two variables: the light displacement tonnage of the vessel as recorded in the recycling completion certificate, and the price per light displacement tonne published quarterly by the committee constituted under the scheme. Anchoring the calculation to a quarterly published price rather than a fixed administrative rate means the entitlement tracks the scrap market, protecting the value of the instrument against price movement in either direction across a ten-year scheme life.

Redemption. Redemption may be effected at any time after the launching of the new vessel and before the release of the final tranche of assistance under the Shipbuilding Financial Assistance Scheme. Since the final tranche represents 30 per cent released on delivery, this defines a redemption window running from float-out to handover. The shipowner must submit the application within three months from the last date of completion of scrapping, on the basis of the certificate of recycling. For these purposes the shipowner means the legal owner as recorded in the vessel registration certificate issued by the flag administration of the vessel.

The three-month application deadline and the launch-to-delivery redemption window together impose a discipline on the instrument. The entitlement must be claimed promptly after recycling, and applied within a defined phase of the newbuild programme. This prevents the accumulation of a large stock of undated credit notes that would create an open-ended contingent liability against the $0.44 Bn allocation, while the three-year validity still allows sufficient commercial flexibility for an owner to sequence disposal and replacement.

7.5. Pillar 2: Maritime Development Fund

Fund architecture, priority sectors and instruments

The second pillar addresses capital. Shipbuilding is capital intensive, has long gestation, and presents a risk profile that Indian commercial lenders have historically been reluctant to underwrite. The Maritime Development Fund is capitalised at $2.8 Bn, with budgetary support extending from financial year 2026 to financial year 2036. The contribution of the Government of India is held and managed by the Shipping Maritime Finance Corporation Limited in a fiduciary capacity, within an Alternative Investment Fund structure. Against the public contribution the fund is structured to mobilise private capital, with the indicative split being 49 per cent public and 51 per cent private.

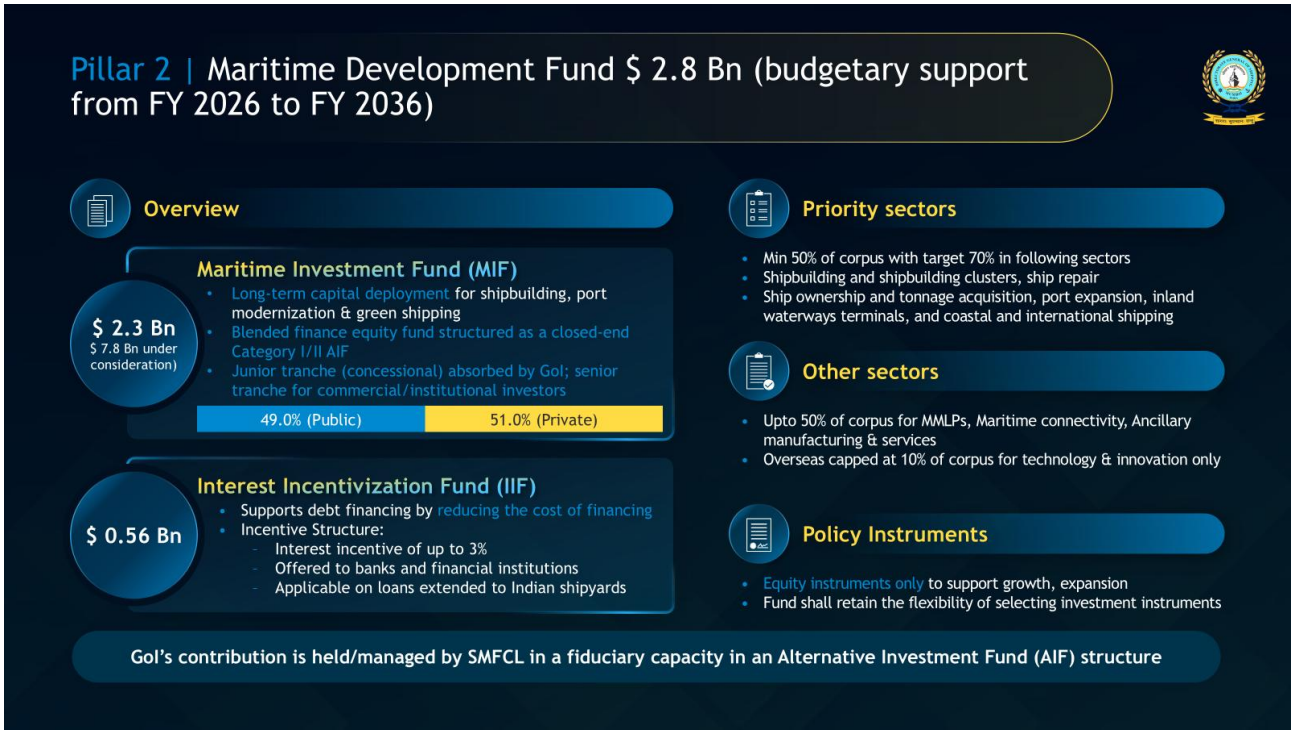


Exhibit 5.1: Maritime Development Fund: structure, sectors and instruments

The fund operates through two distinct sub-instruments addressing equity and debt respectively.

The Maritime Investment Fund, $2.2 Bn. This is a blended finance equity fund structured as a closed-end Category I or Category II Alternative Investment Fund. Its purpose is long-term capital deployment across shipbuilding, port modernisation and green shipping. The blended structure is the essential feature: the junior tranche, which bears first loss and is therefore concessional, is absorbed by the Government of India, while the senior tranche is offered to commercial and institutional investors. This allocation of risk is what permits the 51 per cent private participation. Institutional investors are not being asked to underwrite the full risk of a nascent shipbuilding sector;

they are being offered a senior position behind a government-funded first loss cushion. Against the $2.2 Bn committed to the fund, the presentation records a further $7.8 Bn as being under consideration, which indicates the scale of investment the instrument is ultimately intended to mobilise.

The Interest Incentivization Fund, $0.56 Bn. This instrument addresses the cost rather than the availability of debt. It provides an interest incentive of up to 3 per cent, offered to banks and financial institutions and applicable on loans extended to Indian shipyards. Its function is to reduce the effective cost of financing and thereby support debt provision to the sector. At an incentive of up to 3 per cent, a $0.56 Bn allocation can support a considerably larger stock of underlying debt, which is the leverage the instrument is designed to achieve.

Deployment of the corpus is governed by sectoral rules. A minimum of 50 per cent of the corpus, with a target of 70 per cent, is to be deployed in priority sectors. These comprise shipbuilding and shipbuilding clusters and ship repair; and ship ownership and tonnage acquisition, port expansion, inland waterways terminals, and coastal and international shipping. Up to 50 per cent of the corpus may be deployed in other sectors, comprising multimodal logistics parks, maritime connectivity, and ancillary manufacturing and services. Overseas deployment is capped at 10 per cent of the corpus and is confined to technology and innovation.

On policy instruments, the fund is to use equity instruments to support growth and expansion, while retaining flexibility in the selection of investment instruments. The combination of a stated minimum for priority sectors and a higher target creates a governance structure in which the fund is bound to concentrate on shipbuilding and adjacent maritime activity while retaining the latitude to deploy across the wider ecosystem where that supports the primary objective. The narrow overseas allowance confined to technology and innovation is consistent with the technology transfer logic underlying the anchor partnership approach described in section 2.5.

7.6. Pillar 3: Shipbuilding Development Scheme

Scheme composition and allocation of $2.2 Bn

The third pillar addresses physical capacity. Favourable unit economics and available capital are of no consequence if there is no yard capable of building vessels of the size and complexity the market requires. The Shipbuilding Development Scheme is allocated $2.2 Bn with a validity of ten years, running until 31 March 2036.

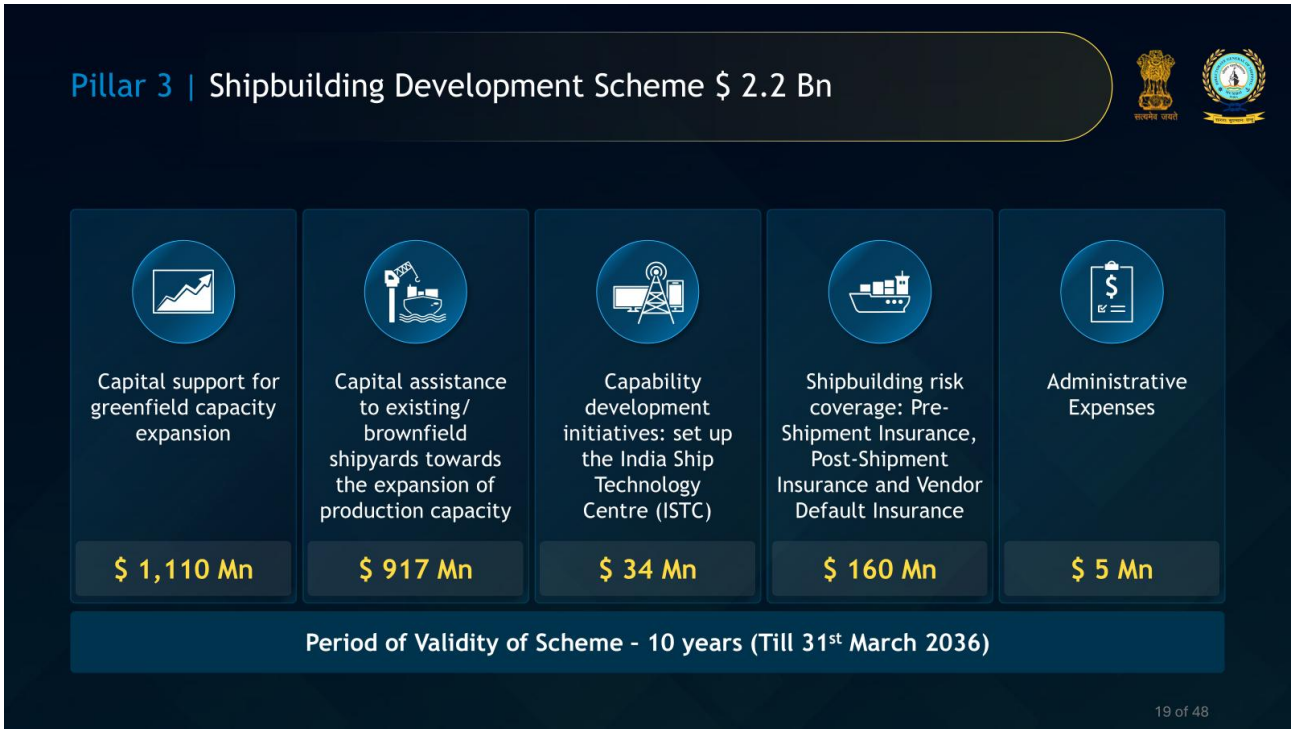


Exhibit 6.1: Shipbuilding Development Scheme: allocation by component

Component	Allocation
Capital support for greenfield capacity expansion	$1,110 Mn
Capital assistance to existing and brownfield shipyards towards expansion of production capacity	$917 Mn
Shipbuilding risk coverage: pre-shipment insurance, post-shipment insurance and vendor default insurance	$160 Mn
Capability development initiatives, including establishment of the India Ship Technology Centre	$34 Mn
Administrative expenses	$5 Mn
Total	$2.2 Bn

Table 6.1: Allocation of the Shipbuilding Development Scheme by component

The allocation reveals the strategic balance the scheme strikes. Greenfield and brownfield together account for $2,027 Mn, or approximately 91 per cent of the total, so the scheme is overwhelmingly a capacity creation instrument. Within that, greenfield receives $1,110 Mn and brownfield $917 Mn, a near-even division that reflects a considered choice: neither approach alone is sufficient.

The reasoning is one of timing. Greenfield clusters can be designed from the outset for the large vessels that section 2.3 identifies as the growth segment, unconstrained by the dimensions of legacy facilities, but they take years to build. Brownfield expansion at existing yards can deliver incremental capacity considerably faster, because the yard, workforce and supply relationships already exist, but it is bound by the physical envelope of the site. Funding both allows near-term capacity to come from brownfield expansion while the greenfield clusters are under construction, which matters given the cyclical window discussed in section 2.2.

The $160 Mn for risk coverage is small in proportion but addresses a specific market failure. Pre-shipment, post-shipment and vendor default insurance cover the risks that make shipbuilding contracts difficult to finance: that the yard fails to complete, that the buyer fails to take delivery, or that a critical supplier defaults. In the absence of such cover, lenders price these risks into the cost of debt or decline the exposure altogether. Providing the cover from public funds is a more capital-efficient intervention than subsidising the resulting interest cost.

The $34 Mn for capability development, principally the India Ship Technology Centre, addresses the design and engineering capability that section 2.5 identifies as a binding constraint. The sum is modest relative to the scheme total but is directed at the element least amenable to purchase. Physical capacity can be built and capital can be raised; design and production engineering competence accumulates through practice and institutional continuity.

Greenfield clusters: objective, structure and conditions

The greenfield component is the more ambitious half of the Shipbuilding Development Scheme, and its design reflects the conclusion that India requires not simply new shipyards but complete industrial ecosystems around them.

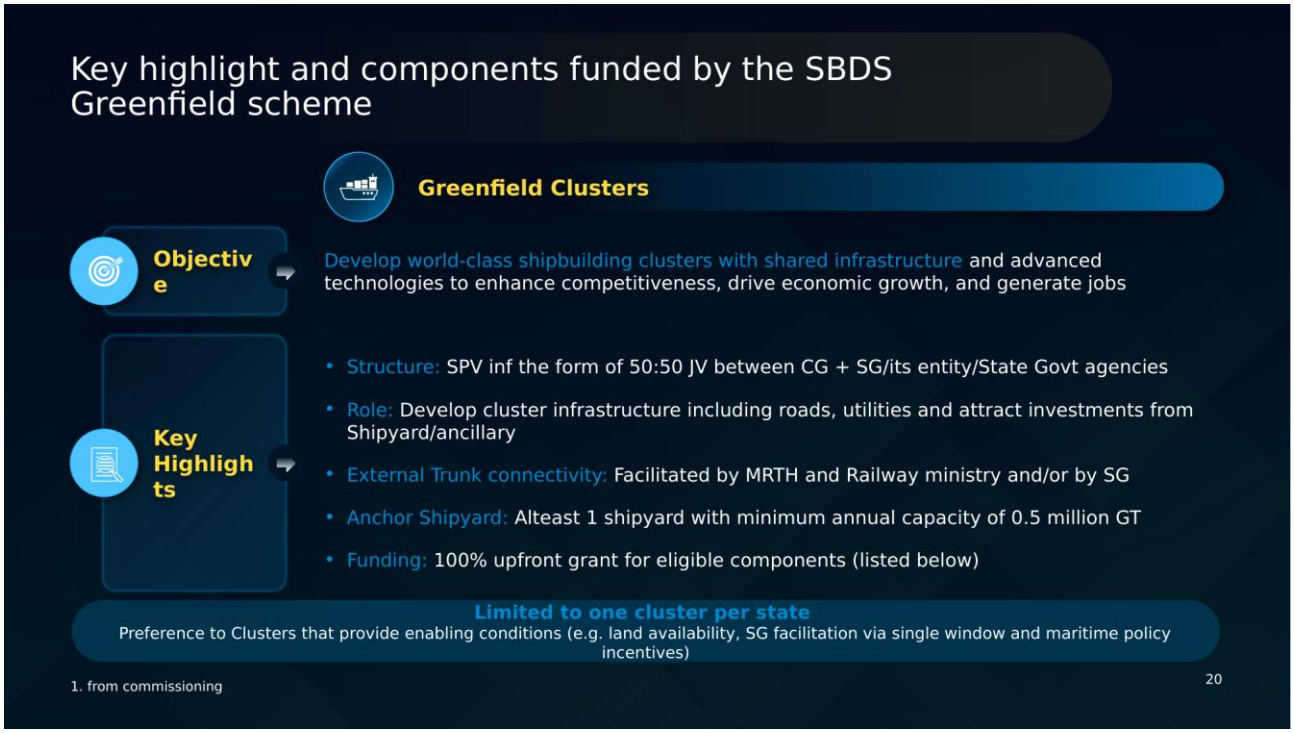


Exhibit 6.2: Greenfield cluster scheme: objective and key highlights

The stated objective is to develop world-class shipbuilding clusters with shared infrastructure and advanced technologies, in order to enhance competitiveness, drive economic growth and generate employment. The choice of a cluster model rather than standalone yards follows from the economics of shipbuilding. A yard depends on a tier of component suppliers, on block fabrication capacity, on heavy lift and marine support assets, and on a resident workforce. Where these are co-located, shared assets are used efficiently and connectivity infrastructure serves multiple users. Where a yard stands alone, each of these must be duplicated or procured at distance.

Institutional structure. Each cluster is developed by a Special Purpose Vehicle constituted as a 50:50 joint venture between the Central Government and the State Government or their respective entities or agencies. The Special Purpose Vehicle develops the cluster infrastructure, including internal roads and utilities, and is responsible for attracting investment from shipyards and ancillary industry. The joint venture structure aligns the two levels of government whose cooperation the project requires: the Centre brings the capital assistance, and the State brings land, clearances and policy facilitation.

External connectivity. Trunk connectivity beyond the cluster boundary is facilitated by the Ministry of Road Transport and Highways and the Ministry of Railways, and by the State Government. This is a deliberate allocation of responsibility. A cluster is only as useful as its links to the hinterland from which components, steel and labour arrive, and those links lie outside the remit of the Special Purpose Vehicle.

Anchor shipyard requirement. Each cluster must have at least one anchor shipyard with a minimum annual capacity of 0.5 million gross tonnes. This is the single most consequential condition in the scheme. It ensures that the cluster is built around a yard of genuine scale rather than an aggregation of small operators, and it is calibrated to the vessel size analysis in section 2.3. A yard of 0.5 million gross tonnes annual capacity is capable of building the large tonnage in which replacement demand is concentrated.

Funding. The scheme provides a 100 per cent upfront grant for eligible components, which are enumerated in section 6.3. Full central funding of common infrastructure removes from the anchor investor the cost that is hardest to justify commercially, since breakwaters and dredged channels are shared assets whose benefit cannot be fully appropriated by any single user.

Selection conditions. Support is limited to one cluster per state, with preference accorded to clusters that provide enabling conditions, including availability of land, State Government facilitation through a single window mechanism, and maritime policy incentives. The one-cluster-per-state limit prevents dilution of the allocation across too many sites, while the preference criteria create competitive pressure among states to improve their offer. Section 6.5 shows this operating in practice.

Common maritime infrastructure funded by the Centre

The 100 per cent upfront grant applies to five categories of common infrastructure, all of which are developed by the Special Purpose Vehicle and held for shared use across the cluster.

Exhibit 6.3: The five categories of common infrastructure funded under the greenfield scheme

- Breakwaters, tide-independent basins and wave breakers. These provide the sheltered water without which vessel construction, launch and outfitting cannot proceed reliably through the year, and they are the classic instance of infrastructure whose cost no single yard can carry alone.
- Channel and basin development, comprising capital dredging, land reclamation, area grading and turning basins. This determines the maximum vessel size the cluster can physically handle, and therefore directly governs whether the site can serve the large-vessel demand identified in section 2.3.
- Regional shipbuilding capability development centres, providing skill training, research and development, green shipbuilding technology and certification facilities. These address the workforce and technology constraint at cluster level rather than leaving each yard to solve it independently.
- Common maritime assets, comprising shared floating cranes, barges, tugs and auxiliary marine craft serving the cluster. Such assets are registered under the Special Purpose Vehicle and used collectively for heavy lift, transport, assembly and vessel movement, and are admissible only as common-use cluster infrastructure approved by the National Shipbuilding Mission.
- Internal infrastructure, utilities and land development, including site development, rail and road connectivity within the cluster, utilities such as water supply, power distribution, drainage and firefighting systems, and social infrastructure including medical and dining facilities.

Funding is backed by 100 per cent upfront capital assistance and governed through milestone-linked release of funds with independent monitoring. The Special Purpose Vehicle oversees cluster-wise development and commences construction of the common structures. Certain items are explicitly excluded from the grant, namely the human resources of the Special Purpose Vehicle, operations and maintenance expenditure, maintenance dredging, and the cost of land, which is instead transferred to the Special Purpose Vehicle by the State Government at a nominal consideration of one rupee.

The exclusions are as instructive as the inclusions. By funding capital creation but not operation and maintenance, the scheme requires each Special Purpose Vehicle to establish a revenue model, principally through lease rentals from the anchor shipyard and ancillary units, sufficient to sustain the asset base it has been given. This is a deliberate guard against the creation of publicly funded infrastructure that subsequently deteriorates for want of a maintenance income.

Cluster locations and site characteristics

Five cluster locations across five coastal states are presently envisaged. Their physical characteristics are set out below.

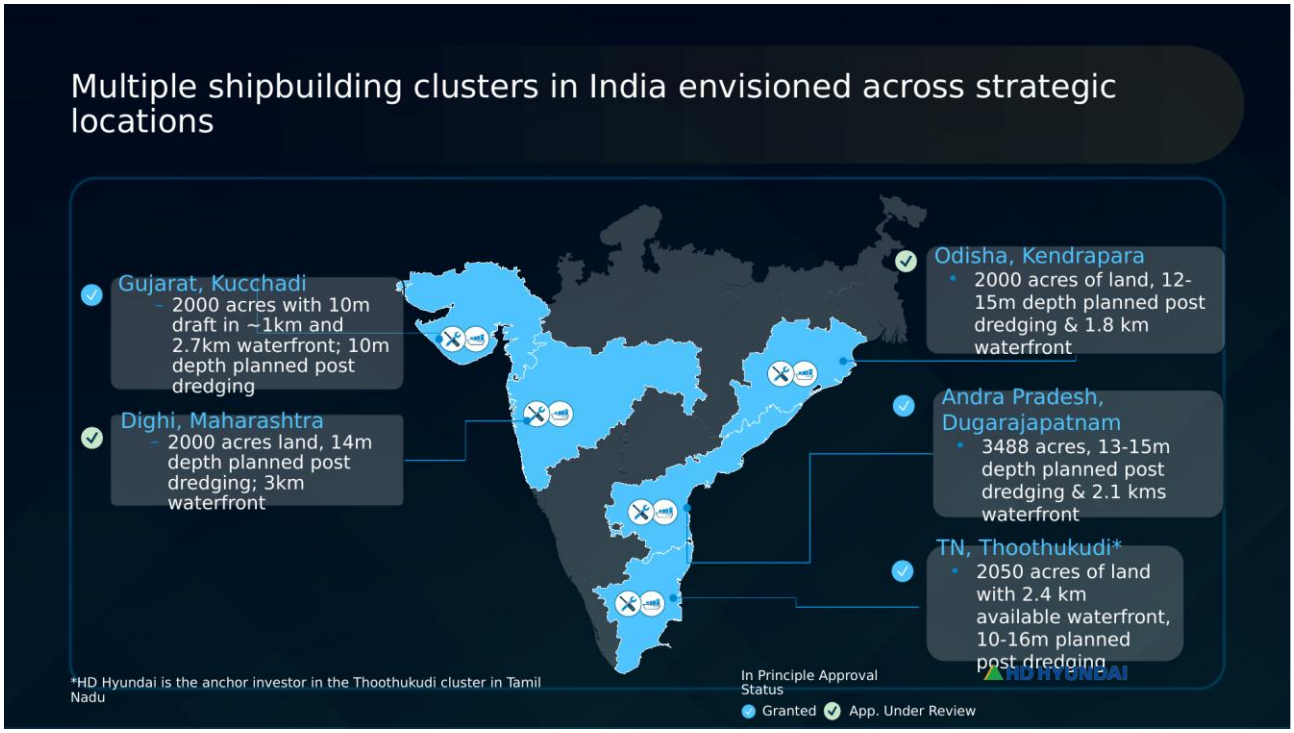


Exhibit 6.4: Envisaged shipbuilding cluster locations across coastal states

State and location	Land area	Planned depth post-dredging	Waterfront
Andhra Pradesh, Dugarajapatnam	3,488 acres	13 to 15 metres	2.1 km
Tamil Nadu, Thoothukudi	2,050 acres	10 to 16 metres	2.4 km
Odisha, Kendrapara	2,000 acres	12 to 15 metres	1.8 km
Maharashtra, Dighi	2,000 acres	14 metres	3.0 km
Gujarat, Kucchadi	2,000 acres	10 metres	2.7 km

Table 6.2: Site characteristics of the envisaged shipbuilding clusters

The sites are broadly comparable in scale, at 2,000 acres or more, with Dugarajapatnam the largest at 3,488 acres. Planned depths after dredging range from 10 to 16 metres and waterfronts from 1.8 to 3 kilometres. These parameters are consistent with the requirement to build vessels above 100 metres in length overall and above 10,000 deadweight tonnes, which section 2.3 identified as the growth segment of the market. The Gujarat site at Kucchadi is noted as presently offering a 10 metre draft over approximately one kilometre, with 10 metre depth planned after dredging.

The geographic distribution across the eastern seaboard at Dugarajapatnam and Kendrapara, the western seaboard at Dighi and Kucchadi, and the southern tip at Thoothukudi is strategically deliberate. It positions capacity to serve distinct trade routes,

spreads exposure to weather and cyclone risk, and distributes the industrial and employment benefit across five coastal states, which supports the political sustainability of a programme spanning a decade.

HD Hyundai is recorded as the anchor investor in the Thoothukudi cluster in Tamil Nadu. This is a material development in relation to the analysis in section 2.5, which identified anchor partnerships with Korean original equipment manufacturers as the route to large conventional vessel capability and named HD Hyundai specifically. The commitment demonstrates that the anchor investor model is attracting participation from precisely the class of partner the strategy contemplates, rather than remaining an aspiration.

On in-principle approval status, the presentation distinguishes between clusters where approval has been granted and those where the application remains under review. The state-level position is set out in section 6.5.

State readiness and institutional preparedness

The greenfield model depends on state-level execution, since the State Government provides land, clearances and fiscal incentives, and holds half the equity of the Special Purpose Vehicle. The presentation therefore assesses readiness across the five participating states along four dimensions: the status of the Special Purpose Vehicle, availability of the Techno Economic Feasibility Report, in-principle approval, and state policy.

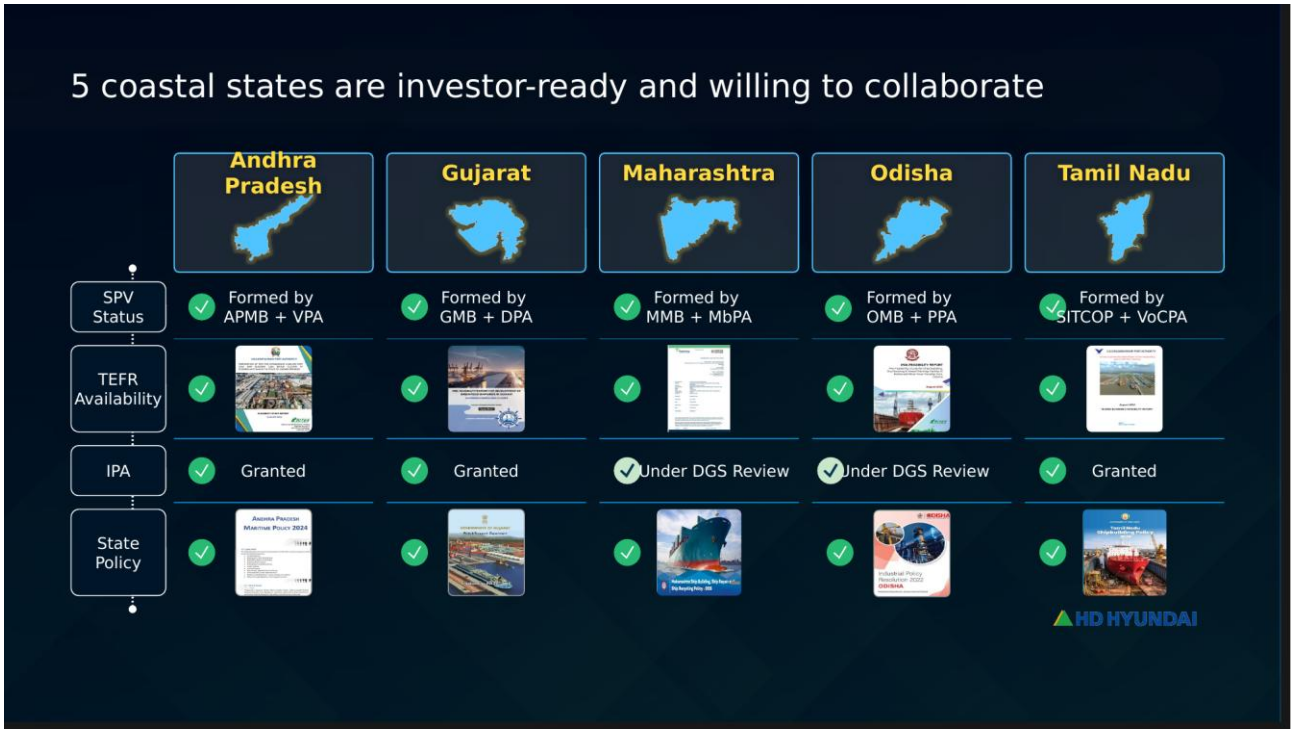


Exhibit 6.5: Readiness of the five participating coastal states

State	Special Purpose Vehicle constituted by	In-principle approval
Andhra Pradesh	Andhra Pradesh Maritime Board and Visakhapatnam Port Authority	Granted
Gujarat	Gujarat Maritime Board and Deendayal Port Authority	Granted
Tamil Nadu	SITCOP and V.O. Chidambaranar Port Authority	Granted
Maharashtra	Maharashtra Maritime Board and Mumbai Port Authority	Under review by the DGMA
Odisha	Odisha Maritime Board and Paradip Port Authority	Under review by the DGMA

Table 6.3: Special Purpose Vehicle composition and approval status by state

All five states have constituted their Special Purpose Vehicles, and in each case the vehicle pairs the State Maritime Board with a major port authority. This is a well-judged pattern. The State Maritime Board brings state jurisdiction over land, coastal regulation and state policy; the port authority brings marine engineering capability, existing waterfront assets and experience of operating regulated marine infrastructure. Neither institution alone possesses the full range of competence required.

In-principle approval has been granted for Andhra Pradesh, Gujarat and Tamil Nadu. The applications of Maharashtra and Odisha remain under review by the Directorate General of Shipping. Three of five clusters have therefore cleared the first regulatory gate. The description of all five states as investor-ready and willing to collaborate, taken with the fact that every Special Purpose Vehicle has been constituted, indicates that the constraint at this stage is regulatory processing rather than state-level willingness.

The Techno Economic Feasibility Report is the analytical foundation on which in-principle approval rests. Each report assesses technical suitability, environmental sustainability and financial viability of the proposed site. Priority is accorded to sites where land is available, where preliminary statutory and environmental clearances including environmental clearance, coastal regulation zone clearance, safety and port clearances have been secured, and where implementation readiness can be demonstrated. Feasibility work has been completed for the principal sites, including Dugarajapatnam in Andhra Pradesh, Kendrapara in Odisha, Kucchadi in Gujarat and Thoothukudi in Tamil Nadu.

The brownfield capacity expansion scheme

The second component of the Shipbuilding Development Scheme, allocated $917 Mn, supports capacity expansion at existing Indian shipyards. Its purpose is to facilitate

capacity augmentation, modernisation and technological upgradation in order to enhance competitiveness and efficiency.

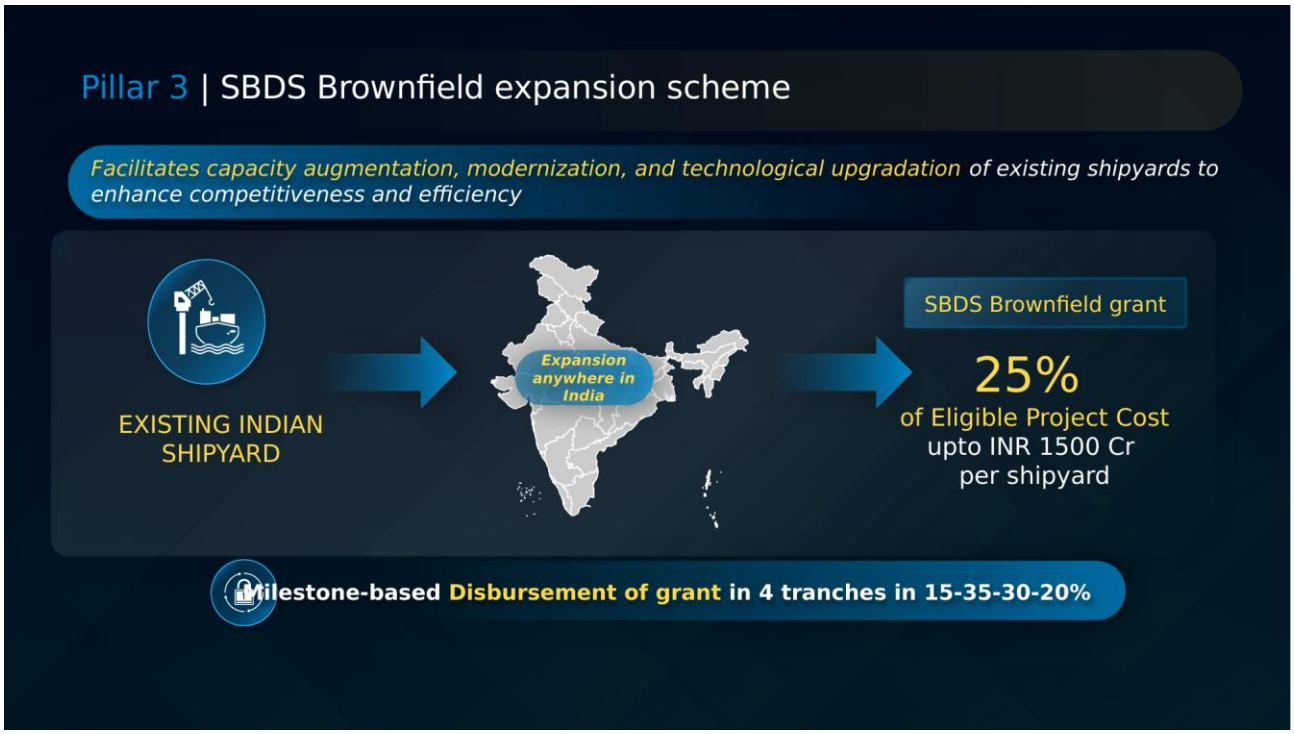


Exhibit 6.6: The brownfield expansion scheme: support structure

The grant covers 25 per cent of eligible project cost, subject to a ceiling of $167 Mn, or Rs. 1,500 crore, per shipyard, and expansion may be undertaken anywhere in India. Disbursement is milestone based, released in four tranches of 15 per cent, 35 per cent, 30 per cent and 20 per cent.

Three features of this design merit comment. The first is the choice of a 25 per cent grant rather than fuller support. Unlike greenfield common infrastructure, brownfield expansion creates assets whose benefit accrues wholly to the shipyard that owns them. A minority public contribution is therefore appropriate: it improves project returns sufficiently to trigger investment decisions that would otherwise be deferred, while requiring the yard to commit the majority of the capital and thereby retain the commercial discipline of its own exposure.

The second is the per-shipyard ceiling of $167 Mn. Against an allocation of $917 Mn, the ceiling ensures that support is distributed across a number of yards rather than concentrated in one or two very large projects. It also implies a maximum supported project size of $667 Mn, at which point the 25 per cent grant reaches the cap.

The third is the milestone-linked tranche profile, which is deliberately back-weighted in its early stages. Only 15 per cent is released at the first milestone, rising to 35 per cent at the second. This protects public funds against projects that commence but do not progress, while ensuring that the substantial releases occur once execution is

demonstrably underway. The pattern differs from the Shipbuilding Financial Assistance Scheme, where 70 per cent is released before delivery to serve as a working capital bridge. The distinction is appropriate: vessel construction under a signed contract carries a defined counterparty and delivery obligation, whereas capacity expansion carries execution risk against no external commitment.

Eligible and excluded components for brownfield support

The scheme enumerates the facilities eligible for brownfield capital assistance, together with an explicit list of exclusions.

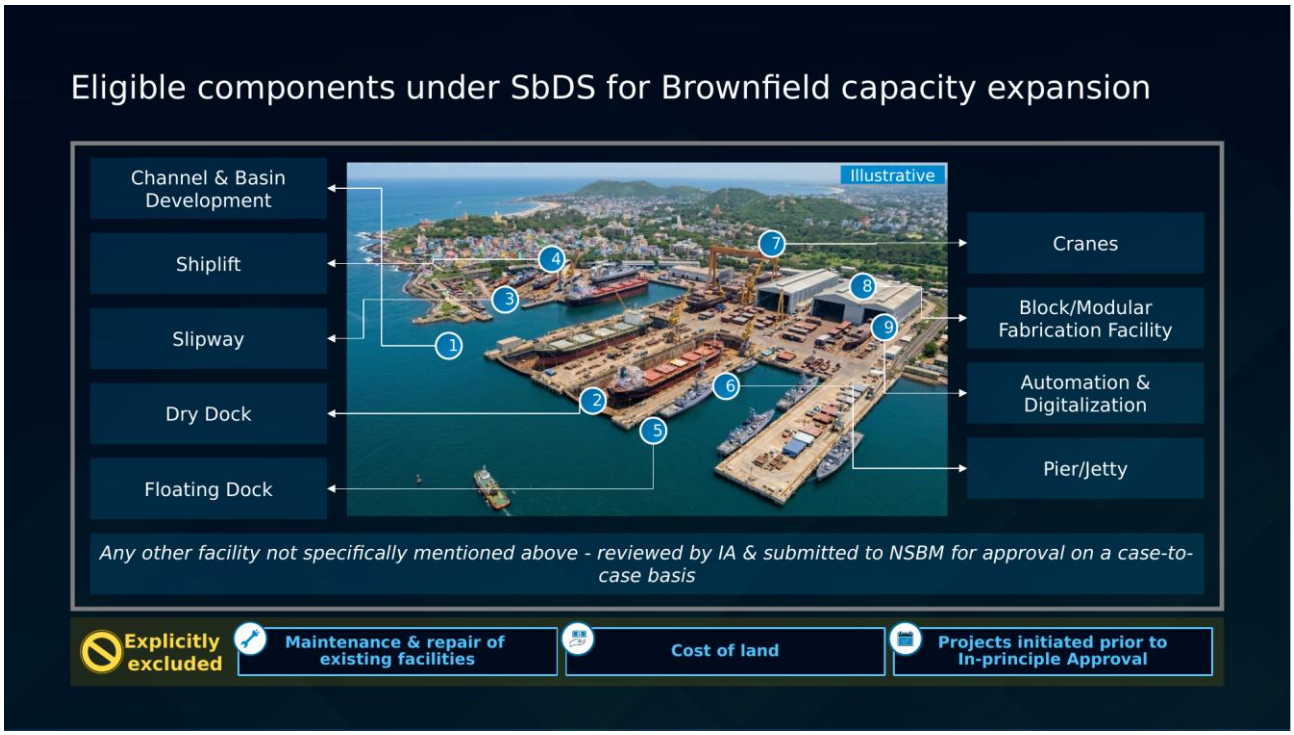


Exhibit 6.7: Eligible and excluded components under the brownfield scheme

The eligible components comprise dry docks, floating docks, slipways, shiplifts, piers and jetties, channel and basin development, block and modular fabrication facilities, cranes, and automation and digitalisation. Any other facility not specifically listed may be considered, subject to review by the implementing agency and submission to the National Shipbuilding Mission for approval on a case-to-case basis.

The composition of this list reflects a coherent view of what constrains an existing yard. Dry docks, floating docks, slipways and shiplifts determine the size of vessel a yard can accommodate and the number it can handle simultaneously. Channel and basin development determines the draft of vessel that can reach the yard at all. Piers and jetties determine outfitting capacity, which is frequently the binding constraint on throughput once hull construction capacity has been expanded. Cranes determine the weight of block that can be lifted, and therefore the degree of pre-outfitting achievable before erection, which is one of the principal determinants of build efficiency. Block and

modular fabrication facilities support the modular construction methods used by competitive international yards. Automation and digitalisation address productivity per worker.

Three items are explicitly excluded: maintenance and repair of existing facilities, projects initiated prior to in-principle approval, and the cost of land. Each exclusion is purposeful. Excluding maintenance ensures that the scheme funds additional capability rather than the upkeep a yard should fund from operations. Excluding projects initiated before in-principle approval ensures that the grant influences investment decisions rather than rewarding those already taken, which is the standard test of whether a subsidy is additional. Excluding land cost avoids the scheme becoming a vehicle for real estate acquisition, and mirrors the equivalent exclusion under the greenfield component.

The brownfield project pipeline

The brownfield component has generated a substantial pipeline. Four in-principle approvals have been issued, one application is under review, and three or more further applications are anticipated. Across eleven identified projects, the presentation records total applications of approximately $944 Mn, equivalent to about Rs. 8,500 crore as shown on the slide, of which approximately $239 Mn has received in-principle approval and approximately $706 Mn is expected from seven shipyards.

4 IPAs issued, 1 app. under review with 3+ apps incoming

~₹8,000 crore Brownfield upgrade opportunities identified across eight 11 projects

	Shipyard	Investment (₹ crore)	Likely submission	Remarks/Project description
1	Titagarh Naval Systems (TNSL)	516	IPA granted	New yard at Falta, 10–12 vessels upto 160m/yr
2	Swan Defence (SDHI)	504	IPA granted	Ph1: Goliath Crane & ELL Crane
			Q4 2026	Ph2: Outfitting workshop & robotics/fabrication
3	Mat Marine	105	IPA granted	SB/SR Infra incl. slipways for +1000 GT/yr
4	Cochin Shipyard limited	920	IPA granted	Ship repair facility at Vadinar along with DPA
5	Synergy Shipbuilders N Dock Works Ltd	35	App. Submitted	Upgradation of Mangalore facility
		110–120 500–550		Upgradation of machine shops, installation of cranes and Shiplift
7	Shoft Shipyard Pvt Ltd	400–500		
7	Chowgule SBD Pvt Ltd	1,500–1,600		DD+ Slipway - from 10,000 to 25,000 DWT
8	L & T Shipbuilding Ltd	—		DPR under preparation, evaluation stage
9	Mandovi Drydocks Ltd	40, 10, 100, 50, 100, 250, 350		Expansion plan at 7 different locations
10	Square Port Shipyard Pvt Ltd	650 (Phase 1) 2,000 (Phase 2)		Ph1: Installation of floating transfer dock & 265 m jetty to handle ships up to 200 m
11	Knowledge Marine & Eng.Works	240–250		DPR under preparation

Total applications worth ~₹8,500 Cr, ~ ₹ 2150 IPA granted and ₹ 6350 apps. expected from 7 Shipyards

Exhibit 6.8: The brownfield project pipeline by shipyard

Shipyard	Investment ($ Mn)	Status	Project description
Titagarh Naval Systems	57	IPA granted	New yard at Falta, 10 to 12 vessels up to 160 m per year
Swan Defence	56	IPA granted	Phase 1: Goliath crane and ELL crane
Swan Defence (Phase 2)	To be submitted Q4 2026	Expected	Phase 2: outfitting workshop and robotics or fabrication
Mat Marine	12	IPA granted	Shipbuilding and ship repair infrastructure including slipways for over 1,000 GT per year
Cochin Shipyard	102	IPA granted	Ship repair facility at Vadinar with Deendayal Port Authority
Synergy Shipbuilders N Dock Works	4	Application submitted	Upgradation of Mangalore facility
Continuation of the above	12 to 13 and 56 to 61	Expected	Upgradation of machine shops, installation of cranes and shiplift
Shoft Shipyard	44 to 56	Expected	Not specified in the source
Chowgule SBD	167 to 178	Expected	Dry dock and slipway, from 10,000 to 25,000 DWT
L and T Shipbuilding	Not stated	Expected	Detailed project report under preparation, at evaluation stage
Mandovi Drydocks	4, 1, 11, 6, 11, 28 and 39	Expected	Expansion plan across seven different locations
Square Port Shipyard	72 (Phase 1) and 222 (Phase 2)	Expected	Phase 1: floating transfer dock and 265 m jetty for ships up to 200 m
Knowledge Marine and Engineering Works	27 to 28	Expected	Detailed project report under preparation

Table 6.4: Brownfield pipeline: shipyards, investment and status

The four projects that have secured in-principle approval, namely Titagarh Naval Systems, Swan Defence, Mat Marine and Cochin Shipyard, together represent approximately $227 Mn of investment. Their character illustrates the range of the scheme. Titagarh Naval Systems is establishing a new yard at Falta with capacity for 10 to 12 vessels of up to 160 metres a year, which is a substantial addition to Indian capability for mid-sized tonnage. Swan Defence is proceeding in phases, beginning with heavy lift craneage before moving to outfitting and automation. Mat Marine is a smaller intervention addressing slipway capacity. Cochin Shipyard is developing a ship repair

facility at Vadinar in partnership with Deendayal Port Authority, which extends the scheme beyond construction into repair.

The prospective pipeline is more ambitious in scale. Chowgule SBD proposes to raise capability from 10,000 to 25,000 deadweight tonnes, which is a step change in vessel size directly aligned with the analysis in section 2.3. Square Port Shipyard proposes a two-phase development, with Phase 1 comprising a floating transfer dock and a 265 metre jetty capable of handling ships up to 200 metres. Mandovi Drydocks proposes expansion across seven locations. Several applicants, including L and T Shipbuilding and Knowledge Marine and Engineering Works, have detailed project reports under preparation.

Two observations follow. First, the pipeline is geographically dispersed across the eastern and western coasts, which is consistent with the greenfield distribution and reinforces the resilience of the overall capacity build. Second, the aggregate pipeline of approximately $944 Mn in project investment would attract grant support of approximately 25 per cent, or roughly $233 Mn, against an allocation of $917 Mn. The brownfield allocation is therefore not close to being exhausted by the current pipeline, and considerable headroom remains for further applications. Readers should note that the source slide states the total pipeline as approximately $889 Mn in its heading and approximately $944 Mn in its footnote; this note uses the latter, which is consistent with the stated split between approved and expected amounts. The point is recorded in section 11.

7.7. Demand Aggregation

The domestic fleet expansion plan

Capacity without orders is a liability rather than an asset. A yard commissioned into an empty order book cannot retain its workforce, service its debt or descend the learning curve on which competitiveness depends. The fourth element of the programme therefore addresses demand directly, by consolidating the tonnage requirements of public sector entities into a visible and time-bound pipeline. The demand aggregation plan was launched in December 2025 and is described in the address as marking a decisive acceleration in India's shipbuilding push.

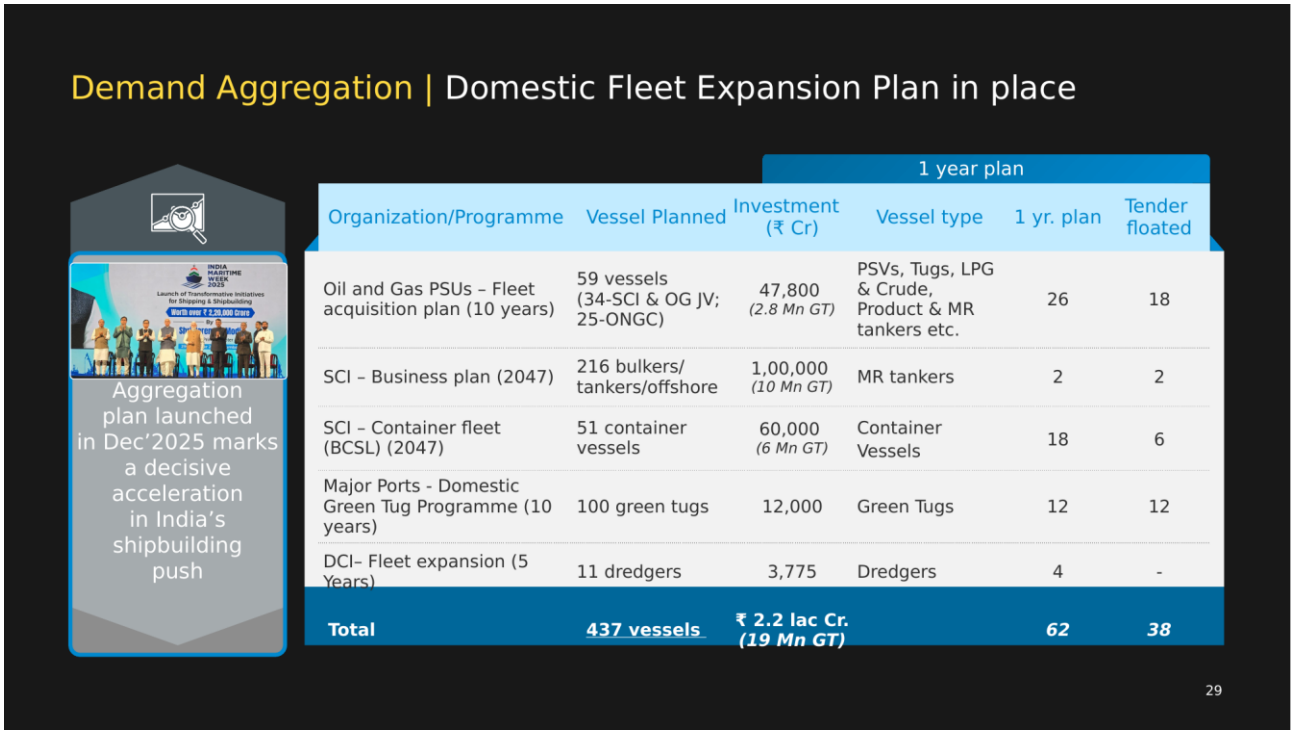


Exhibit 7.1: The domestic fleet expansion plan by organisation and programme

Organisation and programme	Vessels planned	Investment ($ Bn)	One year plan	Tendered
Oil and gas public sector undertakings, fleet acquisition plan over 10 years	59 vessels (34 with SCI and oil and gas joint venture; 25 with ONGC)	5.3 (2.8 million GT)	26	18
Shipping Corporation of India, business plan to 2047	216 bulkers, tankers and offshore vessels	11.1 (10 million GT)	2	2
Shipping Corporation of India, container fleet through BCSL, to 2047	51 container vessels	6.7 (6 million GT)	18	6

Organisation and programme	Vessels planned	Investment ($ Bn)	One year plan	Tendered
Major ports, Domestic Green Tug Programme over 10 years	100 green tugs	1.3	12	12
Dredging Corporation of India, fleet expansion over 5 years	11 dredgers	0.4	4	Nil
Total	437 vessels	Approximately 24.8 (19 million GT)	62	38

Table 7.1: Domestic fleet expansion plan: vessels, investment and tendering status

The aggregate plan comprises 437 vessels representing approximately $24.8 Bn of investment, equivalent to about Rs. 2.2 lakh crore as shown on the slide, and 19 million gross tonnes. To place this in proportion, the investment is more than three times the entire approximately $7.8 Bn public outlay across the four pillars. The demand side of the programme is therefore substantially larger in financial terms than the supply side support, which is as it should be: public funds are being used to make domestic construction viable, while the orders themselves are commercial procurement by entities that require the tonnage in any event.

The composition of the plan is instructive. The Shipping Corporation of India accounts for the largest element, with 216 bulkers, tankers and offshore vessels under its business plan to 2047 at approximately $11.1 Bn and 10 million gross tonnes, together with 51 container vessels through Bharat Container Shipping Limited at approximately $6.7 Bn and 6 million gross tonnes. The oil and gas public sector undertakings account for 59 vessels at approximately $5.3 Bn and 2.8 million gross tonnes, comprising 34 vessels with the Shipping Corporation of India and an oil and gas joint venture and 25 with the Oil and Natural Gas Corporation, spanning platform supply vessels, tugs, liquefied petroleum gas carriers, crude carriers, product tankers and medium range tankers. Major ports account for 100 green tugs at approximately $1.3 Bn under the Domestic Green Tug Programme, and the Dredging Corporation of India for 11 dredgers at approximately $0.42 Bn.

The vessel mix maps closely onto the demand analysis in section 2.4. Tankers, bulkers and general cargo tonnage dominate the volume, which corresponds to the categories where global replacement demand is concentrated. Tugs and dredgers, which together account for 111 vessels, correspond to categories where the ageing fleet is large and where Indian yards already possess relevant experience at smaller vessel sizes. Container vessels represent a newer capability. The plan therefore provides both a volume base in familiar categories and a route into more demanding tonnage.

The most important columns of the table are the last two. Of the 437 vessels in the total programme, 62 fall within the one year plan and 38 have already been tendered or floated. This is the difference between an aspiration and a pipeline. The Domestic Green Tug Programme has tendered all 12 vessels in its one year plan, and the oil and gas programme has tendered 18 of 26. The Dredging Corporation of India has four vessels in its one year plan with none yet tendered. That 38 vessels are already in the market provides Indian yards with immediate, contestable order flow rather than a prospective commitment, which is what allows brownfield expansion decisions under section 6.6 to be taken on a commercial basis now.

7.8. Ship Component Manufacturing

The component market and the import dependence problem

The preceding sections address the capacity to build vessels and the orders to fill that capacity. This section addresses what those vessels will be built from. It is the element of the programme with the greatest bearing on whether Indian shipbuilding generates domestic industrial value or becomes an assembly operation for imported packages.

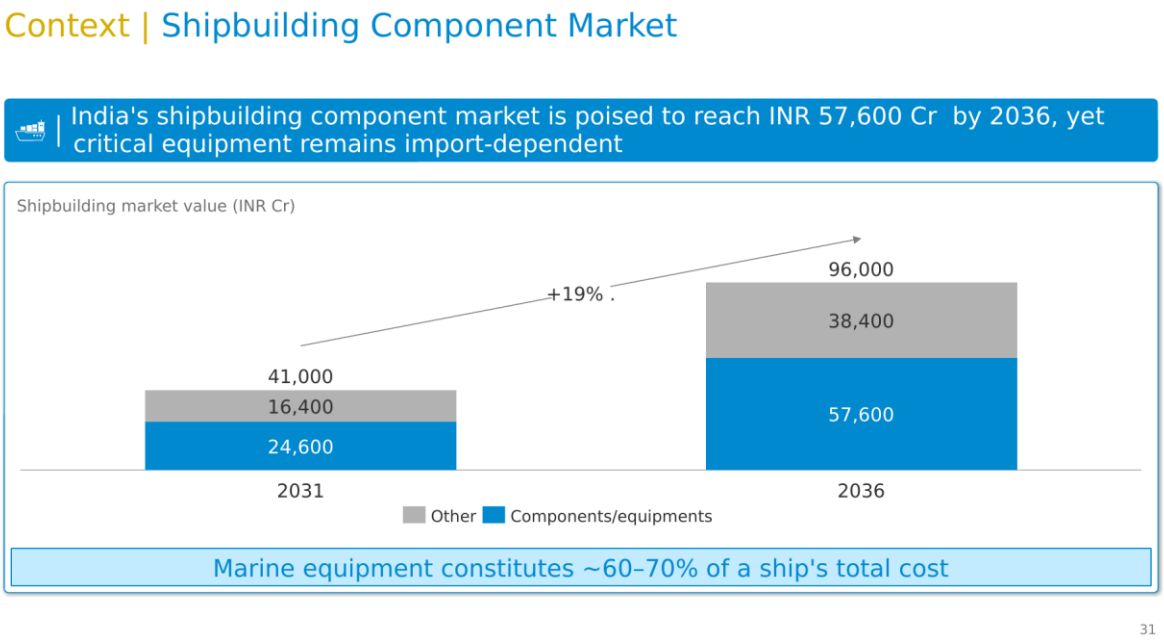


Exhibit 8.1: The Indian shipbuilding component market to 2036

The Indian shipbuilding market is projected to grow from approximately $4.6 Bn in 2031 to approximately $10.7 Bn in 2036, equivalent to Rs. 41,000 crore and Rs. 96,000 crore respectively as shown on the slide, a compound rate of approximately 19 per cent a year. Within this, the component and equipment segment is projected to grow from approximately $2.7 Bn to approximately $6.4 Bn over the same period.

The reason components command this share is that marine equipment constitutes approximately 60 to 70 per cent of the total cost of a ship. The hull, which is what a shipyard visibly produces, accounts for a minority of vessel value. The majority resides in the propulsion system, the auxiliary machinery, the electrical systems, the navigation and communication suite and the accommodation fit-out. A country that builds hulls but imports systems captures the smaller part of the value it appears to be creating.

This is precisely the position India currently occupies, and it is why the domestic content threshold in the Shipbuilding Financial Assistance Scheme, described in section 4.1, is set at 40 per cent with no support below 30 per cent. That threshold is not achievable

through hull fabrication and labour alone at scale; it requires domestic sourcing of equipment. The component agenda and the vessel assistance agenda are therefore mutually dependent. Absent domestic component capability, yards will find the 40 per cent threshold difficult to clear and will receive only pro-rated assistance. Absent yard demand at scale, component manufacturers lack the volume to justify investment in capability and certification. The schemes described in this section are intended to resolve that circularity from the component side while demand aggregation resolves it from the vessel side.

The systems taxonomy and where value concentrates

To make the component problem tractable, all shipbuilding components have been classified within 8 systems and 80 sub-systems. Each system is then characterised by two variables: its share of the total component value of a vessel, and the extent to which India presently depends on imports to supply it.

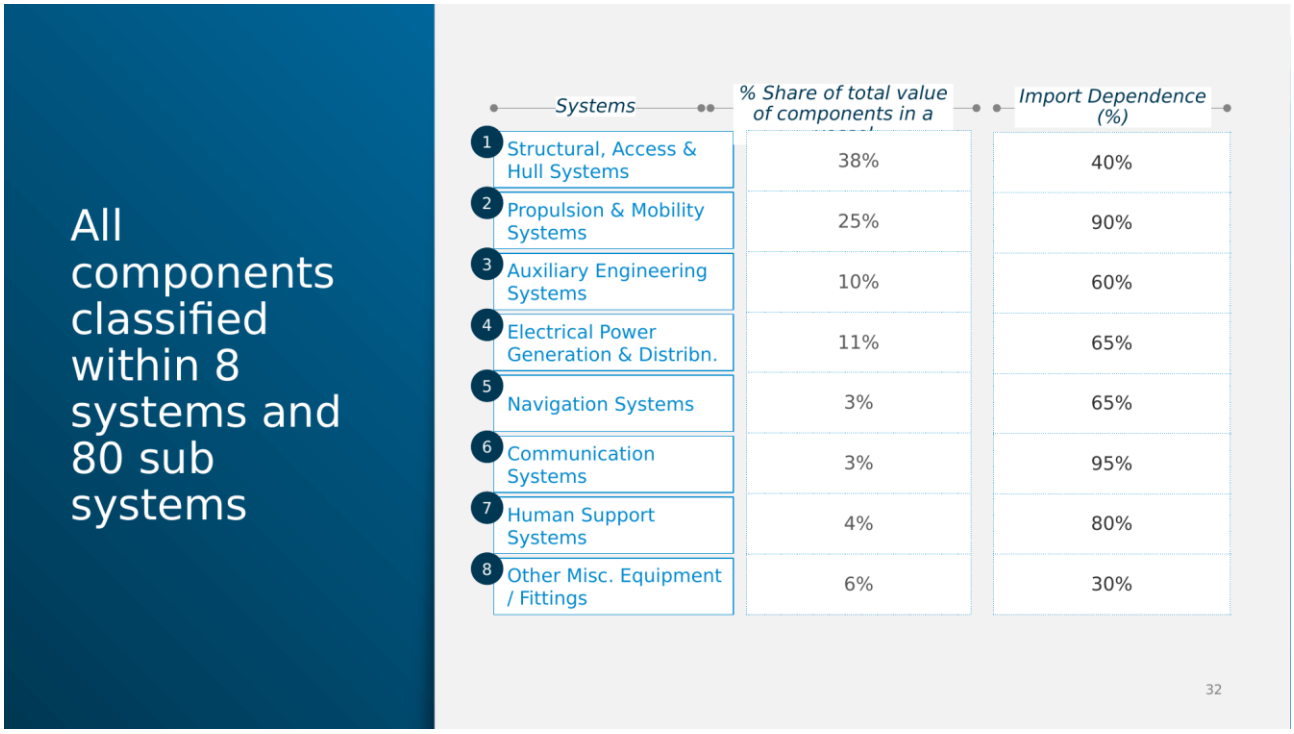


Exhibit 8.2: The eight systems by share of vessel value and import dependence

System	Share of total component value	Import dependence
Structural, access and hull systems	38%	40%
Propulsion and mobility systems	25%	90%
Electrical power generation and distribution	11%	65%

System	Share of total component value	Import dependence
Auxiliary engineering systems	10%	60%
Other miscellaneous equipment and fittings	6%	30%
Human support systems	4%	80%
Navigation systems	3%	65%
Communication systems	3%	95%

Table 8.1: The eight systems by value share and import dependence

Read together, the two columns identify where intervention matters most. Structural, access and hull systems represent the largest single share of component value at 38 per cent, and here import dependence is comparatively low at 40 per cent. This is the area of established Indian competence, resting on a domestic steel industry and existing fabrication capability. It is not the problem.

Propulsion and mobility systems present the critical exposure. They account for 25 per cent of component value, the second largest share, and import dependence stands at 90 per cent. Main engines, gearboxes and propulsion equipment are almost entirely imported. Because this is simultaneously a high-value and high-dependence category, it represents the single largest leakage of value from Indian shipbuilding, and it is also the most technically demanding category in which to establish domestic capability.

Communication systems show the highest import dependence at 95 per cent but account for only 3 per cent of component value. Navigation systems are similar, at 65 per cent dependence and 3 per cent of value. These are strategically sensitive but financially small. Human support systems, at 80 per cent dependence and 4 per cent of value, fall into a comparable category. Electrical power generation and distribution, at 11 per cent of value and 65 per cent dependence, and auxiliary engineering systems, at 10 per cent of value and 60 per cent dependence, occupy an intermediate position where both value and dependence are material.

The distribution makes clear that a uniform policy across all 80 sub-systems would be inefficient. A sub-system representing a fraction of a per cent of vessel value, where Indian industry is already capable, requires no intervention beyond removing barriers. A sub-system representing several per cent of value where no domestic capability exists requires sustained industrial development over many years. The archetype framework in section 8.3 is the response to this.

The four intervention archetypes

The 80 sub-systems have been tagged to four archetypes, defined along two dimensions: the maturity of Indian industry, measured as the number of capable domestic suppliers with a threshold of five, and the indicative share of vessel value, with a threshold of 1 per cent. Each archetype carries a distinct policy response, because the constraint in each is different.

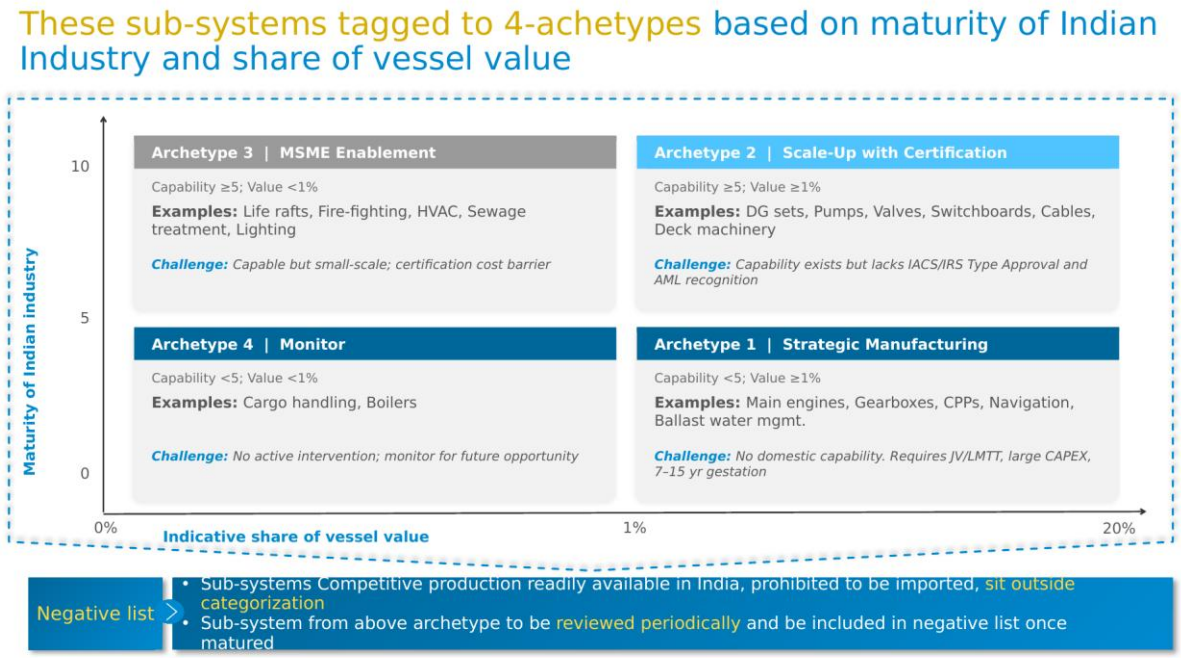


Exhibit 8.3: The four intervention archetypes for component sub-systems

Archetype 1, Strategic Manufacturing. Fewer than five capable domestic suppliers, and 1 per cent or more of vessel value. Examples include main engines, gearboxes, controllable pitch propellers, navigation equipment and ballast water management systems. The challenge is the absence of domestic capability altogether. Establishing it requires joint ventures or long-term manufacturing technology transfer, large capital expenditure, and a gestation period of 7 to 15 years. This is the hardest category and the one that maps onto the propulsion exposure identified in section 8.2.

Archetype 2, Scale-Up with Certification. Five or more capable domestic suppliers, and 1 per cent or more of vessel value. Examples include diesel generating sets, pumps, valves, switchboards, cables and deck machinery. Here capability exists but lacks International Association of Classification Societies or Indian Register of Shipping type approval and approved maker list recognition. The constraint is certification rather than manufacturing competence, and it is therefore the most tractable high-value category: the intervention required is qualification and recognition rather than industrial creation.

Archetype 3, MSME Enablement. Five or more capable domestic suppliers, and less than 1 per cent of vessel value. Examples include life rafts, fire-fighting equipment, heating, ventilation and air conditioning systems, sewage treatment plant and lighting. Suppliers are capable but operate at small scale, and the cost of certification is a barrier relative to the value of the business. The response is enablement of micro, small and medium enterprises, principally by reducing the relative burden of certification.

Archetype 4, Monitor. Fewer than five capable domestic suppliers, and less than 1 per cent of vessel value. Examples include cargo handling equipment and boilers. No active intervention is warranted; the category is monitored for future opportunity. Explicitly designating a set of sub-systems as requiring no action is a discipline that prevents the dispersion of policy attention across items that cannot justify it.

Sub-systems for which competitive production is readily available in India sit outside this categorisation altogether and are prohibited from being imported. These constitute the negative list examined in section 8.4. Sub-systems within the archetypes are to be reviewed periodically and moved to the negative list as domestic capability matures, so the framework is dynamic rather than fixed: a sub-system in Archetype 2 that completes certification and demonstrates competitive supply becomes a candidate for the negative list, and the policy attention it previously required is released.

The negative list and the indigenisation trigger

The negative list is the instrument through which indigenisation is converted from an aspiration into a requirement. Once a sub-system is placed on the list, it may not be imported, and yards must source it domestically.

Exhibit 8.4: Conditions for inclusion in the negative list

Because the consequence is a binding restriction, the test for inclusion is demanding. A sub-system moves to the negative list, following industry consultation, only if all three of the following conditions are satisfied.

- Sufficient capacity. More than the threshold number of suppliers exists in India, and those suppliers are able to support the anticipated production volumes.
- Quality and reliability. India-made products match foreign makes on quality and reliability, with comparable after-sales service and support.
- Cost competitiveness. The price of the domestically available component is comparable to, or within the same range as, the foreign make.

The requirement that all three conditions be met, rather than any one, is what distinguishes this from a conventional import substitution measure. A restriction imposed where domestic capacity is insufficient would delay vessel delivery. One imposed where quality is inferior would compromise vessel safety and the yard's reputation with international owners. One imposed where domestic prices are materially higher would erode the competitiveness that the assistance under section 4.1 is intended to create. By requiring capacity, quality and price to be established before restriction applies, the mechanism protects the yards it is intended to support.

On progress, 76 items have been proposed for the negative list, based on the report of the Indigenization Committee and finalised after discussion with industry stakeholders. The role of industry consultation is important. Yards and component manufacturers hold the information on which the three conditions turn, and a restriction imposed without their input would risk being founded on an inaccurate view of domestic capability.

Sub-systems are to be reviewed periodically and added to the negative list as domestic capability matures. This makes the negative list the principal ratchet mechanism of the component agenda. As Archetype 2 sub-systems obtain certification and Archetype 3 suppliers achieve scale, they qualify for the list, and the domestic content share of each vessel rises. That in turn makes it progressively easier for yards to clear the 40 per cent domestic content threshold under the Shipbuilding Financial Assistance Scheme, which improves their assistance entitlement. The component agenda and the vessel assistance agenda thus reinforce one another over time.

7.9. Container Manufacturing Promotion Scheme

Scheme architecture and support components

The final instrument addressed in this section of the address concerns containers rather than vessels. Containers are the physical unit of global trade, and India has historically depended on imports for them, principally from a small number of overseas manufacturing hubs. The Container Manufacturing Promotion Scheme is a targeted support package intended to build self-reliant and globally competitive container manufacturing capacity in India.

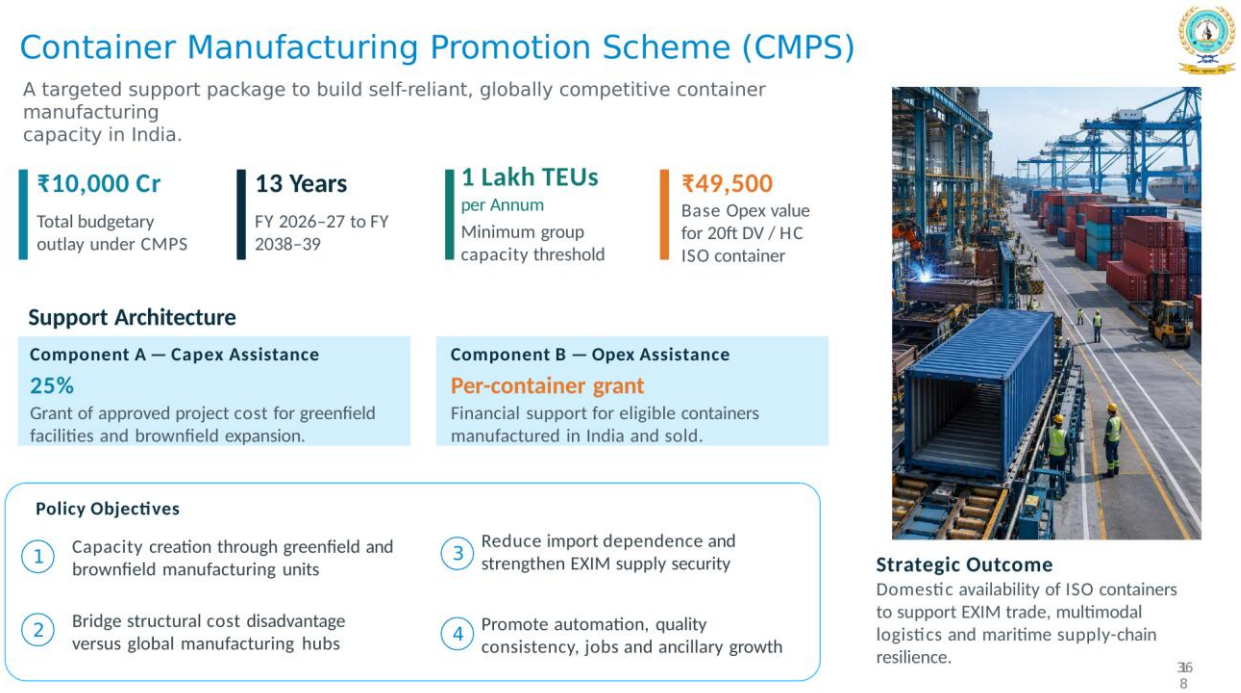


Exhibit 9.1: Container Manufacturing Promotion Scheme: architecture and parameters

Parameter	Provision
Total budgetary outlay	$1.1 Bn (Rs. 10,000 crore)
Scheme duration	13 years, from financial year 2026-27 to financial year 2038-39
Minimum group capacity threshold	1 lakh TEUs per annum
Base operating expenditure reference value	$550 for a 20 foot dry van or high cube ISO container
Component A, capital expenditure assistance	25 per cent grant of approved project cost for greenfield facilities and brownfield expansion

Parameter	Provision
Component B, operating expenditure assistance	Per-container grant for eligible containers manufactured in India and sold

Table 9.1: Key parameters of the Container Manufacturing Promotion Scheme

The scheme rests on two support components addressing different economic problems. Component A provides capital expenditure assistance of 25 per cent of approved project cost, for greenfield facilities and brownfield expansion alike. This mirrors the brownfield rate under the Shipbuilding Development Scheme described in section 6.6 and reflects the same reasoning: a minority public contribution sufficient to alter the investment decision while leaving the majority of capital and the commercial risk with the promoter.

Component B provides operating expenditure assistance as a per-container grant for eligible containers manufactured in India and sold. This is the more distinctive element. Capital assistance alone would create capacity that then failed to operate competitively, because the disadvantage Indian manufacturers face against established hubs is a recurring cost disadvantage in steel, labour, scale and logistics rather than a one-time capital disadvantage. A per-container grant addresses the recurring gap directly, and by conditioning payment on containers manufactured and sold it links support to output rather than to installed capacity.

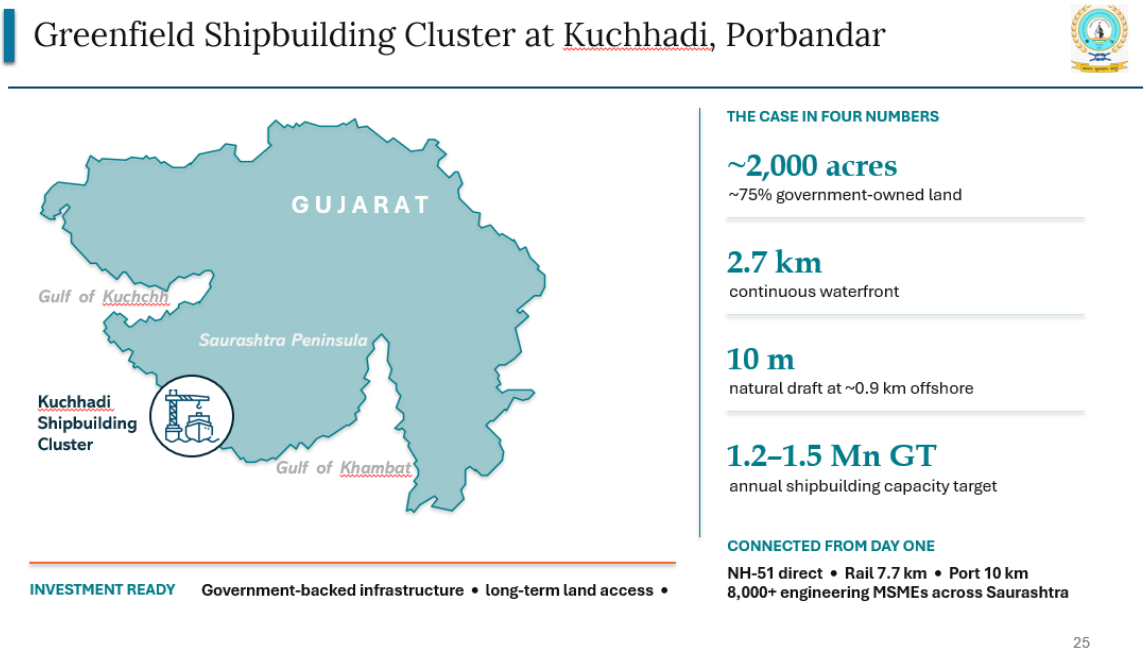
The base operating expenditure reference value of $550 for a 20 foot dry van or high cube ISO container provides the benchmark against which the per-container grant is determined. The minimum group capacity threshold of 1 lakh TEUs per annum sets the scale of participation. This threshold reflects the economics of container manufacturing, which is a volume business where competitiveness depends on continuous production and automated fabrication. A threshold set materially lower would support sub-scale operations unable to compete once assistance concluded.

The scheme pursues four policy objectives: capacity creation through greenfield and brownfield manufacturing units; bridging the structural cost disadvantage against global manufacturing hubs; reducing import dependence and strengthening the security of export and import supply chains; and promoting automation, quality consistency, employment and ancillary industrial growth. The strategic outcome sought is domestic availability of ISO containers to support export and import trade, multimodal logistics and maritime supply chain resilience.

The thirteen-year duration, running from financial year 2026-27 to financial year 2038-39, exceeds the ten-year horizon of the shipbuilding schemes. This is consistent with the nature of the support: whereas capital assistance is a one-time intervention, the operating expenditure component must persist long enough for domestic manufacturers

to reach the scale at which the structural cost gap narrows through volume and learning rather than through subsidy.

7.10. Gujarat Strengthening India's Shipbuilding and Ship Repair Ecosystem – Kuchhadi and Vadinar Initiatives

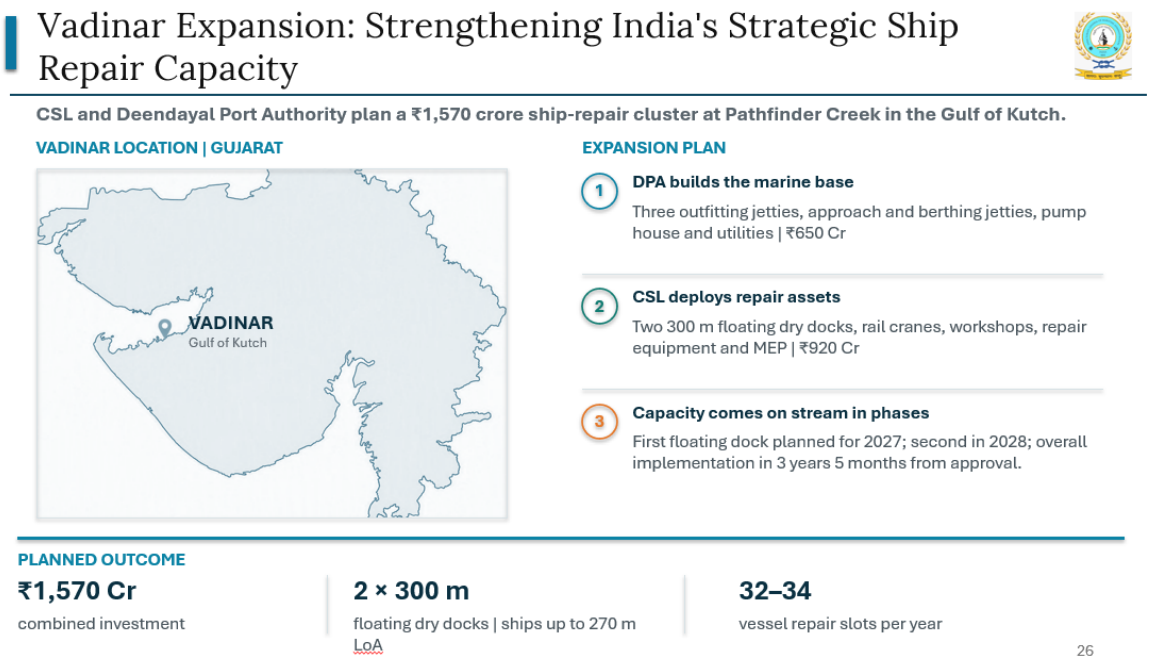


Gujarat has emerged as one of the most important centres of maritime development in India, supported by its extensive coastline, strong industrial base, established port infrastructure, and long-standing maritime heritage. As India seeks to enhance its capabilities across shipbuilding, ship repair, maritime manufacturing, and coastal industrial development, Gujarat is playing a pivotal role through the development of new maritime infrastructure and capacity creation initiatives. Two significant projects in this regard are the proposed **Greenfield Shipbuilding Cluster at Kuchhadi, Porbandar** and the planned **ship-repair expansion at Vadinar in the Gulf of Kutch**. Together, these initiatives represent complementary investments that strengthen both vessel construction and vessel maintenance capabilities within India's maritime ecosystem.

The proposed Greenfield Shipbuilding Cluster at Kuchhadi is envisioned as a dedicated maritime manufacturing hub designed to support the long-term growth of India's shipbuilding industry. The development seeks to leverage Gujarat's strategic location along major international shipping routes, the availability of large coastal land parcels, favorable marine conditions, and strong industrial connectivity. Modern shipbuilding facilities require extensive waterfront access, large areas for fabrication and assembly, supporting infrastructure, and proximity to supply chains. The Kuchhadi site offers many of these advantages and has the potential to evolve into an integrated ecosystem that

brings together shipyards, equipment manufacturers, engineering industries, service providers, training institutions, and ancillary industries.

The cluster-based approach reflects international best practices in maritime industrial development. By creating a concentrated ecosystem of shipbuilding-related activities, the project can generate economies of scale, improve competitiveness, attract investment, and support technology adoption. Beyond vessel construction, such developments create opportunities for employment generation, skill development, engineering services, and manufacturing growth across a wide range of sectors linked to maritime activities.



While shipbuilding creates new maritime assets, ship repair forms an equally critical component of the maritime value chain. The proposed expansion at Vadinar seeks to strengthen India's ability to provide maintenance, repair, and lifecycle support services for commercial vessels. Located in the strategically important Gulf of Kutch region, Vadinar offers access to major shipping routes and existing maritime infrastructure, making it well suited for the development of large-scale repair facilities.

Ship repair capability is increasingly important as global shipping fleets continue to expand and modernize. Timely repair and maintenance services are essential for ensuring vessel safety, operational efficiency, regulatory compliance, and reduced downtime. Historically, a significant share of repair work for vessels operating in Indian waters has been undertaken outside the country. Expanding domestic repair infrastructure can help retain economic value within India, reduce dependence on foreign facilities, and strengthen the country's maritime service offerings.

Together, the Kuchhadi and Vadinar initiatives represent two interconnected pillars of maritime industrial development. While Kuchhadi focuses on creating future shipbuilding capacity and developing an integrated maritime manufacturing ecosystem, Vadinar seeks to strengthen repair and maintenance infrastructure required to support vessels throughout their operational lifecycle. This combination of construction and repair capability contributes to the development of a more complete and self-sustaining maritime ecosystem.

From a broader perspective, these projects support national objectives related to maritime self-reliance, industrial growth, employment generation, coastal development, and enhanced global competitiveness. They also align with the vision of creating a stronger maritime economy supported by modern infrastructure, advanced capabilities, and integrated industrial ecosystems. As India's maritime sector continues to evolve, initiatives such as Kuchhadi and Vadinar have the potential to reinforce Gujarat's position as a leading maritime state while contributing significantly to the country's long-term maritime ambitions.

8. Gujarat: 98% of Ship Recycling

8.1. Ship Recycling

Ship recycling forms a critical component of the maritime value chain, supporting the circular economy, resource efficiency, environmental sustainability, and industrial development. As ships reach the end of their operational lives, responsible recycling enables the recovery of valuable materials, equipment, and components that can be reintegrated into manufacturing and industrial supply chains. Over the decades, India has emerged as one of the world's leading ship-recycling destinations, and Gujarat has been at the centre of this transformation. The state's ship-recycling ecosystem has evolved from a specialized coastal activity into a strategic national asset that supports industrial growth, resource conservation, employment generation, and maritime sustainability.

The prominence of Gujarat within India's ship-recycling sector is primarily driven by the Alang–Sosiya ship-recycling cluster located on the Gulf of Khambhat coast. Over the years, the cluster has developed into one of the largest and most established ship-recycling locations globally. Its unique geographical characteristics, tidal conditions, extensive waterfront, supporting industrial ecosystem, and accumulated operational expertise have enabled Gujarat to establish a dominant position in the sector. Today, the vast majority of India's ship-recycling activity is concentrated within the state, making Gujarat a key contributor to the country's maritime and industrial economy.

Beyond the dismantling of vessels, ship recycling has significant economic and industrial implications. The process enables the recovery of large quantities of reusable steel,

machinery, electrical systems, marine equipment, and other materials that can be reused across multiple sectors. Recovered steel from recycled vessels contributes meaningfully to domestic raw material availability, reducing dependence on imported scrap and lowering the requirement for virgin resource extraction. This aligns closely with broader national objectives relating to resource security, sustainability, and circular economic growth.

The sector also plays an important role in supporting downstream industries. Materials recovered from ships find applications in steel manufacturing, engineering industries, construction, fabrication, machinery production, and numerous small and medium enterprises. As a result, ship recycling generates economic value far beyond the recycling yard itself, creating linkages across a wide industrial ecosystem. The concentration of ship-recycling activity in Gujarat has therefore contributed to the development of a broader maritime-industrial cluster that supports employment, manufacturing, logistics, and trade.

In recent years, the global ship-recycling industry has witnessed increasing attention towards environmental performance, worker safety, and sustainable operational practices. International regulations, particularly the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC), have established new standards governing recycling activities. Compliance with these standards has become increasingly important for attracting vessels from international shipowners and maintaining credibility within the global maritime community.

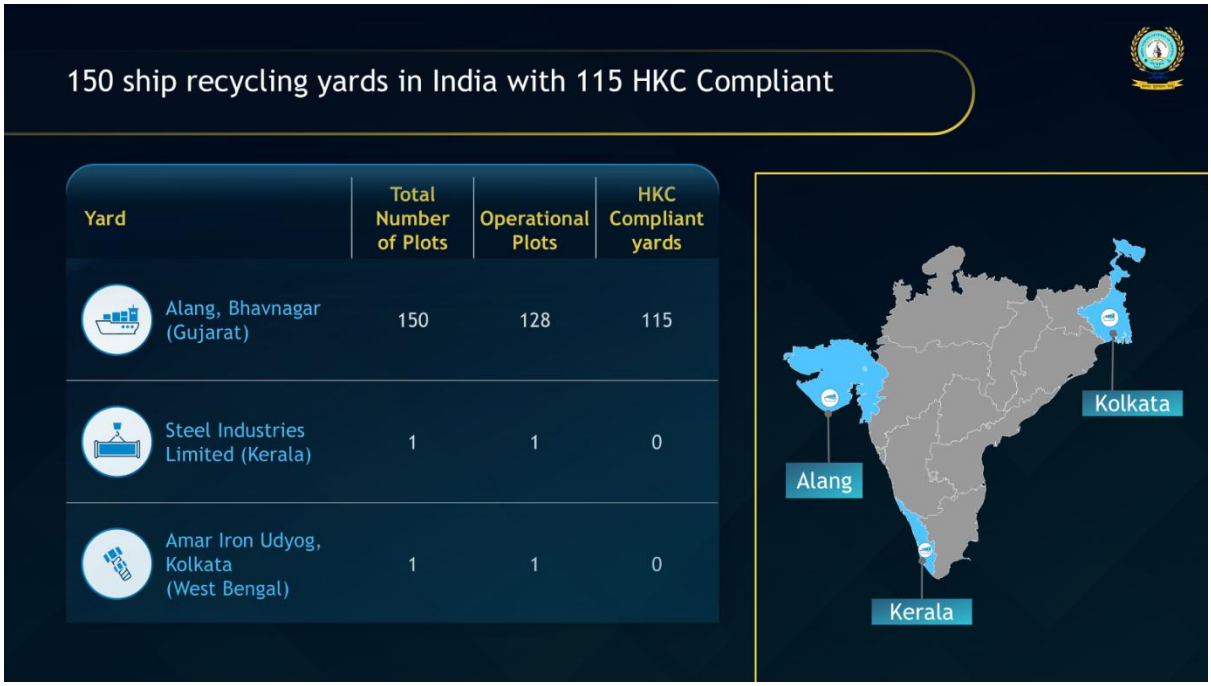
India has made significant progress in aligning its ship-recycling industry with these evolving requirements. Gujarat's ship-recycling facilities have been at the forefront of adopting improved safety systems, environmental management practices, worker welfare measures, hazardous material handling procedures, and infrastructure upgrades. The increasing number of compliant recycling facilities reflects the industry's transition towards globally accepted standards and demonstrates India's commitment to sustainable maritime practices.

The significance of ship recycling extends beyond economics and environmental management. The sector is also a major source of employment and livelihood generation. Thousands of workers are directly employed within recycling yards, while many more benefit indirectly through associated industries, transportation services, equipment recovery operations, fabrication units, and support services. The economic activity generated by ship recycling contributes significantly to local communities and coastal development across the region.

From a strategic perspective, Gujarat's leadership in ship recycling complements India's broader maritime ambitions. As the country seeks to expand its presence across shipping, ports, shipbuilding, coastal logistics, and maritime manufacturing, ship recycling provides an important foundation for creating a complete maritime ecosystem. The sector contributes to resource efficiency, strengthens domestic industrial supply

chains, supports manufacturing competitiveness, and reinforces India's position within the global maritime value chain.

Looking ahead, the continued modernization of ship-recycling infrastructure, adoption of international best practices, integration of digital monitoring systems, and strengthening of environmental and safety standards will be essential to sustaining long-term growth. Gujarat's experience demonstrates how a specialized maritime activity can evolve into a globally significant industrial ecosystem that delivers economic, environmental, and social benefits. As India advances towards its long-term maritime vision, Gujarat's ship-recycling ecosystem will continue to play a vital role in supporting sustainable industrial development, circular economy objectives, and the country's emergence as a leading maritime nation.



India’s Leadership

India today occupies a central position in global ship recycling. The Alang–Sosiya ship recycling cluster in Bhavnagar, Gujarat is the largest such cluster in the world .

Current status of the Alang cluster:

- 150 total plots
- 128 operational plots
- 115 HKC compliant yards

The fact that 115 yards are HKC compliant is significant. It reflects not only infrastructure upgradation but a conscious regulatory transition over the past decade. No other

recycling nation currently has over 100 HKC compliant facilities concentrated in a single cluster .

In volume terms, India handles approximately 30–35% of global ship recycling tonnage annually

At the national level, the sector supplies around 20–25% of India's ferrous scrap requirement Given India's steel production expansion targets, this contribution is strategically relevant.

The sector provides direct employment to more than 15,000 workers and sustains a broader ecosystem involving logistics operators, re-rolling mills, scrap traders and ancillary service providers .

India's leadership is therefore based on scale, regulatory alignment and economic integration.

Strategic Importance

Ship recycling intersects with India's priorities in steel production, maritime manufacturing and sustainability commitments.

First, it strengthens domestic scrap availability. Scrap-based steel production is less energy intensive compared to primary steelmaking and reduces dependence on iron ore extraction and coal usage. In the context of decarbonisation and resource efficiency, this is important.

Second, it supports maritime industrial integration. The introduction of the Ship Recycling Credit Note under SBFA 2.0 has created a policy linkage between dismantling and new shipbuilding . This ensures that economic value generated from recycling remains within the domestic maritime ecosystem.

Third, post-HKC, shipowners assess recycling destinations on compliance credentials. India's compliance depth strengthens its credibility and reduces the risk of business diversion to alternative jurisdictions.

8.2. Hong Kong Convention (HKC)

The Hong Kong Convention establishes binding obligations for both ships and recycling facilities.

For ships:

- New ships are required to comply from 26 June 2025.
- Existing ships must comply by 26 June 2030 .

Ships proceeding for recycling after 26 June 2025 must carry:

- A valid Inventory of Hazardous Materials (IHM).
- Updated IHM Parts II and III.
- A ship-specific Recycling Plan.
- An International Ready for Recycling Certificate (valid for three months) .

For recycling facilities:

- An approved Ship Recycling Facility Plan is mandatory.
- Authorisation by the competent authority is required.
- A valid Document of Authorisation for Ship Recycling (DASR) must be held .

India's Recycling of Ships Act, 2019 operationalises these requirements domestically, ensuring harmonisation between international obligations and national enforcement.

Compliance and Risk

In the current regime, compliance gaps carry both regulatory and commercial consequences.

Improper handling of hazardous materials such as asbestos, PCBs, oils or sludge can result in environmental contamination and worker safety incidents. Documentation deficiencies in IHM or recycling plans can undermine international confidence.

Reputational risk is particularly relevant in the post-HKC environment, where shipowners and flag administrations are expected to exercise due diligence in selecting recycling destinations.

India's approach has therefore emphasised:

- Yard infrastructure upgradation.
- Adoption of internationally recognised management systems.
- Structured inspection and oversight.
- Progressive digitalisation of compliance processes.

The objective is to institutionalise compliance rather than rely solely on periodic enforcement.

Inventory of Hazardous Materials (IHM)

The IHM framework is central to safe and environmentally sound recycling.

The IHM consists of three parts:

- Part I – Hazardous materials present in ship structure and equipment.
- Part II – Operational wastes.
- Part III – Stores.

Ships must maintain a valid IHM certificate, generally with a five-year validity . Prior to recycling, Parts II and III must be completed and verified.

The IHM enables:

- Identification of hazardous substances.
- Planning of removal and segregation.
- Safe disposal pathways.
- Worker safety during dismantling.

In practical terms, effective IHM governance reduces uncertainty at the yard stage and supports structured dismantling.

8.3. ISO Standards for Ship Recycling

A significant number of Indian recycling facilities operate under ISO-based management systems , including:

- ISO 9001 – Quality Management.
- ISO 14001 – Environmental Management.
- ISO 30000 – Ship Recycling Management.
- ISO 45001 – Occupational Health and Safety.

These systems formalise documentation control, environmental monitoring, safety audits and corrective action mechanisms. ISO certification strengthens process discipline and enhances international credibility.

Ferrous Scrap Development Fund (FSDF)

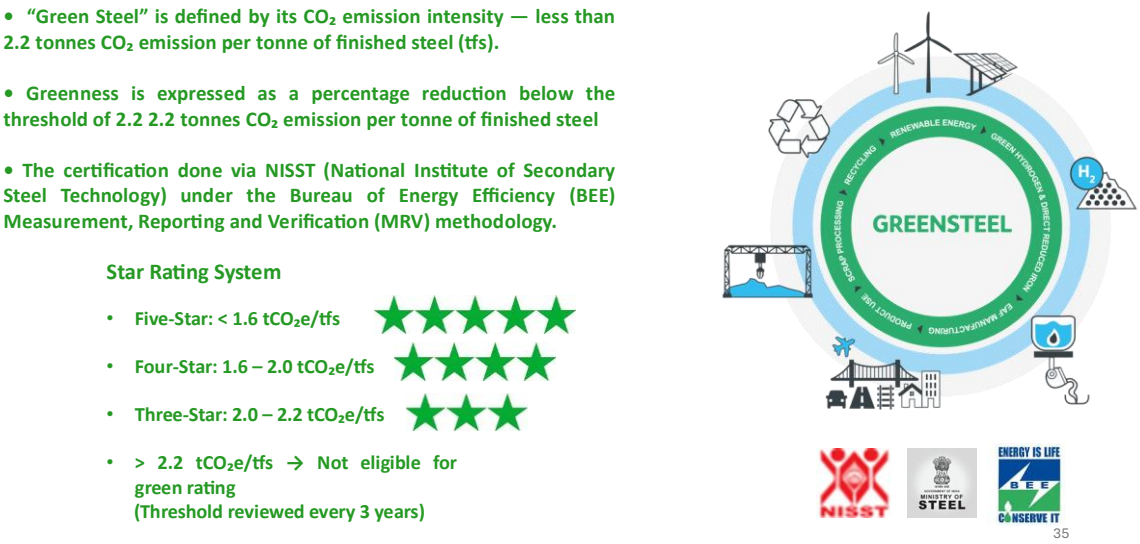
The Ferrous Scrap Development Fund supports systemic improvements in the recycling ecosystem

The Fund is utilised for:

- Yard infrastructure improvements.
- Effluent treatment and hazardous waste management systems.
- Worker housing and welfare facilities.
- Skill development and training initiatives.
- Research and consultancy inputs.

The objective is to ensure that compliance and safety improvements are capital-backed and sustainable.

8.4. Green Steel



Green Steel is defined as steel with emission intensity below 2.2 tonnes of CO_2 per tonne of finished steel

Scrap-based steel production significantly reduces resource consumption. For every tonne of scrap steel used:

- 1,370 kg of iron ore is conserved.
- 780 kg of coal is saved.
- 270 kg of limestone is saved

Ship recycling therefore directly contributes to resource conservation and emissions reduction objectives.

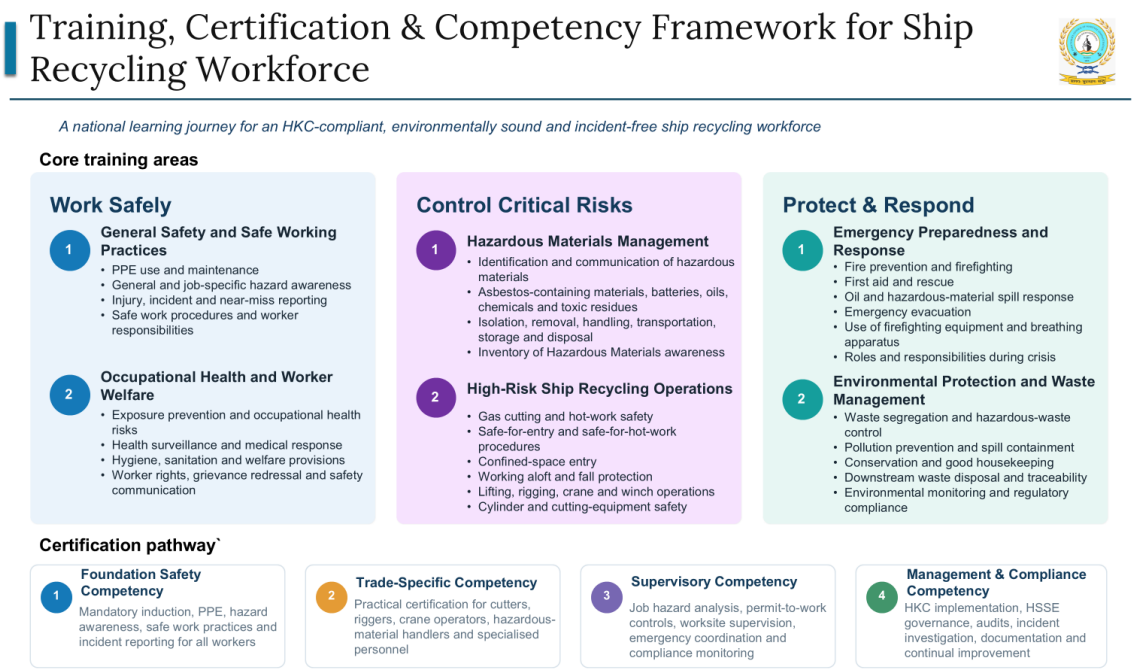
Circular Economy Linkage

India's ship recycling model now reflects a structured circular framework:

- Ships are dismantled in HKC-compliant yards.
- Scrap is channelled into domestic steel production.
- The Credit Note incentivises new vessel construction in India.
- Fleet renewal supports technological modernisation.
- FSDF reinvests in safety and infrastructure.
- Digital governance improves transparency and oversight.

The emphasis going forward will be on maintaining documentation integrity, strengthening digital systems and ensuring that worker safety and environmental safeguards remain embedded in operations.

9. Ship Recycling Workforce Training Framework (proposed)



The transition towards environmentally sound and internationally compliant ship recycling requires a skilled workforce possessing the technical knowledge, practical skills and safety competencies necessary for handling complex recycling operations. The entry into force of the **Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC)** has further strengthened the need for a structured competency-based approach to workforce development across all ship recycling facilities.

Ship recycling involves a wide range of high-risk activities including gas cutting, heavy lifting, confined-space entry, hazardous-material handling, work at height and waste management. These activities require personnel to possess clearly defined competencies supported by systematic training, periodic assessment and continuous skill upgradation.

A standardised national training and certification framework would help establish uniform competency standards across Indian ship recycling facilities, improve occupational safety, strengthen environmental compliance and support sustained implementation of the Hong Kong Convention.

Objectives of the Competency Framework

The proposed framework should aim to:

- Develop a skilled and safety-conscious ship recycling workforce.
- Establish uniform national competency standards across recycling facilities.
- Improve compliance with the Hong Kong Convention and applicable national regulations.
- Reduce occupational accidents, injuries and environmental incidents.
- Promote continual professional development through refresher training and periodic certification.
- Enhance confidence among international ship owners and regulatory authorities regarding the competence of the Indian ship recycling workforce.

Core Training Areas

A comprehensive competency framework should include structured training across the following core areas.

General Safety and Safe Working Practices

This forms the foundation for all personnel entering ship recycling facilities.

Training should cover:

- Personal Protective Equipment (PPE) selection, use and maintenance.
- General hazard awareness and job-specific risk identification.
- Safe work procedures and worker responsibilities.
- Incident, injury and near-miss reporting.
- Permit-to-work systems.
- Toolbox talks and behavioural safety practices.

High-Risk Ship Recycling Operations

Specialised technical training should be provided for personnel engaged in hazardous operational activities.

Training areas include:

- Gas cutting and hot-work safety.
- Safe-for-entry and safe-for-hot-work procedures.
- Confined-space entry.
- Lifting, rigging and crane operations.

- Working at height and fall protection.
- Cylinder handling and cutting-equipment safety.
- Heavy structural dismantling techniques.

Hazardous Materials Management

Workers should be trained in the identification, handling and safe disposal of hazardous materials commonly encountered during ship recycling.

Training should include:

- Inventory of Hazardous Materials (IHM) awareness.
- Identification and communication of hazardous substances.
- Safe handling of asbestos-containing materials, oils, chemicals, batteries and toxic residues.
- Isolation, removal, storage, transportation and disposal procedures.
- Spill prevention and contamination control.

Emergency Preparedness and Response

Emergency response capability is essential for minimising the consequences of accidents.

Training should include:

- Fire prevention and firefighting.
- First aid and rescue.
- Oil and hazardous-material spill response.
- Emergency evacuation procedures.
- Use of firefighting equipment and breathing apparatus.
- Roles and responsibilities during emergency situations.

Environmental Protection and Waste Management

Personnel should understand the environmental responsibilities associated with ship recycling.

Training should cover:

- Waste segregation.
- Hazardous-waste management.
- Pollution prevention.
- Spill containment.
- Good housekeeping practices.

- Downstream waste disposal and traceability.
- Environmental monitoring and regulatory compliance.

Occupational Health and Worker Welfare

The competency framework should also address worker health, welfare and occupational hygiene.

Training should include:

- Prevention of occupational illnesses.
- Health surveillance and medical response.
- Hygiene and sanitation practices.
- Worker welfare provisions.
- Safety communication.
- Worker rights and grievance redressal mechanisms.

Competency Categories

A tiered competency framework may be adopted to reflect the different responsibilities within a ship recycling facility.

Foundation Safety Competency

Applicable to all personnel before deployment.

The competency should include:

- Mandatory induction.
- PPE usage.
- Hazard awareness.
- Safe working practices.
- Incident reporting.
- Basic emergency response.

Trade-Specific Competency

Applicable to personnel performing specialised operational tasks.

Examples include:

- Gas cutters.
- Riggers.
- Crane operators.
- Heavy-equipment operators.

- Hazardous-material handlers.
- Waste-management personnel.

Certification should combine classroom instruction with practical assessment.

Supervisory Competency

Supervisors should receive additional training covering:

- Job Hazard Analysis.
- Permit-to-work systems.
- Worksite supervision.
- Safety leadership.
- Emergency coordination.
- Regulatory compliance monitoring.
- Incident investigation.

Management and Compliance Competency

Management personnel should possess competencies relating to:

- Hong Kong Convention implementation.
- HSSE management systems.
- Internal audits.
- Documentation and record management.
- Continual improvement.
- Regulatory liaison.
- Contractor management.

Certification Framework

A national certification framework may include:

- Standardised competency standards for each job category.
- Accredited training centres.
- Qualified trainers and assessors.
- Practical and theoretical assessments.
- Digital competency records.
- Defined validity periods for certificates.
- Periodic refresher training and re-certification.

Digital certification records may also improve traceability and facilitate verification by regulatory authorities, employers and international stakeholders.

Institutional Framework

Implementation of a national competency framework would require coordinated participation by:

- Directorate General of Maritime Administration (DGMA)
- Gujarat Maritime Board (GMB)
- Indian Register of Shipping (IRS)
- Ship Recycling Facilities (SRFs)
- Training institutions
- Industry associations
- Occupational health and safety experts
- Environmental agencies

Such collaboration would support uniform implementation of competency standards across the ship recycling sector.

Benefits

Implementation of a structured national training and certification framework can contribute to:

- Improved worker safety and reduced accident rates.
- Enhanced compliance with the Hong Kong Convention.
- Better environmental protection and hazardous-material management.
- Uniform operational practices across ship recycling facilities.
- Improved emergency preparedness.
- Increased international confidence in India's ship recycling industry.
- Development of a professionally trained and globally competitive workforce.
- Strengthening India's position as a leading destination for safe and environmentally sound ship recycling.

10. Proposed International Ship Recycling Conclave - Alang

India is one of the world's leading ship recycling nations, with Alang–Sosiya in Gujarat forming the centre of the country's ship recycling ecosystem. The cluster brings together recycling yards, regulators, workers, downstream industries, service providers and supporting infrastructure within a concentrated maritime-industrial ecosystem.

With the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC) having entered into force, the global ship recycling industry is moving towards greater emphasis on safety, environmental compliance, traceability, worker welfare and responsible downstream waste management. This transition provides an opportunity for India to showcase the transformation of its ship recycling sector, strengthen engagement with the international maritime community and position Alang as a global centre for safe, sustainable and competitive ship recycling.

In this context, an International Ship Recycling Conclave is proposed to be organised at Alang, bringing together policy makers, regulators, shipowners, recyclers, technology providers, classification societies, financiers, academia, labour representatives and international organisations on a common platform.

Concept and Overview

The proposed Conclave is envisaged as a high-level international forum on the future of sustainable ship recycling. It would provide a structured platform for dialogue between governments, industry and technical stakeholders on the evolving requirements of the

global ship recycling sector and the measures required to strengthen safety, environmental sustainability, technological capability and commercial competitiveness.

The Conclave can position ship recycling within the wider maritime circular economy. End-of-life vessels contain significant quantities of recoverable steel, machinery, equipment and other materials. Environmentally sound recycling therefore has implications not only for shipping but also for resource efficiency, circularity, secondary steel production, waste management and maritime decarbonisation.

The forum would also provide an opportunity to showcase India's regulatory, institutional and infrastructure developments in ship recycling and demonstrate the capabilities developed at Alang.

Purpose and Key Objectives

A principal objective of the Conclave would be to facilitate international exchange of best practices and technological innovation in ship recycling. The sector is increasingly influenced by developments in hazardous-material management, worker safety, environmental monitoring, mechanisation, digital traceability and downstream waste management. Bringing international and domestic stakeholders together can facilitate exchange of experience on these issues and identify technologies and practices suitable for wider adoption in India.

Another important objective would be to enhance the international visibility of Alang. The Conclave can provide global stakeholders with direct exposure to the scale, infrastructure and operational capabilities of the Alang–Sosiya cluster and the improvements undertaken towards HKC-compliant recycling.

The forum would facilitate engagement with international shipowners and global recyclers, who are central to the commercial sustainability of the sector. Direct engagement can help understand the considerations governing the selection of recycling destinations, including compliance, safety performance, transparency, price competitiveness, ESG requirements and downstream material management.

Engagement with technology providers would enable exploration of solutions for mechanisation, material handling, hazardous-waste management, environmental monitoring, worker safety and digitalisation of the recycling lifecycle.

The Conclave can also serve as a platform for policy and regulatory dialogue. Discussions can cover implementation of the HKC, evolving international requirements, domestic regulatory mechanisms, certification and auditing, environmentally sound management of hazardous materials and measures required to maintain the competitiveness of Indian recycling facilities.

A further objective would be to strengthen trust and confidence among international shipowners, investors, classification societies and global clients. Greater transparency regarding Indian recycling practices, regulatory oversight and improvements undertaken

at Alang can support its positioning as a credible destination for responsible recycling of end-of-life vessels.

Alang as the Proposed Venue

Holding the Conclave at Alang itself would provide significant value beyond organising a conventional conference at a metropolitan location.

Alang provides an opportunity to combine policy dialogue with direct exposure to the operating ecosystem. International participants can gain first-hand understanding of the ship recycling process and interact directly with recyclers, regulators, workers and supporting industries.

The Conclave can therefore include structured site visits to selected HKC-compliant recycling yards and associated facilities, allowing participants to observe operational practices, worker-safety arrangements, hazardous-material handling, dismantling processes and environmental safeguards.

Exposure can also be provided to the wider downstream ecosystem associated with recycling, including the movement and utilisation of recovered materials and the management of hazardous and non-hazardous waste streams.

Organising the event at Alang would consequently enable discussions to remain grounded in actual operating conditions, with technical and policy deliberations taking place alongside practical demonstration of the infrastructure and processes being discussed.

It would also strengthen Alang's visibility internationally by bringing global decision-makers directly to the cluster rather than presenting India's ship recycling capabilities exclusively through international conferences and external outreach.

Government and Regulatory Participation

Participation from the Government of India, Government of Gujarat, DGMA and other relevant regulatory and institutional authorities would provide the policy and regulatory dimension of the Conclave.

Government participation can facilitate discussions on India's ship recycling framework, implementation of the HKC, infrastructure development, environmental compliance, worker welfare, capacity building and future policy interventions for strengthening the sector.

International maritime administrations and regulators may also be invited to facilitate exchange of experience regarding implementation of international ship recycling requirements and to strengthen regulatory cooperation.

Shipowners and Ship Recyclers

Shipowners constitute one of the most important stakeholder groups because their decisions ultimately determine where end-of-life ships are recycled.

Participation by Indian and international shipowners would enable discussion on the factors influencing responsible recycling decisions, including regulatory compliance, ESG requirements, commercial considerations, documentation, transparency and assurance regarding downstream disposal.

Participation by Indian and international ship recyclers and recycling associations would provide the operational perspective. Discussions could cover yard infrastructure, productivity, mechanisation, compliance costs, workforce safety, market conditions and opportunities for technological upgrading.

Bringing shipowners and recyclers together can help bridge the gap between the expectations of vessel owners and the operational realities of recycling facilities.

Ports and Maritime Organisations

Ports and maritime organisations can contribute to discussions on the broader lifecycle of ships and the interface between ship recycling, maritime logistics and the circular economy.

Participation by maritime bodies can also facilitate discussion on international standards, knowledge sharing and collaborative programmes relating to sustainable shipping and recycling.

Relevant international organisations and maritime institutions can provide perspectives on global regulatory developments, capacity building, environmental sustainability and worker welfare.

Steel and Waste-Value-Chain Stakeholders

Ship recycling is closely linked to the steel and downstream materials ecosystem. Steel recovered from end-of-life vessels represents an important source of secondary material and contributes to the principles of resource efficiency and circularity.

Participation from steel producers, rerolling mills, scrap processors and other downstream industries would allow the Conclave to examine the complete material value chain rather than focusing only on vessel dismantling.

Similarly, hazardous-waste treatment and disposal agencies and other waste-management stakeholders are important to ensuring that materials generated during ship recycling are handled in an environmentally sound manner.

Dialogue across the complete value chain can support improvements in material traceability, waste segregation, recovery, recycling and environmentally sound disposal.

Technology Providers and Innovation Ecosystem

Technological modernisation will be important for improving productivity, worker safety and environmental performance at recycling yards.

The Conclave can bring together technology providers working in areas such as mechanised dismantling, lifting and material handling, hazardous-material

identification, pollution-control systems, fire and occupational safety, environmental monitoring and digital tracking.

This would provide Indian yards with exposure to emerging technologies while enabling international technology providers to understand the scale and requirements of the Indian ship recycling market.

Technology sessions may also be linked with practical demonstrations and interactions with recycling yards to identify solutions that can be piloted or deployed at Alang.

Finance, Insurance and Classification Societies

The transition towards higher standards of sustainable recycling requires investment in yard infrastructure, technology, safety systems and environmental facilities.

Participation from financial institutions, insurers and investors can facilitate discussions on financing mechanisms for modernisation and development of sustainable ship recycling infrastructure.

Classification societies can provide technical perspectives on surveys, certification, compliance verification and international standards. Their participation would also be important in building confidence among international shipowners regarding the technical and compliance capabilities of Indian recycling facilities.

The combined participation of financiers, insurers and classification societies can help connect improved environmental and safety performance with greater access to finance, risk assurance and international business opportunities.

Academia, Labour and International Organisations

Worker safety and welfare remain fundamental to sustainable ship recycling. The Conclave should therefore include participation from worker representatives, training institutions and organisations dealing with occupational health and labour welfare.

Academic and research institutions can contribute to discussions on technology, environmental management, occupational safety, circular economy and future skills required by the sector.

Participation of relevant international organisations would provide an opportunity to connect India's domestic initiatives with international programmes relating to safe and environmentally sound ship recycling, labour standards, capacity building and sustainable maritime development.

Potential Thematic Areas

The substantive discussions at the Conclave may be structured around the future requirements of the sector, including HKC implementation and global regulatory developments; safe and environmentally sound recycling; worker safety and welfare; green and circular steel; hazardous-material and downstream waste management;

digitalisation and traceability; technology and mechanisation of recycling yards; financing and insurance; ESG considerations; and international market access.

Dedicated sessions can also examine the future of Alang as an integrated ship recycling cluster, including infrastructure development, skills and training, research capabilities and opportunities for international cooperation.

Expected Outcomes

The Conclave should be designed as an outcome-oriented international engagement rather than only a conference or awareness event.

Potential outcomes may include identification of international best practices suitable for adoption in India, technology partnerships and pilot opportunities, stronger engagement with international shipowners and classification societies, cooperation with international organisations and identification of infrastructure and capacity-building requirements for the sector.

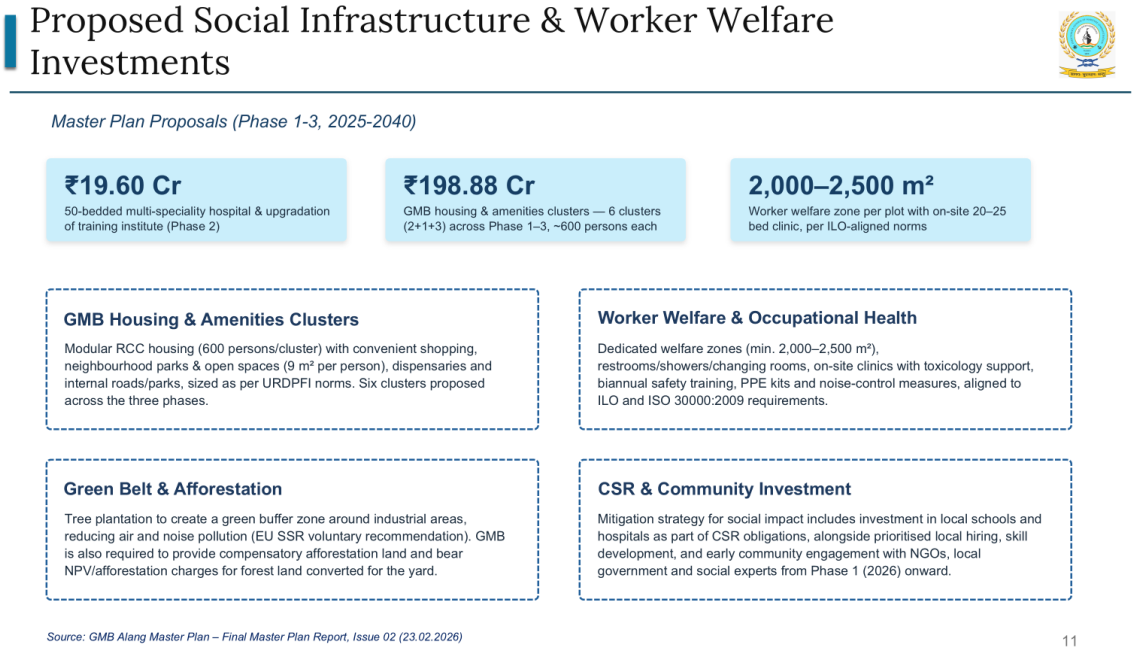
It can also create a structured mechanism for showcasing the capabilities of Indian recycling yards and strengthening the international positioning of Alang as a destination for safe, environmentally sound and commercially competitive ship recycling.

11. Social Welfare, Health and Education Infrastructure at Alang-Sosiya Ship Recycling Yard

Existing Social Welfare, Health & Education Infrastructure

Alang-Sosiya Ship Recycling Cluster

Worker Safety & Training Institute	Mandatory 2-week (12-day) safety and ship-recycling training provided free to all workers before employment. Two training halls, each equipped with audio-visual aids and seating for ~60 trainees, run under the dedicated safety training & labour welfare institute.
Medical Infrastructure – Alang Hospital	35-bed hospital managed by the Indian Red Cross Society with GMB financial and administrative support, offering free services including cardiology, plastic surgery, orthopaedics and a special burn ward. Equipped with MRI, CT and X-ray; specialists visit at least weekly. A second Red Cross facility offers primary care only.
Labour Housing Colony	Dormitory-type colony developed jointly by GMB and the Ship Recycling Industrial Association (SRIA), with capacity for 1,008 workers across 7 blocks (G+2), canteen, offices, shops and STP-served sanitation, provided free of charge as a welfare measure. Current occupancy stands at 20-30% of capacity.



The Alang–Sosiya Ship Recycling Yard is a large industrial ecosystem whose long-term sustainability depends not only on the technical and environmental performance of ship recycling facilities but also on the safety, health, welfare and living conditions of the workforce and surrounding communities. Ship recycling is labour-intensive and involves occupational risks associated with dismantling operations, heavy material handling, confined spaces, hazardous materials, fire, noise and other industrial activities. A strong social infrastructure framework is therefore an essential component of safe and sustainable ship recycling.

Over the years, a number of institutional facilities have been developed at Alang for worker training, healthcare and accommodation. These provide an important existing foundation for worker welfare. The next phase of development envisaged under the GMB Alang Master Plan (Phase 1–3, 2025–2040) seeks to substantially expand this foundation through additional healthcare capacity, decentralised worker housing and amenities, occupational-health infrastructure, green belts and community-oriented investments.

The overall approach is therefore to progress from individual welfare facilities towards a more comprehensive worker-centric social infrastructure ecosystem, integrating occupational safety, healthcare, housing, training, environmental quality and community development.

Worker Safety and Training Infrastructure

Worker safety is a fundamental requirement of the ship recycling ecosystem. A dedicated safety training and labour welfare institute operates at Alang to provide workers with structured training before they enter ship recycling operations.

A mandatory two-week training programme, comprising 12 days of safety and ship-recycling training, is provided free of cost to workers prior to employment. The training is intended to ensure that workers entering the yards have a basic understanding of the hazards associated with ship recycling and the safety practices required during dismantling operations.

The existing training infrastructure comprises two training halls, each equipped with audio-visual facilities and having seating capacity for approximately 60 trainees. This provides an institutional mechanism through which safety awareness and basic occupational preparedness can be developed before deployment of workers at recycling yards.

Going forward, worker training needs to remain a continuous process rather than being limited to induction. The proposed framework therefore envisages biannual safety training, alongside provision of appropriate PPE and occupational-health interventions. Refresher training can help address changing work practices, new equipment, emerging hazards and lessons learnt from operational experience.

Existing Healthcare Infrastructure – Alang Hospital

Healthcare infrastructure is another important component of the existing social-support system at Alang. A 35-bed hospital managed by the Indian Red Cross Society, with financial and administrative support from the Gujarat Maritime Board (GMB), provides medical services to the workforce and local population.

The hospital provides free medical services and includes specialist facilities in areas such as cardiology, plastic surgery and orthopaedics, along with a dedicated burn ward, which is particularly relevant to the occupational risk profile associated with industrial and ship recycling operations.

Diagnostic infrastructure includes MRI, CT and X-ray facilities, while specialist doctors visit the hospital at least once every week. This provides Alang with a level of secondary medical capability in proximity to the ship recycling cluster.

A second Red Cross facility provides primary healthcare services, supplementing the main hospital and strengthening access to routine medical care.

The presence of these facilities provides an important healthcare base. However, the future expansion and modernisation of the ship recycling ecosystem will require corresponding enhancement of medical capacity, particularly in occupational medicine, trauma response, toxicology, burns management and emergency care.

Existing Labour Housing Colony

Worker accommodation is a major social-infrastructure requirement considering the large workforce associated with ship recycling and the migrant nature of a significant part of industrial labour.

A dedicated dormitory-type labour housing colony has been developed jointly by GMB and the Ship Recycling Industrial Association (SRIA). The colony has capacity to accommodate 1,008 workers across seven G+2 blocks.

The housing facility is supported by common amenities including a canteen, offices, shops and sanitation infrastructure served by a Sewage Treatment Plant (STP). Accommodation is provided free of charge as a worker-welfare measure.

The existing occupancy, however, is approximately 20–30% of total capacity. This indicates that future housing development should not focus only on creation of additional physical capacity but should also consider the factors influencing utilisation, including location, accessibility to workplaces, quality and type of accommodation, availability of daily amenities and the requirements and preferences of the workforce.

The proposed expansion of housing under the Master Plan therefore provides an opportunity to develop more decentralised and integrated worker communities closer to the areas of employment.

Proposed Social Infrastructure and Worker Welfare Investments

The GMB Alang Master Plan, covering Phases 1–3 from 2025 to 2040, envisages significant expansion of social and worker-welfare infrastructure. The proposals cover healthcare and training, housing and amenities, occupational health, environmental improvement and broader community development.

Expansion of Hospital and Training Infrastructure

An investment of approximately ₹19.60 crore is envisaged during Phase 2 for development of a 50-bedded multi-speciality hospital and upgradation of the training institute.

The proposed enhancement would build upon the existing 35-bed healthcare facility and provide additional medical capacity to support the workforce and the wider Alang community. Given the occupational characteristics of ship recycling, the upgraded healthcare system can place particular emphasis on emergency and trauma response, burns treatment, occupational medicine, toxicology and diagnostics, in addition to general and specialist medical care.

Upgradation of the training institute can similarly strengthen the existing mandatory worker-training system by improving training infrastructure and enabling more specialised and continuous programmes.

The combined development of healthcare and training facilities would strengthen both the preventive and responsive dimensions of occupational safety—preventing incidents through better training while improving medical preparedness and response where incidents or occupational-health issues occur.

GMB Housing and Amenities Clusters

A major component of the proposed social-infrastructure programme is the development of six GMB housing and amenities clusters across Phases 1–3, with an estimated investment of approximately ₹198.88 crore.

The six clusters are proposed to be developed in a phased configuration of two clusters in one phase, one in another and three in the remaining phase, with each cluster designed to accommodate approximately 600 persons.

The proposed accommodation is based on modular RCC housing, supported by a broader neighbourhood-level amenities framework. Rather than creating standalone dormitory blocks, the concept envisages worker settlements incorporating convenient shopping facilities, neighbourhood parks, open spaces, dispensaries and internal roads/parking.

Open spaces are proposed at approximately 9 square metres per person, with the overall development to be sized in accordance with applicable URDPFI norms.

The proposed cluster-based model therefore seeks to improve not merely the quantity of worker accommodation but the overall quality of living conditions, accessibility to basic services and integration of housing with everyday social requirements.

Lessons from the relatively low utilisation of the existing labour colony can also inform the planning of these new clusters so that location, connectivity, amenities and worker requirements are incorporated into their design and implementation.

Dedicated Worker Welfare Zones

An important proposed intervention is the creation of dedicated worker welfare zones at the plot level, with a minimum area of approximately 2,000–2,500 square metres per plot.

These zones are intended to bring essential welfare and occupational-health facilities closer to the actual workplace rather than concentrating all services at central locations.

Facilities envisaged within these zones include restrooms, showers and changing rooms, enabling workers to maintain appropriate hygiene and change from work clothing after exposure to industrial operations.

Each welfare zone is also envisaged to have an on-site clinic with approximately 20–25 beds, together with toxicology support. The decentralised availability of medical facilities can improve immediate response to workplace injuries and occupational exposure while the larger hospital continues to provide higher-level medical care.

The approach is intended to align worker-welfare infrastructure with relevant ILO principles and ISO 30000:2009 requirements, embedding occupational health and welfare within the functioning of the recycling yards.

Occupational Health and Safety

The proposed welfare framework places increased emphasis on occupational health, recognising that worker protection extends beyond prevention of accidents.

Ship recycling operations can involve exposure to hazardous substances, dust, fumes, high noise levels and physically demanding working conditions. Occupational-health interventions therefore need to include periodic health monitoring, toxicology support, adequate PPE, hygiene facilities and appropriate controls for workplace exposure.

The proposed system includes biannual safety training, provision of PPE kits and noise-control measures, alongside the plot-level welfare and healthcare infrastructure.

Together with the existing mandatory pre-employment training, these measures can create a more comprehensive safety lifecycle covering induction, continuous training, workplace protection, health surveillance, immediate medical response and specialist healthcare.

Green Belt and Afforestation

Worker welfare and industrial sustainability are also connected with the environmental quality of the surrounding area. The Master Plan envisages tree plantation and development of green buffer zones around industrial areas.

Green belts can contribute to reduction of air and noise pollution, improve the environmental quality of industrial and residential areas and provide a physical buffer between intensive industrial operations and surrounding uses.

The proposal is also aligned with voluntary recommendations associated with sustainable ship recycling practices. GMB is required to provide land for compensatory afforestation and bear the applicable Net Present Value (NPV)/afforestation charges where forest land is converted for development of the yard.

Afforestation and green-belt development should therefore be viewed as part of the wider transformation of Alang into a cleaner and greener ship recycling cluster, alongside improvements in industrial and social infrastructure.

CSR and Community Investment

Development of Alang has implications beyond the workers employed directly within ship recycling yards. The long-term sustainability of the cluster also depends on its relationship with surrounding communities and the extent to which industrial development contributes to local social and economic development.

The Master Plan therefore envisages CSR and community investment as an integral part of the social-impact mitigation strategy.

Potential interventions include investment in local schools and hospitals, together with local hiring and skill-development initiatives. Early and sustained engagement with local communities, NGOs, local government and social-sector experts is also envisaged from the initial phases of implementation.

Such an approach can help ensure that the benefits of the development of the ship recycling cluster extend to surrounding communities and that potential social impacts are identified and addressed during the planning and implementation stages.

Education and skill development can be particularly important in creating pathways for local youth to participate in the evolving maritime, recycling and downstream industrial economy.

Integrated Worker Welfare Approach

The proposed investments provide an opportunity to move towards an integrated model in which worker safety, health, housing, education, skills and environmental quality are treated as interconnected components of sustainable ship recycling.

At the workplace level, workers would have access to dedicated welfare zones, hygiene facilities, PPE, safety training and on-site medical support. At the cluster level, the proposed housing developments would provide accommodation together with neighbourhood amenities and open spaces. At the institutional level, an upgraded training institute and expanded multi-speciality hospital would provide specialised support. At the community level, investments in schools, healthcare, skills and local development would extend the benefits beyond the immediate workforce.

This creates a layered welfare architecture comprising yard-level facilities, common cluster infrastructure and community-level social development.

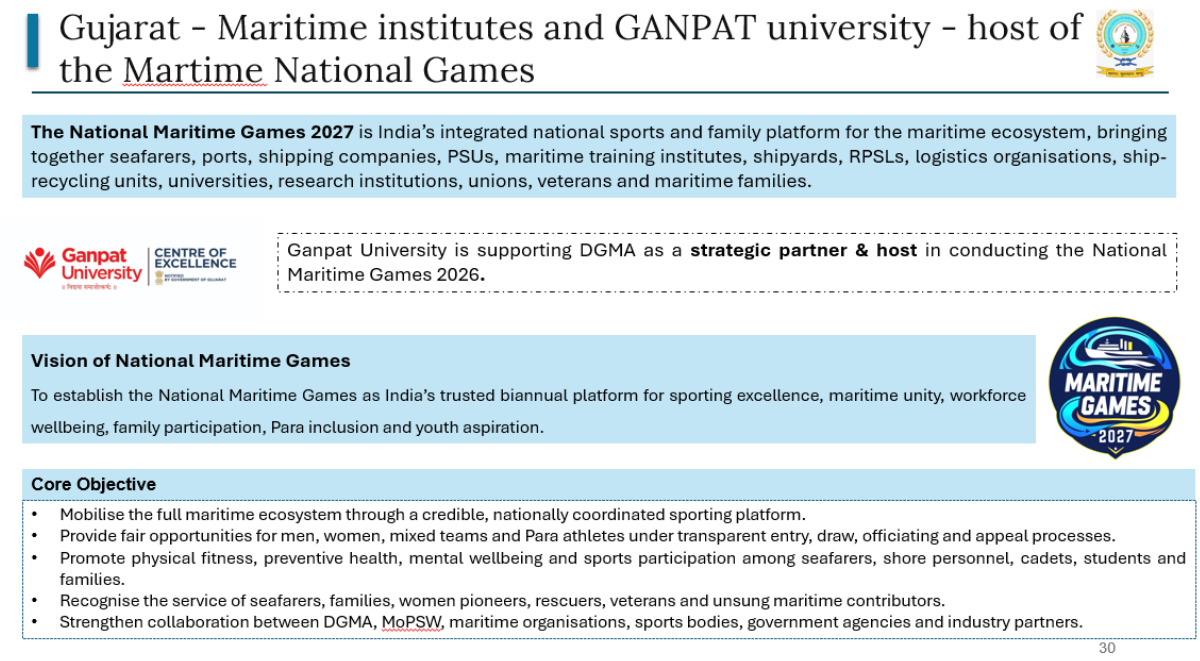
Way Forward

Alang already possesses an established foundation of worker-welfare infrastructure through its safety and training institute, Red Cross healthcare facilities and dedicated labour housing colony. The proposed investments under the GMB Alang Master Plan 2025–2040 can substantially strengthen this foundation and address the requirements of a modern, internationally competitive and socially responsible ship recycling ecosystem.

The proposed ₹19.60 crore investment in a 50-bedded multi-speciality hospital and training institute upgradation, ₹198.88 crore investment in six housing and amenities clusters, establishment of 2,000–2,500 m^2 worker welfare zones with 20–25 bed on-site clinics, continuous occupational-safety measures, green-belt development and community investments collectively represent a shift towards a more comprehensive welfare model.

The long-term objective should be to develop Alang as a ship recycling ecosystem where international standards of environmental and technical compliance are accompanied by equally strong standards of worker safety, healthcare, living conditions, skills and social welfare. This would strengthen the overall sustainability of the Alang–Sosiya cluster and reinforce India's positioning as a global centre for safe, environmentally sound and socially responsible ship recycling.

12. Gujarat - Maritime institutes and GANPAT university - host of the Martime National Games



The maritime sector is often viewed through the lens of ports, shipping, shipbuilding, and logistics; however, its true strength lies in the people who drive the industry. Seafarers, maritime professionals, students, trainers, researchers, port personnel, shipyard workers, and their families collectively form the backbone of the maritime ecosystem. As India's maritime ambitions continue to expand under Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047, there is an increasing recognition that human capital development, workforce wellbeing, and stakeholder engagement are as important as physical infrastructure and industrial growth. Within this context, Gujarat's strong maritime education ecosystem and the role of institutions such as Ganpat University assume significant importance.

Gujarat has long been one of India's leading maritime states, not only because of its extensive coastline and maritime infrastructure but also due to the presence of a robust network of maritime education and training institutions. The state hosts a range of institutions offering programs in marine engineering, nautical science, port and shipping management, logistics, maritime law, offshore operations, and allied disciplines. These institutions play a vital role in creating a skilled workforce capable of supporting the evolving requirements of the maritime sector. Through academic programs, practical training, industry engagement, and research initiatives, Gujarat continues to contribute significantly to India's maritime talent pool.

As the maritime industry evolves, there is a growing need to foster stronger connections between educational institutions, industry stakeholders, regulatory bodies, and maritime communities. The concept of the National Maritime Games emerges from this broader vision of creating a more integrated and inclusive maritime ecosystem. The initiative seeks to move beyond traditional conferences and professional engagements by creating a national platform that promotes interaction, camaraderie, wellbeing, and collaboration among stakeholders across the maritime sector.

The National Maritime Games are envisioned as a unique platform that brings together diverse participants from across the maritime community. These include seafarers, port authorities, shipping companies, public sector undertakings, maritime training institutes, shipyards, recruitment and placement service providers, logistics organizations, ship recycling units, universities, research institutions, industry associations, veterans, and maritime families. By creating opportunities for interaction beyond the workplace, the initiative seeks to strengthen professional networks, promote a shared maritime identity, and build a stronger sense of community within the sector.

A key feature of the initiative is its focus on holistic wellbeing. Maritime professions often involve demanding working conditions, extended periods away from home, and significant physical and mental challenges. Promoting physical fitness, preventive healthcare, mental wellbeing, and family participation is therefore increasingly recognized as an important component of workforce development. Sporting events and community engagement activities provide an effective avenue to encourage healthy lifestyles, improve morale, and strengthen social support systems across the maritime sector.

Ganpat University's role as a strategic partner and host institution reflects the growing importance of academic institutions in supporting maritime sector development beyond conventional education and training. Universities today are expected to function as centers of innovation, collaboration, research, and community engagement. By supporting initiatives such as the National Maritime Games, institutions can contribute to building stronger links between academia and industry while creating opportunities for students and young professionals to engage with the broader maritime ecosystem.

The vision behind the National Maritime Games extends beyond sports and recreation. It seeks to establish a credible and nationally coordinated platform that promotes inclusion, participation, recognition, and collaboration across the maritime sector. The initiative also aims to provide equal opportunities for men, women, youth, veterans, and para-athletes, reflecting the sector's commitment to diversity and inclusivity. At the same time, it offers a platform to recognize the contributions of seafarers, maritime families, rescuers, pioneers, and other stakeholders whose efforts often remain outside the public spotlight.

Ultimately, the National Maritime Games represent an innovative approach to strengthening the human dimension of India's maritime ecosystem. By combining sporting excellence, workforce wellbeing, family participation, youth engagement, and industry collaboration within a single platform, the initiative seeks to reinforce the sense of unity and shared purpose that will be essential in achieving India's long-term maritime aspirations. Gujarat, through its maritime institutions and the participation of Ganpat University, is well positioned to support this vision and contribute to the development of a stronger, more connected, and future-ready maritime community.

13. Strengthening Maritime Security: Bureau of Port Security (BoPS) and National Centre of Excellence for Port Security

The Bureau of Port Security (BoPS) has been established as a dedicated national authority to regulate, oversee, and strengthen security at India's ports and port facilities. Constituted under Section 13(1) of the Merchant Shipping Act, 2025, BoPS serves as the statutory body responsible for implementing and enforcing security measures at port facilities and vessel-port interfaces in accordance with the requirements of the International Ship and Port Facility Security (ISPS) Code. Its establishment addresses the need for a centralized institutional framework to ensure consistent security standards across the country's maritime infrastructure. Through a notification issued by the Ministry of Ports, Shipping and Waterways on 27 June 2026, the Bureau was formally constituted, with the Director General of Maritime Affairs (DGMA) designated to function as the interim Director General of BoPS until a dedicated leadership structure is approved by the Government.

BoPS has been envisaged as the designated authority for maritime security assurance, creating a single-point mechanism for security oversight at all port facilities in India. In this role, the Bureau is responsible for reviewing and approving Port Facility Security Assessments (PFSAs) and Port Facility Security Plans (PFSPs), conducting compliance audits and inspections, undertaking certification activities, and ensuring adherence to ISPS Code requirements. The Bureau also acts as the nodal agency for coordination among ports, security agencies, maritime authorities, and other stakeholders involved in safeguarding maritime infrastructure. To strengthen the security assurance ecosystem, DGS Circular No. 22 of 2026 dated 06 May 2026 authorized the Central Industrial Security Force (CISF) as a Recognized Security Organisation (RSO) for port facilities, alongside the Indian Register of Shipping (IRS). This enables CISF to undertake security assessments,

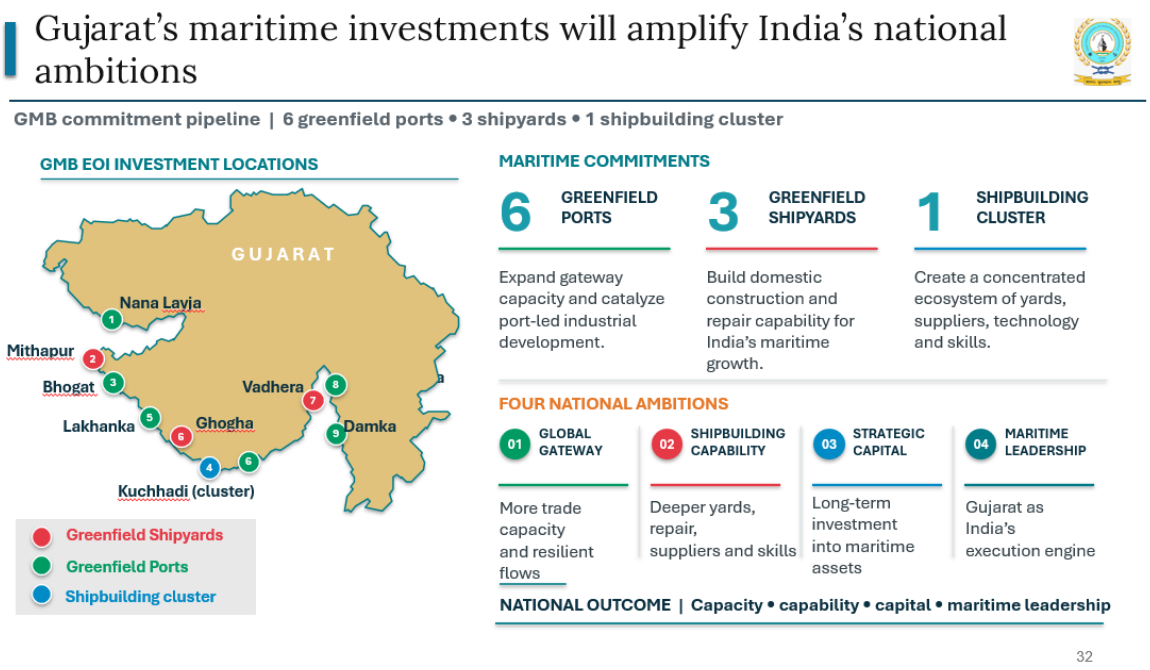
audits, certification activities, and provide security-related advisory support to port facilities.

Looking towards future security challenges, BoPS has proposed the establishment of a dedicated Coordination, Technology and Cyber Security Division to enhance cyber resilience across India's port sector. With increasing digitization and automation of port operations, cyber threats have emerged as a critical risk to maritime infrastructure. The proposed division would issue cyber security advisories, support implementation of cyber security measures across port facilities, develop sector-specific cyber security frameworks, and facilitate adoption of technology-driven security solutions. The division is expected to strengthen the ability of ports to prevent, detect, respond to, and recover from cyber incidents, thereby ensuring the continuity and resilience of maritime trade and logistics operations.

In addition to regulatory and cyber security functions, BoPS is also focused on building long-term national capacity in maritime security. In collaboration with CISF, a proposal has been developed to establish a National Centre of Excellence for Port and Coastal Security at Okha, Gujarat. The proposed centre would serve as a premier institution for training, certification, research, and capacity building in the fields of port security, coastal security, and maritime risk management. It is envisaged to provide specialized training programmes for security personnel, conduct research on emerging security threats, develop best practices, facilitate inter-agency cooperation, and promote professional excellence in maritime security management. The centre would play a crucial role in creating a highly skilled workforce capable of addressing evolving security challenges in the maritime domain.

Overall, the establishment of the Bureau of Port Security represents a significant milestone in strengthening India's maritime security architecture. By providing statutory backing, centralized oversight, a dedicated compliance and assurance framework, enhanced cyber security capabilities, and a national platform for security training and research, BoPS is expected to significantly improve the security, resilience, and preparedness of India's ports and maritime infrastructure while ensuring compliance with national and international security standards.

14. Gujarat Maritime Investments



This slide highlights Gujarat's pivotal role in advancing India's maritime transformation through a large-scale pipeline of port, shipbuilding, and maritime infrastructure investments being pursued under the Gujarat Maritime Board (GMB). As India seeks to strengthen its position as a leading maritime nation under Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047, Gujarat has emerged as a key execution engine for translating national maritime aspirations into on-ground infrastructure and industrial capacity.

The slide presents a comprehensive investment commitment pipeline comprising **six greenfield ports, three greenfield shipyards, and one dedicated shipbuilding cluster**, representing one of the largest maritime development programs undertaken by any coastal state in India. These projects are strategically distributed across Gujarat's coastline and are intended to strengthen port capacity, expand shipbuilding capability, attract maritime investments, and create a robust industrial ecosystem linked to maritime trade and logistics.

The proposed investment locations include **Nana Lavia, Mithapur, Bhogat, Lakhanka, Ghogha, Kuchhadi, Vadhera, and Damka**, covering both port-led infrastructure and shipbuilding developments. The Kuchhadi location has been identified as the proposed shipbuilding cluster, while the remaining sites represent a combination of greenfield ports and shipyard projects. Together, these developments are expected to create a network of maritime assets spanning Gujarat's western coastline, reinforcing its position as the maritime gateway of India.

The six proposed greenfield ports are aimed at expanding gateway capacity and supporting future cargo growth. As trade volumes continue to increase and industrial corridors expand, these ports will play an important role in enhancing logistics efficiency,

reducing congestion at existing facilities, and enabling port-led industrialization. The developments are also expected to support emerging sectors such as coastal shipping, offshore energy, renewable energy logistics, and multimodal transportation networks.

In parallel, the proposed greenfield shipyards will contribute significantly to strengthening India's domestic shipbuilding and ship-repair capabilities. Shipbuilding has been identified as a strategic national priority due to its strong linkage with manufacturing, engineering, technology, employment generation, and national security. The development of new shipyards in Gujarat is expected to enhance indigenous vessel construction capacity, support maintenance and repair services, and create opportunities for marine equipment manufacturers and ancillary industries.

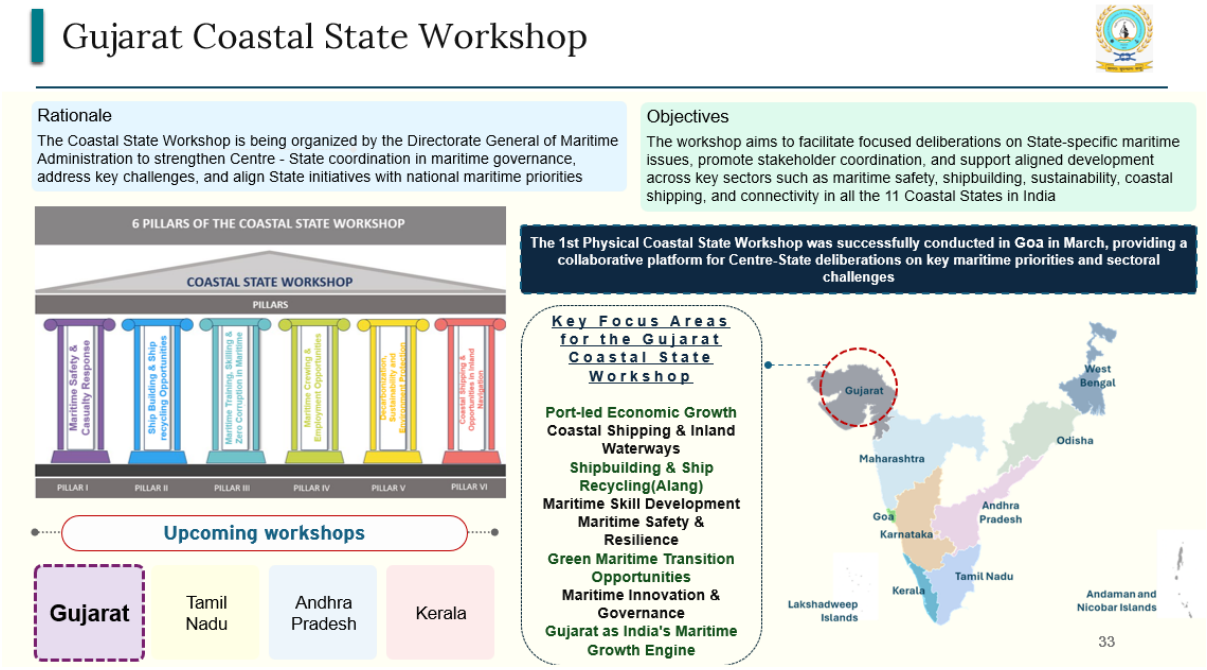
A key component of the investment pipeline is the proposed **Kuchhadi Shipbuilding Cluster**, which seeks to create an integrated ecosystem of shipyards, suppliers, marine equipment manufacturers, technology providers, training institutions, and support services. The cluster approach is intended to leverage economies of scale and create a concentrated maritime manufacturing hub capable of supporting large-scale vessel construction and repair activities. By integrating shipbuilding infrastructure with ancillary industries and skilled workforce development, the cluster is expected to improve competitiveness and attract both domestic and international investment.

The slide further links these investments to four broader national ambitions. The first is the creation of a **Global Gateway**, enabling higher trade capacity, resilient supply chains, and improved connectivity. The second is strengthening **Shipbuilding Capability** through deeper shipyard infrastructure, enhanced repair facilities, and a stronger domestic supplier ecosystem. The third ambition focuses on **Strategic Capital Formation**, encouraging long-term investment into maritime assets and industrial infrastructure. Finally, the investments contribute towards **Maritime Leadership**, positioning Gujarat as a key driver of India's maritime growth and a leading maritime state within the national ecosystem.

Collectively, these initiatives are expected to deliver substantial economic and strategic benefits. Increased port capacity will support trade growth and industrial expansion, while shipbuilding investments will create high-value employment opportunities and strengthen domestic manufacturing capabilities. The projects will also enhance coastal development, stimulate private investment, improve logistics competitiveness, and reinforce India's efforts towards maritime self-reliance.

The central message of the slide is that Gujarat's maritime investments extend beyond state-level development objectives and directly contribute to national priorities. Through the creation of new ports, shipyards, and maritime industrial ecosystems, Gujarat is helping build the capacity, capability, capital base, and leadership required for India to emerge as a globally competitive maritime nation over the coming decades.

15. Gujarat Coastal State Workshops



This slide outlines the rationale, objectives, and thematic focus areas of the proposed **Gujarat Coastal State Workshop**, an initiative being undertaken by the Directorate General of Maritime Administration (DGMA) to strengthen Centre–State coordination in maritime governance and accelerate the implementation of national maritime priorities at the state level. The workshop forms part of a broader engagement strategy aimed at creating a structured platform for deliberation on state-specific maritime opportunities, challenges, and policy interventions across India's coastal states.

The workshop is designed to facilitate focused discussions among key stakeholders from the Central Government, State Government, maritime agencies, ports, industry associations, academia, and maritime institutions. Its primary objective is to align Gujarat's maritime development agenda with national initiatives such as **Maritime India Vision 2030 (MIV 2030)** and **Maritime Amrit Kaal Vision 2047 (MAKV 2047)** while addressing local opportunities and sectoral requirements. The initiative recognizes that many maritime development priorities—including port-led industrialization, coastal shipping, maritime skilling, shipbuilding, sustainability, and logistics connectivity—require close coordination between national and state-level institutions.

The slide highlights that the first physical Coastal State Workshop was successfully conducted in Goa in March 2026, demonstrating the effectiveness of the platform in fostering collaborative dialogue on key maritime priorities. Building on the success of the Goa workshop, Gujarat has been identified as one of the next focus states due to its strategic importance within India's maritime ecosystem. Gujarat possesses the country's longest coastline, hosts several major and non-major ports, accounts for a significant share of India's cargo throughput, and serves as a leading hub for

shipbuilding, ship recycling, maritime manufacturing, and port-led industrial development.

The workshop framework is structured around six thematic pillars that collectively encompass the major dimensions of maritime development. These pillars include maritime safety and security, shipbuilding and ship repair, maritime training and human capital development, sustainable and green maritime growth, coastal shipping and connectivity, and maritime innovation and governance. The multi-pillar approach ensures that discussions extend beyond individual sectors and address the maritime ecosystem in a holistic manner.

The slide further identifies the key focus areas proposed for the Gujarat workshop. These include **port-led economic growth**, **coastal shipping and inland waterways**, **shipbuilding and ship recycling (with special emphasis on Alang)**, **maritime skill development**, **maritime safety and resilience**, **green maritime transition opportunities**, **maritime innovation and governance**, and Gujarat's role as a driver of India's maritime growth story. Collectively, these themes seek to leverage Gujarat's existing strengths while identifying new opportunities to support national maritime ambitions.

Overall, the Gujarat Coastal State Workshop is envisaged as a strategic platform to strengthen policy alignment, promote stakeholder collaboration, and accelerate maritime sector development through coordinated action between the Centre and the State. The outcomes of the workshop are expected to contribute significantly towards achieving India's long-term vision of becoming a globally competitive maritime nation.

16. Proposal for scheme for the traditional Seafarers on mechanized sailing vessels

This slide highlights the systemic welfare, compensation, and social security gaps affecting traditional Indian Sailing Vessel (ISV) seafarers operating on mechanized sailing vessels. The discussion is anchored around the **MSV Al Faiz Noore Soleimani-I incident in May 2026**, which occurred during heightened tensions in the Strait of Hormuz. The casualty resulted in the loss of one seafarer's life, injuries to five others, and the sinking of the vessel. While tragic in itself, the incident exposed a broader structural challenge within India's maritime ecosystem—namely, the absence of a comprehensive welfare and compensation framework for ISV seafarers.

The analysis compares the compensation architecture available to conventional merchant navy seafarers with that available to ISV personnel. Merchant navy seafarers typically benefit from multiple layers of financial protection, including Collective Bargaining Agreement (CBA) compensation, war-zone protection, P&I-backed shipowner liability coverage, Seafarers Welfare Fund Society (SWFS) benefits, and war-risk insurance. Collectively, these mechanisms can provide compensation ranging from approximately ₹86 lakh to ₹2.6 crore depending on the nature of the casualty.

In contrast, ISV seafarers currently lack access to most formal protection mechanisms. In many cases, compensation is limited to ex-gratia payments in the range of ₹2–10 lakh, resulting in a compensation disparity estimated at approximately **8 to 130 times** compared to merchant navy personnel. This disparity is not merely financial but reflects a broader exclusion from formal maritime welfare structures.

The slide further introduces a **Multi-Dimensional Deprivation Matrix**, demonstrating that the challenge extends beyond compensation alone. ISV seafarers remain largely excluded from SWFS and other welfare schemes, operate without formal employment agreements, possess limited insurance coverage, and face significant constraints in accessing welfare infrastructure. Their integration with digital maritime platforms such as **e-Samudra** remains limited, restricting visibility within the formal regulatory ecosystem. Capacity-building support, telemedicine facilities, conflict-zone preparedness measures, and family assistance mechanisms are also underdeveloped.

The central message of the slide is that the welfare gap affecting traditional seafarers is structural and multi-dimensional. As India's maritime sector evolves towards a more inclusive and comprehensive regulatory framework under DGMA, there is an urgent need to extend social protection, compensation mechanisms, and institutional support to this vulnerable segment of the maritime workforce.

Building on the gaps identifiedn the previous slide, this slide presents a proposed **Integrated Social Protection Architecture** for traditional seafarers operating on

mechanized sailing vessels. The framework seeks to establish a comprehensive system covering prevention, protection, compensation, crisis response, and family welfare. Rather than relying on a single welfare payment or isolated intervention, the proposal adopts a layered approach designed to provide support across the entire lifecycle of maritime employment.

The framework begins with **Prevention and Preparedness**, focusing on reducing operational risk before incidents occur. Proposed measures include a standardized certification framework, enhanced training through institutions such as the SV Maritime Training Institute (SVMTI), improved safety equipment, telemedicine integration, health screening protocols, and strengthened Human Resource Administration (HRA) practices. The objective is to improve operational readiness and reduce casualty risks through proactive intervention.

The second layer focuses on **Employment Protection**, introducing a Model Sailing Vessel Employment Agreement (MSVEA) that would formalize employment relationships, define minimum compensation standards, and establish a statutory employment framework. This layer seeks to provide traditional seafarers with protections similar to those available within the merchant shipping sector.

The third layer addresses **Insurance Protection** through mandatory crew insurance mechanisms under Rule 59, supported by government premium assistance and participation from public sector insurers. This would ensure affordable access to risk coverage and improve financial resilience for seafarers and their families.

The fourth layer focuses on **Welfare Protection**, integrating traditional seafarers into existing welfare mechanisms such as SWFS while introducing sickness support, rehabilitation assistance, legal aid, seasonal livelihood support, and family welfare measures. This aims to create a sustainable social security net beyond incident-related compensation.

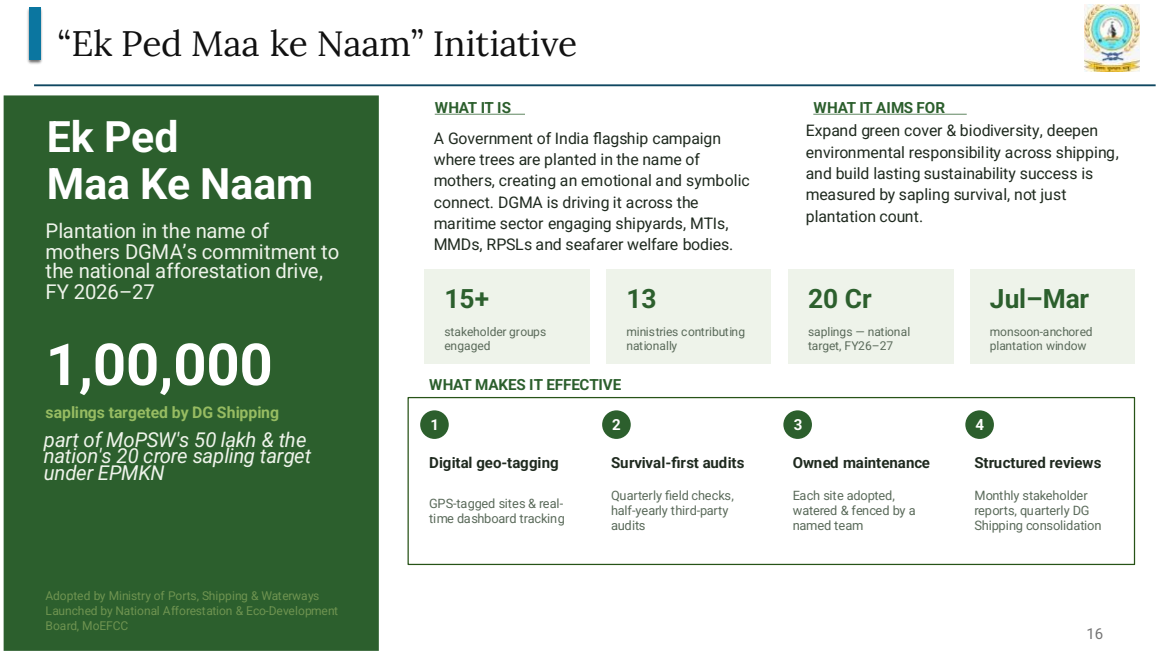
Recognizing the unique risks associated with maritime operations in conflict-prone regions, the framework also proposes a dedicated **Crisis Protection Layer**. This includes a Notified Hostile Maritime Zone (NHMZ) framework, enhanced compensation arrangements, contingency funding mechanisms, and emergency response support for seafarers operating in high-risk waters.

The final layer addresses **Family and Dependent Protection**, extending support to survivors and dependents through healthcare assistance, educational support, counselling services, women seafarer initiatives, and community-level mechanisms such as engagement through Tindal Councils.

Collectively, these measures are intended to achieve compensation parity between traditional seafarers and those employed in the merchant navy. Under the proposed framework, peacetime casualty coverage could increase to approximately ₹51 lakh

through a combination of employment protection, insurance support, and welfare benefits. In hostile maritime zones, compensation levels could increase further through enhanced protection mechanisms. The slide emphasizes that meaningful parity cannot be achieved through a single welfare payment but requires a comprehensive, multi-layered architecture that integrates prevention, insurance, welfare, crisis response, and family support within a unified regulatory framework.

17. “Ek Ped Maa ke Naam” Initiative



17.1. Maritime Sector Participation in India's Afforestation Mission

The “Ek Ped Maa Ke Naam” (EPMKN) initiative is a flagship Government of India campaign that promotes tree plantation in the name of mothers, creating a personal and emotional connection with environmental stewardship. The Directorate General of Maritime Administration (DGMA) has adopted the initiative across the maritime sector, engaging shipyards, maritime training institutes, MMDs, RPSLs and seafarer welfare organizations.

For FY 2026-27, DGMA has set a target of 1,00,000 saplings, contributing to the Ministry of Ports, Shipping and Waterways' afforestation efforts and supporting the national target of 20 crore saplings.

17.2. Sustainability and Stakeholder Engagement

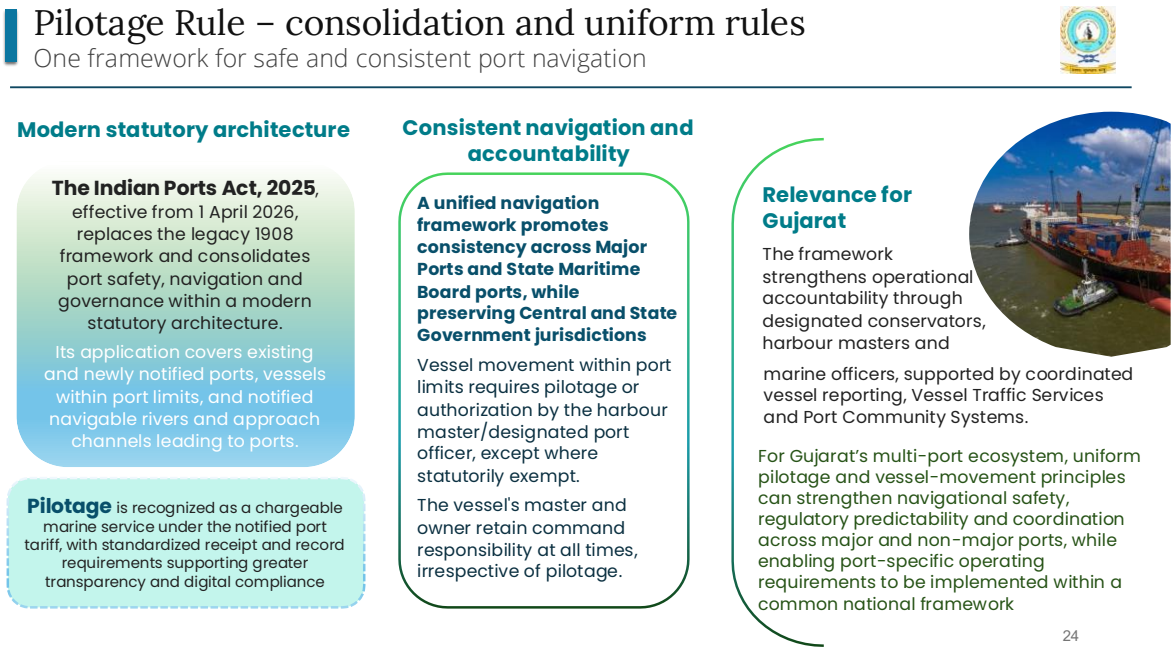
The initiative aims to expand green cover, enhance biodiversity and strengthen environmental responsibility across the maritime ecosystem. More than 15 stakeholder groups are being engaged under the programme, while 13 Ministries are contributing to the national campaign. The plantation drive is planned primarily during the July-March period, aligned with suitable climatic conditions for sapling growth and survival.

A key feature of the programme is its emphasis on long-term sustainability rather than plantation numbers alone. The success of the initiative is intended to be measured through sapling survival, maintenance and environmental impact.

17.3. Monitoring and Implementation Framework

The programme incorporates a structured monitoring framework comprising digital geo-tagging, survival-focused audits, site-level ownership and periodic reviews. GPS-based tagging and dashboard monitoring enable real-time tracking of plantation sites, while field inspections and third-party audits help assess survival rates and maintenance standards.

18. Pilotage Rule - consolidation and uniform rules



18.1. Modernizing the Regulatory Framework

The Indian Ports Act, 2025, effective from 1 April 2026, establishes a modern legal framework for port safety, navigation and governance, replacing the legacy regulatory structure. The Act applies to existing and newly notified ports, vessels operating within port limits and notified navigable channels and waterways leading to ports.

A key feature of the framework is the consolidation of pilotage-related provisions within a single statutory structure, improving regulatory clarity and consistency across ports. Pilotage is recognized as a chargeable marine service, supported by standardized record-keeping and receipt requirements that promote transparency and digital compliance.

18.2. Uniform Navigation and Accountability

The new framework introduces a common set of principles governing vessel movement within port limits across major ports and ports administered by State Maritime Boards. Pilotage or authorization by the harbour master or designated port authority is required for vessel navigation within notified areas, except where statutory exemptions apply.

The framework also clarifies accountability by specifying that, irrespective of pilotage arrangements, the vessel's master and owner continue to retain overall responsibility for the vessel. This approach strengthens operational discipline while ensuring consistency in navigational oversight and safety management.

18.3. Relevance for Gujarat's Multi-Port Ecosystem

For Gujarat, which hosts a large network of major and non-major ports, a uniform pilotage framework can improve navigational safety, operational coordination and regulatory predictability across the maritime sector. The framework strengthens the role of harbour masters, conservators and marine officers while supporting coordinated vessel reporting, Vessel Traffic Services and digital port-management systems.

By creating common national principles while preserving port-specific operational requirements, the pilotage framework supports safer vessel movement and more efficient management across Gujarat's diverse port ecosystem.

19. Establishing GIFT City as a Hub for Maritime Arbitration and Dispute Resolution

19.1. Gujarat International Maritime Arbitration Centre (GIMAC)

The Gujarat International Maritime Arbitration Centre (GIMAC), established by Gujarat Maritime University in GIFT City, Gandhinagar, represents India's first dedicated maritime arbitration centre. The institution has been created to provide specialized dispute resolution services for the maritime, shipping and related commercial sectors, supporting India's ambition to emerge as a global maritime services hub.

19.2. Specialized Maritime Dispute Resolution

GIMAC is designed to provide a range of alternative dispute resolution mechanisms, including arbitration, mediation and expert determination. The centre focuses specifically on maritime and shipping disputes, offering an institutional framework tailored to the unique legal, operational and commercial issues encountered in the maritime sector.

By providing access to specialized dispute resolution services, GIMAC can help reduce reliance on overseas arbitration venues and strengthen India's capacity to resolve maritime disputes within the country.

19.3. Building a Maritime Services Ecosystem

The centre brings together arbitrators, maritime lawyers, industry experts and other stakeholders involved in shipping and maritime commerce. Its location within GIFT City complements broader efforts to develop a comprehensive maritime ecosystem encompassing shipping, finance, leasing and legal services.

The long-term objective is to establish a fast, efficient and internationally benchmarked dispute resolution framework for maritime, commercial and financial conflicts. Such an ecosystem can enhance investor confidence, support contractual certainty and strengthen India's position as a competitive destination for global maritime business and services.

20. Establishing GIFT City as a Hub for Maritime Arbitration and Dispute Resolution

20.1. Gujarat International Maritime Arbitration Centre (GIMAC)

The Gujarat International Maritime Arbitration Centre (GIMAC), established by Gujarat Maritime University in GIFT City, Gandhinagar, represents India's first dedicated maritime arbitration centre. The institution has been created to provide specialized dispute resolution services for the maritime, shipping and related commercial sectors, supporting India's ambition to emerge as a global maritime services hub.

20.2. Specialized Maritime Dispute Resolution

GIMAC is designed to provide a range of alternative dispute resolution mechanisms, including arbitration, mediation and expert determination. The centre focuses specifically on maritime and shipping disputes, offering an institutional framework tailored to the unique legal, operational and commercial issues encountered in the maritime sector.

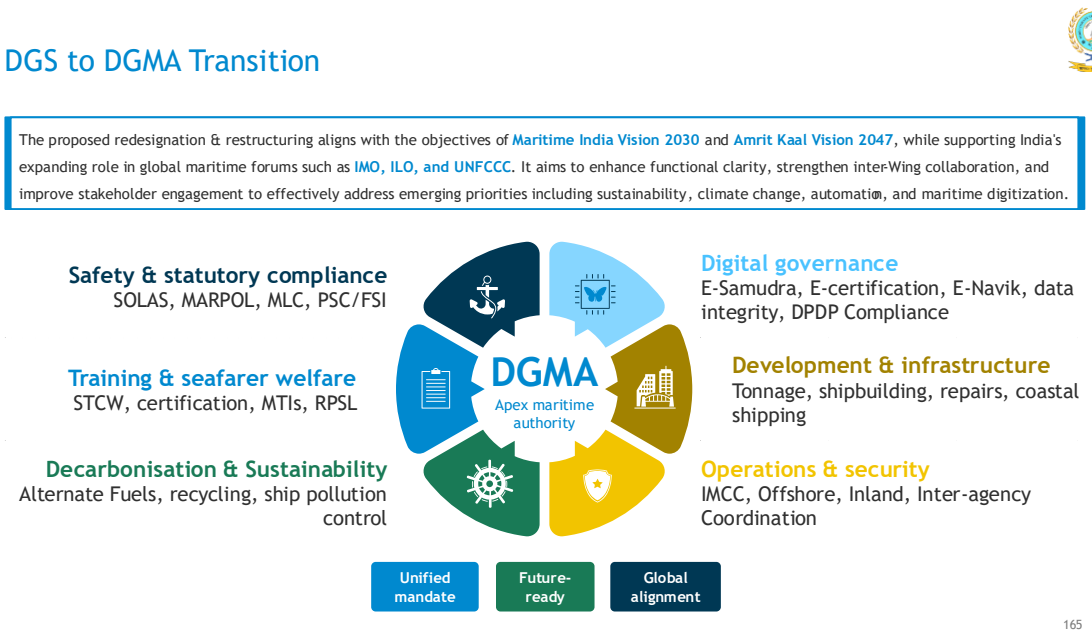
By providing access to specialized dispute resolution services, GIMAC can help reduce reliance on overseas arbitration venues and strengthen India's capacity to resolve maritime disputes within the country.

20.3. Building a Maritime Services Ecosystem

The centre brings together arbitrators, maritime lawyers, industry experts and other stakeholders involved in shipping and maritime commerce. Its location within GIFT City complements broader efforts to develop a comprehensive maritime ecosystem encompassing shipping, finance, leasing and legal services.

The long-term objective is to establish a fast, efficient and internationally benchmarked dispute resolution framework for maritime, commercial and financial conflicts. Such an ecosystem can enhance investor confidence, support contractual certainty and strengthen India's position as a competitive destination for global maritime business and services.

21. DGS to DGMA Transition



The proposed transition from the **Directorate General of Shipping (DGS)** to the **Directorate General of Maritime Administration (DGMA)** is a transformational reform in India's maritime governance architecture. It is not merely a change in nomenclature, but a strategic restructuring intended to create a modern, integrated, technology-enabled, and globally benchmarked maritime administration capable of supporting India's maritime ambitions over the coming decades.

The redesignation is closely aligned with the objectives laid down under **Maritime India Vision 2030 (MIV 2030)** and **Amrit Kaal Vision 2047**, which seek to position India as a global maritime leader, strengthen the blue economy, enhance maritime sustainability, and improve India's competitiveness within the international shipping ecosystem. The existing DGS framework was created under the Merchant Shipping Act, 1958 and was primarily focused on merchant shipping regulation. However, maritime governance today extends far beyond traditional shipping and requires a more holistic institutional mechanism.

The new DGMA structure is therefore envisioned as the apex maritime authority responsible not only for shipping regulation, but also for coordinating broader maritime development, sustainability initiatives, digital governance, maritime safety, security, and international representation. The restructuring will improve organizational clarity, facilitate inter-wing coordination, and create dedicated capacity for emerging maritime

priorities such as decarbonization, digitalization, offshore operations, and climate resilience.

21.1. Key Functional Domains of DGMA

1. Safety and Statutory Compliance

At its core, DGMA will continue to ensure compliance with major international maritime conventions including SOLAS, MARPOL, MLC, Load Line Convention, Ballast Water Management Convention, Anti-Fouling Systems Convention, and other IMO instruments. It will strengthen Port State Control and Flag State Inspection mechanisms while extending oversight beyond traditional merchant shipping to newer categories of maritime assets.

2. Training and Seafarer Welfare

DGMA will oversee standards under the STCW Convention, maritime education and training institutions, seafarer certification systems, welfare measures, recruitment and placement services, and welfare protections for Indian seafarers, including those serving on foreign-flagged vessels. The emphasis will be on creating a globally competitive maritime workforce while ensuring international labour compliance.

3. Decarbonisation and Sustainability

As global shipping transitions toward low-carbon operations, DGMA will play a leading role in promoting green shipping practices, alternate marine fuels, ship recycling compliance under the Hong Kong Convention, pollution control measures, and implementation of evolving IMO greenhouse gas reduction targets. The authority is expected to become a key enabler of India's maritime sustainability agenda.

4. Digital Governance

The future maritime administration will operate through digital-first systems such as e-Samudra, e-Certification, e-Navik, digital licensing systems, maritime databases, dashboards, and electronic compliance mechanisms. These reforms are intended to improve transparency, reduce processing timelines, eliminate paper-based workflows, strengthen data integrity, and support compliance with the Digital Personal Data Protection framework.

5. Maritime Development and Infrastructure

DGMA will support national efforts in shipbuilding, ship repair, coastal shipping, maritime clusters, transshipment hubs, and maritime infrastructure development. This represents a significant broadening of scope compared with the traditional regulatory mandate of DGS.

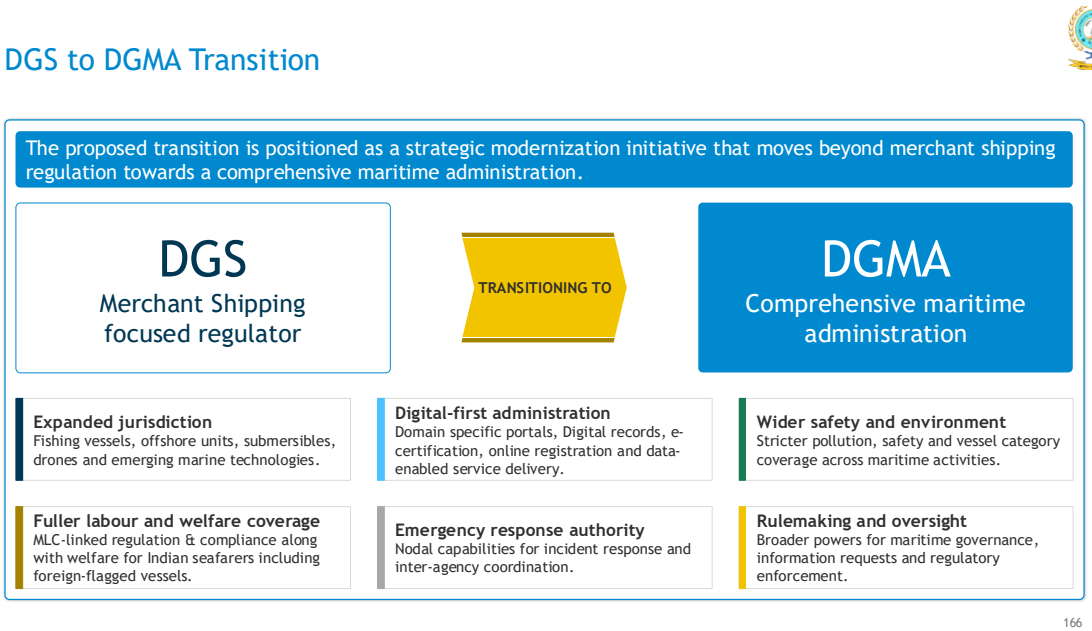
6. Maritime Operations and Security

The authority will also assume a more active role in offshore operations, maritime emergency response, marine incident coordination, inland navigation oversight, and inter-agency maritime coordination. Statutory provisions under the Merchant Shipping Act, 2025 strengthen the maritime administration's ability to coordinate national-level maritime responses.

21.2. Strategic Outcomes

The transition is designed to achieve three strategic outcomes:

- A **Unified Mandate** that integrates fragmented maritime responsibilities under a single apex authority.
- A **Future-Ready Organization** capable of addressing emerging technological, environmental, and operational challenges.
- **Global Alignment** with maritime administrations operating in leading maritime nations such as Singapore, Australia, Norway, and the United Kingdom.



Historically, DGS was designed primarily as a regulatory body for merchant shipping activities. While it has successfully discharged its statutory responsibilities for decades, the maritime sector has rapidly evolved, encompassing offshore operations, digital maritime services, environmental governance, inland waterways integration, maritime

security, and advanced vessel technologies. These new realities require a broader institutional framework than that provided under the Merchant Shipping Act, 1958.

The proposed DGMA therefore represents a modern maritime governance model that aligns with international best practices and provides comprehensive oversight over the entire maritime ecosystem.

Expanded Jurisdiction

One of the most significant changes is the expansion of jurisdiction. Under the Merchant Shipping Act, 2025, the maritime administration will extend oversight beyond traditional merchant vessels to include fishing vessels, offshore units, submersibles, drones, autonomous maritime technologies, and emerging vessel categories. This reflects the changing nature of maritime activities and India's expanding blue economy ambitions.

Digital-First Administration

DGMA will adopt a digital-first governance model through integrated digital platforms supporting registration, certification, compliance monitoring, inspections, licensing, document management, and service delivery. This shift will significantly improve efficiency, transparency, and ease of doing business while reducing administrative burdens on stakeholders.

Wider Safety and Environmental Coverage

Unlike the existing framework, which is heavily centred on merchant shipping, DGMA will adopt a broader maritime safety and environmental governance mandate. Enhanced responsibilities will include pollution response, ballast water management, waste reception facilities, environmental audits, green shipping initiatives, and implementation of international climate commitments.

Fuller Labour and Welfare Coverage

The transition introduces stronger compliance with the Maritime Labour Convention (MLC) and extends labour protections and welfare measures to Indian seafarers serving on foreign-flagged vessels. This significantly enhances India's ability to protect its maritime workforce regardless of vessel registration.

Emergency Response Authority

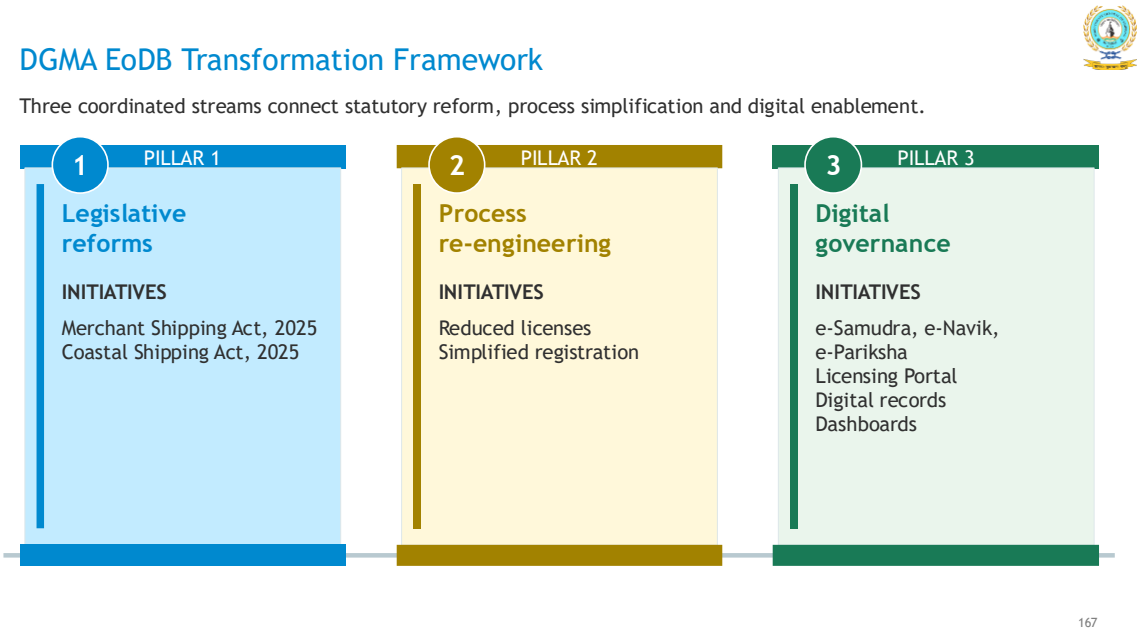
The Merchant Shipping Bill, 2024 provides statutory authority for coordinated maritime incident response and inter-agency resource mobilization. This will enable DGMA to function as a nodal authority during maritime emergencies and environmental incidents, thereby enhancing national preparedness and response capability.

Enhanced Rulemaking and Regulatory Oversight

DGMA will be empowered with broader regulatory and oversight powers covering registration, compliance monitoring, maritime information requests, enforcement actions, and delegated rulemaking. These enhanced powers are intended to support a more responsive and contemporary regulatory framework aligned with international standards.

21.3. Why This Transformation Matters

The transition is essential because India's maritime ambitions now extend far beyond traditional shipping regulation. To achieve the goals of Maritime India Vision 2030 and Amrit Kaal Vision 2047, India requires an institution capable of regulating, developing, coordinating, digitizing, and modernizing the complete maritime ecosystem. DGMA is intended to provide that institutional platform.



The Ease of Doing Business transformation framework outlines how DGMA will modernize maritime governance through three mutually reinforcing pillars: legislative reforms, process re-engineering, and digital governance. These pillars collectively provide the foundation for a simplified, transparent, and technology-enabled maritime administration.

Pillar 1: Legislative Reforms

The first pillar focuses on modernization of the legal framework governing maritime activities.

The recently passed **Merchant Shipping Act, 2025** and **Coastal Shipping Act, 2025** seek to replace legacy provisions with contemporary legislation that reflects modern operational realities, international conventions, technological developments, and environmental obligations. The objective is to establish a comprehensive legal framework capable of supporting future maritime growth while improving regulatory certainty and reducing ambiguities.

Key reforms include:

- Expanded jurisdiction across maritime sectors.
- Enhanced environmental and safety responsibilities.
- Improved labour and welfare protections.
- Greater regulatory flexibility.
- Simplified ownership and registration provisions.
- Stronger enforcement and emergency response mechanisms.
- Decriminalization and rationalization of minor procedural violations where appropriate.

Pillar 2: Process Re-engineering

The second pillar focuses on simplifying regulatory procedures and removing legacy inefficiencies.

Historically, stakeholders have faced lengthy approval timelines, documentation burdens, and fragmented processes. DGMA aims to redesign these processes from first principles to create faster, transparent, stakeholder-centric services.

Key initiatives include:

- Rationalization of licensing requirements.
- Reduction in duplicative approvals and inspections.
- Streamlined vessel registration processes.
- Simplified certification procedures.
- Faster service delivery timelines.
- Improved coordination among maritime agencies and stakeholders.
- Standardized workflows supported by digital tools and dashboards.

The intended outcome is a maritime regulatory environment that promotes investment, reduces compliance costs, and supports India's position as a globally competitive maritime nation.

Pillar 3: Digital Governance

The third pillar focuses on comprehensive digitization of maritime administration.

International best practices indicate that future maritime administrations must be built around integrated digital ecosystems. DGMA intends to develop an end-to-end digital environment that supports regulatory oversight, stakeholder services, data analytics, and evidence-based policymaking.

Major initiatives include:

e-Samudra

A unified maritime platform providing integrated service delivery, application processing, approvals, and stakeholder interfaces.

e-Navik

A digital ecosystem dedicated to seafarer services, certification, training records, competency management, and welfare administration.

e-Pariksha

A digitized examination and assessment framework supporting maritime education and certification processes.

Licensing Portal

An integrated portal supporting online licensing, renewals, approvals, inspections, and compliance management.

Digital Records and Data Governance

Creation of centralized maritime databases enabling seamless access to vessel, seafarer, certification, and regulatory records while improving transparency, accuracy, and data-driven decision-making.

Dashboards and Analytics

Real-time monitoring dashboards will support operational oversight, performance management, policy evaluation, risk identification, and stakeholder service tracking.

Together, these three pillars establish the foundation for an institution that is legally modern, operationally efficient, and digitally empowered. The EoDB framework is

therefore not merely a digitization exercise but a comprehensive governance transformation that supports safety, sustainability, transparency, competitiveness, and maritime sector growth while positioning India to achieve its long-term maritime vision for 2030 and 2047.

22. Suraksha Sarvapratham – Safety in Maritime

The Directorate General of Maritime Administration's "Suraksha Sarvapratham" initiative aims to strengthen maritime safety through prevention, structured incident reporting, root-cause analysis, improved controls, practical training and wider digital learning. The objective is to reduce risks aboard ships and in ports by embedding safety-first behaviour among seafarers, port personnel and other maritime stakeholders.

DGMA seeks support from the Larsen & Toubro facility for practical and experiential Environment, Health and Safety exposure as a limited component of the initiative. The L&T Safety Innovation School at Hazira may be leveraged, where appropriate, to familiarise maritime stakeholders with hands-on safety practices, risk awareness and preventive controls.

The initiative will also use digital learning to expand access to standardised maritime-safety content. A web-based Learning Management System can support online courses, refresher modules and structured awareness programmes, complementing practical training with scalable and continuous learning.

- Prevent accidents and reduce operational risks aboard ships and in ports.
- Standardise incident capture, reporting and review across maritime operations.
- Use root-cause analysis to identify recurring risks and prevent recurrence.
- Strengthen protocols, preventive controls and safety preparedness.
- Promote safety-first behaviour through practical training and digital learning.

Overall, Suraksha Sarvapratham provides a focused framework for improving maritime safety through prevention, reporting, analysis, corrective action and learning. By combining limited experiential exposure through the L&T facility with structured digital courses, the initiative supports a more disciplined and prevention-oriented safety culture across India's maritime ecosystem.

23. Imperative for Maritime Energy Transition

Maritime transport is central to global trade, supply chains and economic development. At the same time, the sector is increasingly required to address greenhouse gas emissions, improve energy efficiency and prepare for a future in which low and zero-emission operations become commercially and operationally necessary. Maritime energy transition, therefore, is not merely an environmental agenda. It is a strategic requirement for ensuring the long-term resilience, competitiveness and sustainability of the maritime ecosystem.

Shipping has traditionally depended on conventional fossil fuels such as heavy fuel oil, marine gas oil and diesel. While these fuels have supported the growth of global trade, continued dependence creates exposure to volatile fuel prices, supply disruptions, import dependence and future compliance risks. It also places the sector under increasing pressure to reduce its greenhouse gas footprint and align with evolving international expectations on cleaner shipping.

The global maritime sector is moving towards decarbonisation through a combination of regulatory measures, market expectations, technological innovation and financial signals. The 2023 IMO GHG Strategy seeks net-zero GHG emissions from international shipping by or around 2050 and includes interim ambitions for 2030 and 2040. It also envisages increasing uptake of zero and near-zero GHG emission technologies, fuels and energy sources. Discussions on the proposed IMO Net-Zero Framework are continuing, including on a global fuel standard and a GHG-pricing mechanism.

This evolving international environment is likely to influence vessel design, fuel selection, ship operations, chartering decisions, access to finance, port infrastructure and future trade competitiveness. Shipping companies that are unable to adapt may

face higher operating costs, reduced market access and greater exposure to regulatory and commercial risks. Conversely, early preparedness can create opportunities for greener fleets, efficient ports, domestic manufacturing, fuel production and new maritime services.

The transition is necessary for five broad reasons.

First, it is essential to reduce greenhouse gas emissions from shipping and associated maritime activities. This includes not only emissions from onboard fuel use but also lifecycle emissions associated with fuel production, transportation, storage and use. A lifecycle approach is important to ensure that emissions are genuinely reduced rather than shifted from ships to other parts of the energy system.

Second, maritime energy transition can strengthen energy security. Diversifying fuel options through sustainable biofuels, green methanol, green ammonia, hydrogen, battery-electric systems and other cleaner technologies can reduce dependence on conventional imported fuels. This is particularly relevant for India, where maritime growth, energy security and domestic green-energy capability must progress together.

Third, the transition is necessary to safeguard the long-term competitiveness of Indian shipping. Future competitiveness will increasingly depend on the ability of vessels and ports to meet efficiency standards, access cleaner fuels, comply with carbon-related requirements and respond to changing expectations from cargo owners, charterers, financiers and international supply chains.

Fourth, the transition can support sustainable economic growth. Development of green-fuel ecosystems, bunkering infrastructure, renewable-energy integration, shipbuilding capability, retrofitting capacity, port electrification, digital systems and specialised skills can generate new economic activity and strengthen domestic maritime capability. It can also create opportunities for Indian ports and coastal regions to emerge as green-fuel production, storage, bunkering and maritime-service hubs.

Fifth, maritime energy transition is necessary to enable a progressive shift towards zero and near-zero emission fuels and technologies. The transition will not follow one uniform pathway. Different vessel segments, routes, operating profiles and port conditions will require different solutions. Energy-efficiency measures, operational optimisation, hull and propulsion improvements, wind-assist technologies, shore power, batteries, hybrid systems and multiple alternative fuels will need to be adopted in a phased and practical manner.

The pathway for transition can broadly be understood in three stages. In the immediate term, the focus should be on improving energy efficiency, optimising operations, reducing fuel consumption and preparing vessels and ports for future requirements. In the medium term, greater deployment of alternative fuels, retrofits, green bunkering

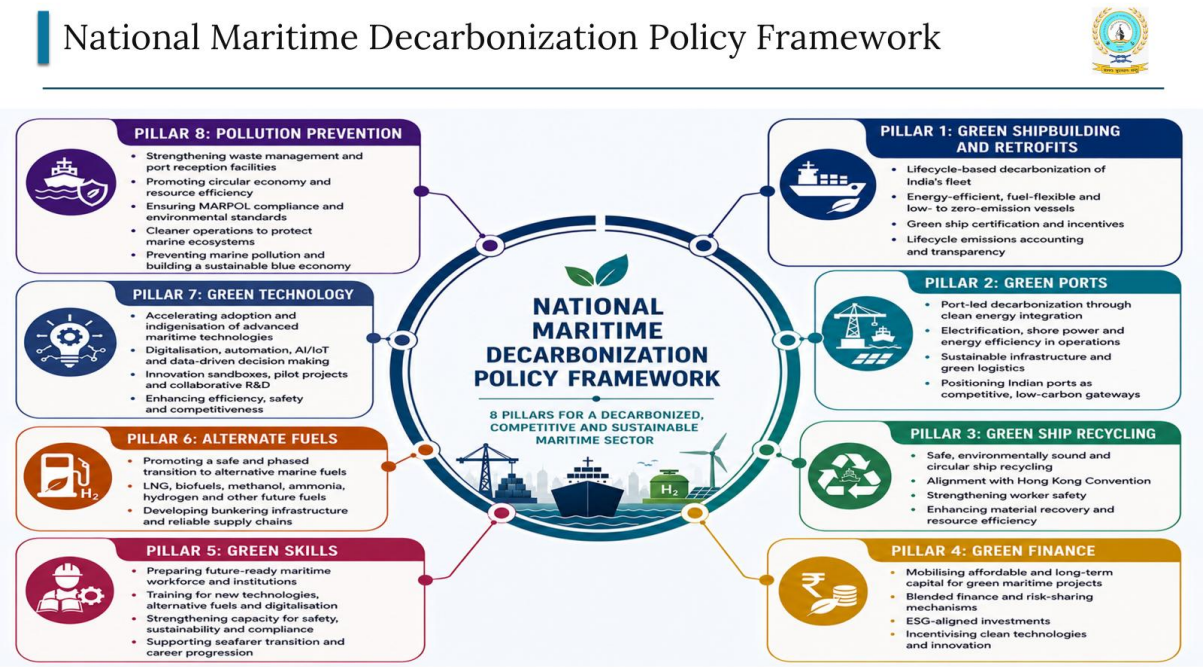
facilities, shore power and digital optimisation systems will be required. In the long term, the objective is to create a net-zero maritime ecosystem supported by cleaner fuels, efficient ships, green ports, reliable infrastructure, skilled personnel and appropriate safety and regulatory frameworks.

Alternative fuels are an important component of this journey, but they are not a standalone solution. Their successful adoption will depend on availability, affordability, safety, lifecycle emissions, storage and bunkering arrangements, vessel compatibility, engine technology, crew training and international standards. The transition must therefore be supported by coordinated action across shipping, ports, shipbuilding, energy, finance, technology, skill development and regulation.

For India, maritime energy transition presents an opportunity to align climate responsibility with national priorities of energy security, Atmanirbhar Bharat, industrial development, port-led growth and Viksit Bharat. It provides a pathway to develop a resilient and future-ready maritime sector that can support trade growth while progressively reducing environmental impact.

The central message is that maritime energy transition should be viewed not as a compliance burden but as a strategic opportunity. A well-planned transition can help decarbonise maritime operations, strengthen energy resilience, improve competitiveness, support innovation and create sustainable economic growth across the maritime value chain.

24. National Maritime Decarbonization Policy Framework



The National Maritime Decarbonization Policy Framework (NMDP) is envisaged as India's umbrella transition framework to systematically decarbonise and green the entire maritime ecosystem. It provides a unified national approach covering ships, ports, marine fuels, shipbuilding and ship repair, ship recycling, green finance, human capital development and digital governance systems, across both coastal and inland waterways.

The NGSP is designed not merely as an environmental policy, but as a strategic transformation instrument that aligns India's maritime growth ambitions with national climate commitments, international regulatory developments and long-term economic competitiveness. It seeks to embed sustainability as a core operational and investment principle across maritime planning, regulation and implementation, rather than treating decarbonisation as a parallel or incremental activity.

Policy Evolution and Development Process

The formulation of the NMDP has followed a phased, consultative and evidence-led approach.

- An initial Consultative Document on the National Green Shipping Policy was developed by Lloyd's Register. This consultative document laid out the preliminary policy landscape, identified gaps in India's green maritime ecosystem and proposed a broad set of policy actions across technology, fuels, ports, finance and regulation. The document was formally released during the Green Shipping Conclave, marking the commencement of structured stakeholder engagement on the proposed policy.
- Building upon this consultative foundation, the draft National Green Shipping Policy was subsequently prepared by TERI – National Centre of Excellence for Green Ports and Shipping (NCoEGPS). This stage involved extensive stakeholder consultations and focused sectoral discussions, covering key maritime verticals including shipping, ports, shipbuilding, ship recycling, green fuels, finance and skill development. Inputs from central ministries, regulators, port authorities, shipowners, shipyards, technology providers, financial institutions, academia and international partners were systematically incorporated to strengthen policy coherence, practicality and implementability.

This two-stage process ensured that the NMDP evolved from a conceptual and gap-identification exercise into a robust, nationally owned draft policy, grounded in stakeholder consensus and aligned with India's developmental and institutional realities.

Role of NMDP as a Convergence Policy

Importantly, the NMDP is not a standalone scheme or isolated programme. It functions as a convergence and integration policy, bringing together multiple existing national visions, guidelines and sectoral initiatives under a single, coherent framework. These include Maritime India Vision 2030, Maritime Amrit Kaal Vision 2047, the Harit Sagar Guidelines and the Green Tug Transition Programme.

By consolidating these initiatives, the NMDP addresses the current fragmentation in India's green maritime landscape, where policies, schemes and pilot projects exist but lack a common definitional basis, emissions baseline, monitoring architecture and implementation sequencing. The policy therefore serves as the principal national reference framework for defining what constitutes "green" in the maritime context, establishing measurable targets, standardised monitoring and reporting mechanisms and enabling coordinated action across ministries, regulators, ports, shipping companies, shipyards and financial institutions.

At a strategic level, the NMDP positions India to pursue a phased, realistic and nationally aligned maritime decarbonisation pathway, balancing developmental

priorities with environmental responsibility, while providing a credible basis for engagement with evolving global maritime decarbonisation frameworks.

Why NMDP Is Imperative Now

The need for a National Maritime Decarbonization Policy Framework (NMDP) has become immediate and unavoidable due to the convergence of global regulatory pressures, domestic policy gaps and India's rapidly expanding maritime footprint. While India has launched several forward-looking green maritime initiatives over the past decade, these efforts remain fragmented, scheme-driven and unevenly implemented, limiting their cumulative impact.

Escalating Global Regulatory and Market Pressures

International shipping is entering a decisive phase of decarbonisation. The International Maritime Organization (IMO), through its Revised GHG Strategy (2023), has committed to achieving net-zero greenhouse gas emissions from international shipping by or around 2050, with interim targets for 2030 and 2040. These developments are being reinforced by emerging market-based measures, fuel standards and emissions reporting requirements across major trading blocs.

In the absence of a comprehensive national framework, Indian shipping, ports and maritime service providers risk:

- Regulatory misalignment with global standards
- Higher compliance costs and trade frictions
- Reduced competitiveness of Indian-flag vessels and ports

The NGSP is therefore required to provide policy certainty, regulatory preparedness and strategic alignment, enabling Indian maritime stakeholders to anticipate and adapt to evolving international obligations in a coordinated manner.

Fragmentation of Domestic Green Maritime Initiatives

India has already initiated several important green maritime measures, including the Harit Sagar Guidelines, the Green Tug Transition Programme, ship recycling reforms and pilot green fuel projects at select ports. However, these initiatives currently operate as standalone interventions, without a common framework for:

- Defining what constitutes a "green ship", "green port" or "green fuel"
- Establishing national emissions baselines across ships, ports and inland waterways
- Standardising Monitoring, Reporting and Verification (MRV) systems
- Sequencing short-term, medium-term and long-term decarbonisation actions

This fragmentation constrains scale-up and dilutes accountability. The policy is imperative to unify these disparate efforts into a single national transition architecture, ensuring coherence across policies, programmes and investments.

Scale and Growth of India's Maritime Sector

India's maritime sector underpins nearly 95% of the country's trade by volume and continues to expand rapidly, supported by major investments in ports, inland waterways, coastal shipping and shipbuilding. With new mega ports, industrial clusters and logistics corridors under development, the carbon footprint of maritime activities is set to increase sharply if sustainability is not embedded at the planning stage.

Without a guiding national policy:

- Infrastructure investments risk locking in carbon-intensive pathways
- Retrofitting costs will rise over time
- Opportunities for early adoption of clean technologies may be missed

The policy is therefore critical to mainstream decarbonisation at the design, procurement and investment stages, rather than treating it as a post-facto corrective measure.

Alignment with India's National Climate Commitments

India's climate commitments under the Panchamrit framework and the Long-Term Low Emission Development Strategy (LT-LEDS) set a national net-zero target for 2070. However, the maritime sector requires a sector-specific transition pathway to translate these economy-wide goals into actionable measures for ships, ports and fuels.

The policy bridges this gap by:

- Translating national climate commitments into maritime-specific targets
- Aligning domestic timelines with global maritime decarbonisation trajectories
- Providing a calibrated and development-sensitive transition pathway

In doing so, it ensures that India's maritime decarbonisation efforts are credible, measurable and nationally appropriate.

Enabling Green Finance and Investment Readiness

The transition to green shipping will require significant capital mobilisation for new vessels, retrofits, alternative fuel infrastructure, renewable energy integration and digital systems. Global climate finance, sustainability-linked lending and green bonds are

increasingly tied to clear policy signals, measurable outcomes and robust governance frameworks.

In the absence of a national policy:

- Investors face uncertainty and higher perceived risks
- Access to international green finance remains constrained
- Domestic financial institutions lack clear guidance on eligibility and metrics

The NMDP is imperative to establish the policy and institutional foundations for green maritime finance, de-risking investments and enabling access to domestic and international capital.

Strategic Opportunity for Global Leadership

Finally, the timing of the NMDP presents a strategic opportunity. India is simultaneously:

- Expanding its maritime and port infrastructure
- Scaling renewable energy capacity
- Emerging as a leader in ship recycling and green fuel potential

By acting now, India can move from being a policy follower to a rule-shaper in global green shipping, positioning itself as a credible hub for green vessels, green fuels and sustainable maritime services.

In essence, the NMDP is imperative now because delay would increase transition costs, fragment action and weaken India's strategic positioning, whereas timely adoption enables a coordinated, cost-effective and globally aligned green maritime transition.

NMDP Objectives and Pillar Architecture

Core Objectives of the National Maritime Decarbonization Policy Framework

The National Maritime Decarbonization Policy Framework (NMDP) articulates a set of clear, interlinked objectives aimed at guiding India's maritime sector through a phased, measurable and inclusive green transition. These objectives serve as the operational foundation for all actions undertaken under the policy.

The key objectives of the NMDP are to:

Decarbonise India's maritime sector in a structured and time-bound manner
The NMDP seeks to progressively reduce greenhouse gas emissions across ships, ports, fuels and associated maritime activities, while aligning domestic action with India's national climate commitments and evolving international maritime decarbonisation frameworks.

Establish a common national definition and standards for "green" maritime activities

A core objective of the policy is to define, standardise and operationalise what constitutes a *green ship*, *green port* and *green fuel*, using measurable, auditable and lifecycle-based criteria. This is intended to remove ambiguity and enable consistency across regulation, procurement, certification and financing.

Create a robust governance, monitoring and reporting framework

The NMDP aims to institutionalise national emissions baselines, Monitoring Reporting and Verification (MRV) systems and performance assessment mechanisms, ensuring transparency, accountability and data-driven decision-making across the maritime ecosystem.

Enable investment and de-risk the green maritime transition

Recognising the scale of capital required, the policy seeks to unlock domestic and international green finance by providing policy certainty, standardised metrics and institutional mechanisms that reduce risk for investors, shipowners, ports and technology providers.

Promote technology adoption, innovation and indigenisation

The NMDP encourages the adoption of clean and energy-efficient maritime technologies while supporting domestic manufacturing, research and innovation in areas such as alternative fuels, propulsion systems, digital solutions and emissions reduction technologies.

Ensure a just, inclusive and capacity-driven transition

The policy explicitly integrates human capital development, green skilling and inclusion of MSMEs, informal operators and coastal communities, ensuring that the benefits of the green transition are equitably distributed.

Pillar Architecture of the NMDP

To operationalise these objectives, the NMDP is structured around a multi-pillar architecture, with each pillar addressing a critical dimension of the maritime ecosystem. The pillars are designed to function interdependently, enabling coordinated implementation rather than isolated interventions.

The NMDP pillar framework comprises:

1. Green Shipbuilding and Retrofits

This pillar focuses on decarbonisation of vessels across coastal, inland and international shipping segments, including shipbuilding and ship repair. It addresses

green ship standards, retrofitting, new builds, emissions monitoring, certification and financial incentives for cleaner vessels.

2. Green Ports

The Green Ports pillar targets reduction of emissions and environmental impacts at ports and terminals through renewable energy integration, energy efficiency, electrification, shore-to-ship power, waste management, digital monitoring and green port certification mechanisms.

3. Green Ship Recycling

The Green Ship Recycling pillar aims to strengthen environmentally sound and safe ship recycling practices, aligned with international conventions and domestic regulations, while promoting circularity, transparency and occupational safety.

4. Green Finance

This pillar focuses on mobilising and de-risking capital for green maritime investments through dedicated funds, sustainability-linked finance instruments, incentives, subsidies and blended finance mechanisms aligned with measurable performance outcomes.

5. Green Skills

This pillar addresses the workforce dimension of the transition by strengthening green skilling, certification, training and institutional capacity across seafarers, port workers, shipyard personnel, regulators and allied maritime professionals.

6. Alternate Fuels

This pillar supports the transition from conventional marine fuels to low- and zero-carbon alternatives such as biofuels, LNG, green hydrogen, ammonia and methanol. It covers fuel standards, lifecycle emissions assessment, bunkering infrastructure, green corridors and fuel transition pathways.

7. Green Technology

The Green Technology pillar promotes adoption and indigenisation of clean maritime technologies, including propulsion systems, energy storage, emissions reduction solutions and digital tools. It also emphasises research, development and international technology collaboration.

8. Pollution Prevention

Preventing Marine Pollution and building sustainable blue economy. Strengthening waste management and port reception facilities, Ensuring MARPOL Compliance and environmental standards. Cleaner operations to protect marine ecosystem.

Relevance of the Pillar Architecture for Implementation

The pillar-based structure allows the NMDP to be **translated into actionable programmes, timelines and responsibilities**, while enabling coordination across ministries, regulators, ports, shipping companies, shipyards, financial institutions and technology providers. It also facilitates **tracking, monitoring and course correction** by clearly mapping actions, stakeholders and outcomes to specific thematic pillars.

25. Alternative Fuels for Maritime

Global Transition Imperative in Maritime Fuels

The global maritime sector is undergoing a structural and irreversible transition driven by the convergence of tightening international climate regulations, rapid technological evolution and shifting fuel economics. Shipping, which has traditionally relied on energy-dense fossil fuels, is now subject to explicit decarbonisation pathways that fundamentally alter how vessels are designed, operated and fuelled.

A critical inflection point in this transition is the adoption of the IMO Net-Zero Framework by the International Maritime Organization, which operationalises global decarbonisation objectives through binding regulatory instruments. Central to this framework is the introduction of mandatory Greenhouse Gas Fuel Intensity (GFI) requirements, assessed on a well-to-wake lifecycle basis, covering emissions from fuel

production, transport and onboard use. This marks a decisive shift away from earlier, predominantly efficiency-based measures toward a fuel-centric regulatory regime.

Under this emerging framework, fuel choice becomes the primary determinant of regulatory compliance. Unlike earlier phases of maritime environmental regulation, where incremental efficiency improvements could offset emissions growth, the new regime directly links compliance status, financial exposure and operational flexibility to the carbon intensity of the fuel used. As a result, vessels relying on conventional fossil marine fuels are increasingly exposed to:

- escalating compliance costs
- reduced commercial attractiveness
- long-term asset obsolescence

Consequently, conventional marine fuels such as heavy fuel oil and marine diesel oil are expected to be progressively displaced over the coming decades by low-carbon and zero-carbon alternatives, including biofuels and hydrogen-derived fuels. In this context, fuel transition has emerged as the single most critical decarbonisation lever for shipping, outweighing incremental gains from hull design, operational optimisation or energy efficiency measures alone.

This global transition imperative establishes the foundational context for national and sectoral strategies on alternate fuels for maritime applications, requiring countries to align domestic fuel pathways with evolving international regulatory trajectories while managing economic, safety and technological constraints.

Indian Maritime Context and Rationale for a Multi-Fuel Pathway

India’s maritime ecosystem is characterised by significant heterogeneity across vessel types, operational profiles, trade routes and fleet age. The national fleet spans inland waterway vessels, coastal and short-sea shipping, offshore support vessels and deep-sea ocean-going vessels (OGVs), each operating under distinct technical, economic and regulatory constraints. This diversity inherently limits the feasibility of a uniform fuel transition pathway.

The Future Fuel Strategy prepared by the Indian Register of Shipping (IRS) and the Advanced Green Fuels Road Map for Maritime Applications led by Dr Piyali Das under TERI–NCoEGPS both converge on the assessment that a single-fuel transition pathway is neither technically viable nor economically optimal for India. Instead, fuel choices must be tailored to vessel size, engine configuration, operating range, voyage duration and refuelling frequency.

The analyses highlight that short-sea, coastal and inland vessels operate under markedly different conditions compared to deep-sea OGVs. These segments typically involve shorter voyage lengths, frequent port calls and smaller engine capacities, which allow for earlier adoption of certain alternate fuels and technologies. In contrast, OGVs face stringent energy density requirements, long endurance needs and limited refuelling opportunities, constraining near-term fuel choices and pushing zero-carbon fuel adoption further into the medium and long term.

Further, the existing fleet composition presents a critical constraint. A substantial proportion of India's operational fleet comprises vessels that were not designed for zero-carbon fuels, making immediate large-scale conversion economically prohibitive. Both IRS and TERI assessments therefore emphasise the necessity of transitional fuel solutions—such as blend fuels and drop-in alternatives—to enable near-term regulatory compliance while avoiding premature asset stranding.

In this context, India's maritime fuel transition is framed as a phased, portfolio-based approach, rather than a linear or single-fuel shift. This approach balances:

- near-term compliance requirements under evolving international regulations
- medium-term technology maturation and infrastructure development and
- long-term decarbonisation objectives aligned with zero-carbon fuels

Such a pathway allows India to manage regulatory risk, control transition costs and progressively align its maritime sector with global decarbonisation trajectories, while remaining responsive to domestic operational realities.

Transitional Fuels and Near-Term Compliance Options

25.1. Fossil-Liquefied Natural Gas (LNG)

Fossil-based LNG is recognised in the NMDP and associated consultative material as a **transitional marine fuel,** offering limited greenhouse gas intensity benefits relative to conventional marine fuels but not constituting a net-zero solution in the long term.

The policy framing reflects international regulatory developments under the IMO, particularly the shift toward well-to-wake greenhouse gas accounting, under which the climate benefits of fossil LNG are constrained by **upstream methane emissions and lifecycle impacts**. As a result, LNG is positioned within NMDP as an **intermediate compliance pathway**, whose long-term acceptability depends on a transition toward bio-LNG or synthetic LNG rather than continued reliance on fossil LNG.

From a lifecycle perspective, fossil LNG can exhibit lower greenhouse gas fuel intensity than heavy fuel oil under specific conditions, particularly when used in high-pressure dual-

fuel engines with minimal methane slip and low upstream leakage. Well-to-wake assessments typically place fossil LNG between approximately **65 and 100 gCO_2eq/MJ, compared to 90–94 gCO_2eq/MJ for HFO**, with outcomes highly sensitive to engine technology and methane slip rates.

While this differential enables near-term compliance gains, it remains insufficient to meet post-2040 and net-zero trajectories without carbon-neutral sourcing or offset mechanisms. This technical limitation underpins NMDP's **explicit avoidance of LNG as an end-state fuel**.

Fuel	Approx. GFI (gCO_2eq/MJ)
HFO	~90-94
LNG	~65-100
Bio-methanol	~9–17
Green ammonia	~3–12

National future fuel assessments referenced in the NMDP documentation further reinforce LNG's transitional status. For Indian shipping, LNG demand is projected to decline over time, reflecting tightening international regulations and the increasing role of hydrogen-derived fuels. While LNG retains relevance in the near term due to existing engine technology, operational familiarity and partial infrastructure availability, the policy framework anticipates that continued use of LNG beyond the medium term will require a shift toward bio-LNG or synthetic LNG to remain compliant with international decarbonisation pathways.

Key Policy Signals on LNG:

- Fossil-LNG is acknowledged as a **lower-carbon alternative to conventional marine fuels**, but not a zero- carbon fuel.
- Its role is explicitly framed as **transitional, supporting early emissions reduction** while alternative fuels mature.
- LNG's long-term compatibility with IMO net-zero targets is conditional on **green or bio-based sourcing.**
- Methane slip and **upstream emissions** limit LNG's effectiveness under well-to-wake GHG accounting.
- Policy emphasis **shifts progressively away from fossil LNG** toward methanol, hydrogen and ammonia pathways.
- Ports and shipowners are cautioned against **long-term lock-in risks** associated with LNG-specific infrastructure and assets.

25.2. Biofuels

Biofuels are recognised in the NDMP as **critical near-term and transitional solutions** for reducing greenhouse gas emissions from shipping, particularly during the early phases of fuel transition. Their policy relevance stems from their **compatibility with existing vessel engines** and fuel handling systems, enabling

emissions reduction **without requiring immediate fleet replacement** or large-scale retrofitting. Within the NDMP framework, biofuels are positioned as an enabling pathway that supports early compliance with evolving IMO greenhouse gas fuel intensity requirements while longer-term zero-carbon fuels mature.

From a lifecycle emissions perspective, biofuels demonstrate **substantially lower well-to-wake greenhouse gas intensity** compared to conventional marine fuels. Assessments referenced in the consultative process indicate that **biodiesel and bio-methanol achieve GFI values in the range of approximately 10-30 gCO_2eq/MJ**, depending on feedstock and production pathway, compared to **~90-95 gCO_2eq/MJ for heavy fuel oil**. This differential allows biofuels to deliver meaningful emissions reductions within existing technical constraints, reinforcing their role as an early-stage compliance option under GFI-based regulatory regimes.

For India, biofuels are particularly relevant in the near to medium term due to **domestic feedstock availability, alignment with waste-to-energy and circular economy objectives and comparatively lower infrastructure complexity**. While biofuels alone are not sufficient to achieve net-zero emissions by mid- century, the policy framework recognises their role in **reducing cumulative emissions, building operational experience and mitigating transition risks** during the early phases of decarbonisation.

Below table summarises the compatibility and infrastructure requirements for biofuels:

Parameter	Biofuels
Engine compatibility	Compatible with existing ICEs (subject to OEM limits)
Vessel modification	Not required for low-percentage blends
Fuel storage	Existing liquid fuel tanks usable
Bunkering systems	Existing liquid bunkering infrastructure
Safety classification	Comparable to conventional liquid fuels
Port readiness requirement	Low incremental change

Key Policy Signals on Bio-fuels:

Biofuels such as biodiesel and renewable diesel as well as e-FT diesel are treated as **transition fuels** and are not considered long-term zero-carbon fuels.

Reported well-to-wake greenhouse gas fuel intensity values for biofuels range from **approximately 9 to 17 gCO_2/MJ**, depending on the feedstock and production method.

Biofuels are mainly considered for **blended or drop-in use**, rather than as sole propulsion fuels.

Long-term decarbonisation will require a move to e-hydrogen, with biofuels playing a supporting role during the transition period.

The use of biofuels requires **clear sustainability criteria and lifecycle emissions accounting** to ensure that greenhouse gas reductions are credible.

Green Ammonia

Ammonia is identified as a long-term zero-carbon fuel option for maritime transport, particularly in the context of achieving deep decarbonisation consistent with international net-zero trajectories. The policy framework treats ammonia as a fuel that will require **significant lead time for technology maturation, safety standardisation and infrastructure development** and therefore positions it primarily in the medium to long term. Only ammonia produced using **renewable electricity and green hydrogen pathways** is considered compatible with long-term decarbonisation objectives. Fossil-derived ammonia does not provide meaningful lifecycle greenhouse gas reductions and is therefore not aligned with net-zero pathways.

From an energy and fuel characteristics perspective, ammonia exhibits a substantially lower energy density than conventional marine fuels. On a mass basis, the lower calorific value of ammonia is approximately **18.6–18.9 MJ/kg**, compared to **~41–44 MJ/kg for HFO and MGO**, implying a requirement of roughly **2.2–2.3 times more fuel by mass** to deliver equivalent energy. More critically for ship design, liquid ammonia has a volumetric energy density of only **~12–13 MJ/L**, versus **~35–40 MJ/L for HFO/MGO**, resulting in a need for approximately **three times the onboard fuel storage volume**. This significant volumetric penalty has direct implications for vessel layout, tank integration and cargo capacity, reinforcing ammonia's positioning as a medium- to long-term fuel option requiring purpose-built vessels and dedicated infrastructure.

This has direct implications for ship design, cargo capacity and retrofitting feasibility, making ammonia more suitable for **newbuild vessels** rather than retrofits in most cases. The document also notes that ammonia combustion presents challenges related to **ignition, flame speed and NOx formation**, which are currently being addressed through engine development, dual-fuel concepts and after-treatment systems.

Currently, ammonia is considered at a **lower technology readiness level compared to LNG and methanol**, with commercial-scale marine engines still under development and early demonstration. As a result, ammonia is treated as a **medium- to long-term fuel option**, with near-term activity expected to focus on **pilots, test vessels and controlled deployment** rather than widespread adoption. The document emphasises that regulatory frameworks, classification rules and international safety standards for ammonia as a marine fuel are still evolving.

Combustion of ammonia can result in **nitrous oxide (N_2O)** emissions, a potent greenhouse gas with a high **global warming potential**, which may materially affect lifecycle greenhouse gas intensity. This risk applies irrespective of whether ammonia is fossil-derived or produced via renewable hydrogen pathways. **Effective mitigation** of N_2O emissions through engine design, combustion control and exhaust after-treatment remains unproven at commercial marine scale, reinforcing the need for **extensive testing and validation** before ammonia can be considered fully aligned with net-zero objectives.

Key Policy Signals on Ammonia:

- The **energy density of ammonia is significantly lower than conventional marine fuels**, resulting in substantially higher onboard fuel storage volume requirements to achieve equivalent range, with direct implications for ship layout and payload capacity.
- Marine engine technology capable of operating on ammonia is **still under development**, with current designs addressing challenges related to **high ignition temperature, low flame speed and combustion stability**.
- Combustion of ammonia leads to **elevated nitrogen oxide (NOx) emissions**, necessitating the use of advanced combustion control strategies and exhaust after-treatment systems to comply with emission limits.
- Retrofitting existing vessels for ammonia use is assessed as **technically complex and economically challenging**, due to fuel storage requirements, material compatibility and safety system integration, making ammonia more suitable for **newbuild vessels**.
- Ammonia is **toxic and corrosive**, requiring dedicated containment systems, continuous leak detection, ventilation, emergency shutdown mechanisms and enhanced crew training to manage operational and safety risks.
- While ammonia is widely handled in industrial applications, **marine fuel use introduces additional risks** related to confined spaces, vessel motion and port interface operations, requiring marine-specific safety standards and procedures.
- **Bunkering and port infrastructure for ammonia as a marine fuel are currently limited**, with requirements for specialised storage tanks, transfer systems, safety exclusion zones and emergency response arrangements.
- Regulatory frameworks, classification rules and international standards for ammonia as a marine fuel are **still evolving**, indicating the need for pilot projects and phased deployment prior to large-scale adoption.

25.3. Green Methanol

Methanol is considered under the NGSP as a **transition fuel that can be deployed at**

scale earlier than hydrogen and ammonia, while still contributing to greenhouse gas reduction when sourced from e-pathways. Its relevance lies in the availability of commercial marine engine technology, simpler storage and handling requirements and compatibility with existing liquid fuel logistics. The policy does not treat methanol as a final zero-carbon fuel, but as an intermediate option that supports phased decarbonisation and reduces transition risk.

The GHG performance of methanol is **directly determined by its production pathway**. Fossil-based methanol does not provide material well-to-wake greenhouse gas reductions and is therefore not aligned with long-term decarbonisation objectives under the NGSP. In contrast, **bio-methanol and green methanol** demonstrate substantially lower lifecycle emissions, with reported greenhouse gas fuel intensity values in the range of **approximately 5-25 gCO_2eq/MJ**, depending on feedstock and production route, compared to **91-95 gCO_2eq/MJ for heavy fuel oil**. Accordingly, only bio-based and renewable methanol pathways are considered relevant for emissions reduction under GFI-based regulatory frameworks.

From an operational and infrastructure perspective, methanol is handled as a liquid fuel at ambient temperature and pressure, eliminating the need for cryogenic storage or high-pressure systems. This enables the use of storage tanks and bunkering arrangements broadly similar to those employed for conventional liquid marine fuels, subject to additional safety provisions related to toxicity and flammability. From an energy standpoint, the lower calorific value of methanol is approximately **19.9–20 MJ/kg**, compared to **~41–44 MJ/kg for HFO and MGO**, meaning methanol contains **around 50–55% less energy per unit mass**. This lower mass-based energy content, combined with methanol's lower density, results in a volumetric energy density of only **~15–16 MJ/L**, versus **~35–40 MJ/L for HFO/MGO**. Consequently, vessels operating on methanol require substantially higher onboard fuel volumes to achieve equivalent range, leading to increased tank space requirements and potential impacts on vessel layout, payload capacity and retrofit feasibility.

25.4. Green Hydrogen as a Marine Fuel

Hydrogen is considered in alternative fuels studies as a **zero-carbon fuel option**, either for direct use onboard vessels or as a **primary energy carrier for hydrogen-derived fuels**. It produces no carbon dioxide at the point of use. Its relevance to maritime decarbonisation is therefore linked to its ability to achieve **very low well-to-wake greenhouse gas emissions**, provided that hydrogen is produced from electrolysis of water using renewable electricity (or nuclear based electricity). Renewable hydrogen and RFNBO (Renewable Fuels of Non-Biological Origin) compliant e-methanol and e-ammonia represent the long-term net-zero pathway. Bio-based methanol and ammonia may play a limited transitional role where sustainable biomass is available, but face scalability constraints.

Hydrogen can be stored onboard vessels either as **compressed gas** or as **liquid hydrogen**. Compressed hydrogen is typically stored at pressures of **350–700 bar**, while liquid hydrogen requires storage at **−253°C**. Both storage options impose significant design and operational constraints compared to conventional marine fuels. Hydrogen has a **high gravimetric energy density (approximately 120–142 MJ/kg)**, but a **very low volumetric energy density**, resulting in large fuel storage volumes and reduced vessel range for a given tank size.To deliver the same energy as conventional fuel oil, **compressed hydrogen at 700 bar requires approximately five to six times the storage volume**, while **liquid hydrogen requires approximately four to five times the storage volume**. These volume penalties directly affect vessel layout, cargo capacity and retrofit feasibility, making hydrogen more suitable for **newbuild vessels or short-range applications**.

Hydrogen propulsion can be achieved using **internal combustion engines adapted for hydrogen** or **fuel cell systems**. Marine hydrogen internal combustion engines remain under development, while fuel cell systems have reached early commercial deployment for **inland waterways and short-sea vessels**. The studies note that hydrogen combustion and handling introduce additional safety considerations due to its **wide flammability range** (approximately 4–75 %by volume in air) and **low ignition energy**, requiring stringent containment, ventilation and detection systems.

Port and bunkering infrastructure for hydrogen is assessed as **limited at present**. Dedicated storage, transfer systems, safety exclusion zones and emergency response arrangements are required. As a result, hydrogen deployment is expected to follow a **pilot-led and phased approach**, aligned with the development of standards, crew training and port readiness.

Additionally, India is stepping up its green energy transition with the development of a Hydrogen Hub under the National Green Hydrogen Mission, which aims to produce and export around 5 million tonnes of green hydrogen over the next five to six years. The initiative is a key part of India's long-term strategy to achieve net-zero carbon emissions by 2070. On January 28th, 2026 Deendayal Port Authority, Kandla, has signed an agreement with energies company, for the design, supply, installation, testing and commissioning of 5 MW Green Hydrogen Plant at Deendayal Port, Kandla.[1]

Key Signals on Hydrogen

- Hydrogen is recognised as a **clean fuel aligned with long-term decarbonisation goals**
- The policy treats hydrogen as part of a **phased transition**, with early focus on pilots, demonstrations and standards development.
- Hydrogen deployment is explicitly linked to **national green hydrogen**

production and renewable energy availability.

- Port and bunkering infrastructure for hydrogen are to be developed **progressively**, alongside safety and regulatory frameworks.

25.5. Battery Electric Energy

Battery electric propulsion is considered P as a **near-term decarbonisation solution for specific vessel segments**, particularly those operating on **short, fixed routes with predictable duty cycles**. The policy recognises that battery electric systems eliminate direct fuel combustion onboard and therefore produce **zero emissions at the point of use**, while overall emissions performance depends on the carbon intensity of grid electricity used for charging.

The NGSP positions battery electric energy as **segment-specific rather than fleet-wide**, due to limitations related to energy density, vessel range, charging time and grid interface requirements. As a result, battery electric propulsion is primarily associated with **inland waterways vessels, ferries, harbour craft, tugs and short-sea coastal operations**, where daily return-to-base operations enable controlled charging.

Battery systems are addressed within the broader framework of **electrification of maritime operations**, alongside shore power and port-side electrification. The policy links battery adoption to port readiness, grid capacity and renewable electricity integration, rather than treating it as a standalone fuel pathway.

25.6. National Green Hydrogen Mission – Enabling Ecosystem

India's long-term maritime fuel transition is underpinned by the National Green Hydrogen Mission, launched in 2023.

- India targets 5 MMT of green hydrogen production annually by 2030
- Green hydrogen is defined using a lifecycle emissions threshold of ≤2 kg CO_2e per kg H_2
- Deendayal Port Authority, V.O. Chidambaranar Port Authority and Paradip Port Authority have been designated as Green Hydrogen Hubs
- Port-based pilot projects have been commissioned to support early adoption

These initiatives establish the upstream production, certification and infrastructure base required for hydrogen-derived maritime fuels.

Alignment with the National Maritime Decarbonization Policy Framework

The National Maritime Decarbonization Policy Framework integrates the above technical assessments into a national policy framework by:

- Recognising blend fuels as near-term compliance solutions
- Positioning methanol and ammonia as long-term decarbonisation fuels
- Linking fuel transition with port infrastructure, safety regulation, finance and skill development

NMDP thus functions as the policy convergence layer, translating evidence-based fuel roadmaps into coordinated national action.

25.7. Alternative Fuels Properties Comparison

Parameter	E-LNG	Methanol	Ammonia	Hydrogen
Physical properties for storage	Liquid at −162 °C	Liquid (up to 65 °C)	Liquid at −33 °C	Compressed gas at > 250 bar or liquid at −253 °C
Fuel tank size for same energy content as MDO	1.8 times	2.5 times	3 times	5–7 times
Flammability limits in air (%V/V)	5%–15% (Methane)	6%–36.5%	15%–28%	4%–75%
Ignition temperature (°C)	595	464	630	560
Flashpoint (°C)	−188	12	132	—

Density of liquid phase (kg/m^3)	450	790	696	71
LCV (MJ/kg)	50	19.9	18.6	120
Energy density (MJ/L)	21.2	15.7	12.7	8.5

26. Alternative Fuel Transition : Challenges and Safety Considerations

The transition towards alternative fuels is a critical component of maritime decarbonisation. However, it is not a simple substitution of conventional marine fuels with cleaner alternatives. It requires coordinated development across ships, ports, fuel production, storage, transportation, bunkering systems, regulations, safety procedures and human capability.

The maritime sector is exploring multiple fuel pathways, including LNG, sustainable biofuels, methanol, ammonia and hydrogen. Each fuel offers different emissions-reduction potential, technical characteristics, infrastructure requirements and safety implications. Therefore, a one-size-fits-all approach is not suitable. Fuel choices will depend on vessel type, route, operational profile, fuel availability, port readiness, technology maturity and lifecycle emissions performance.

The transition must be supported by a safe, reliable and resilient fuel ecosystem from production to shipboard use.

Ships and Propulsion Systems

Alternative fuels require changes in vessel design, propulsion systems, fuel storage arrangements and onboard operating procedures. Depending on the selected fuel, ships may require new engines, dual-fuel engines, dedicated fuel tanks, fuel-conditioning systems, ventilation arrangements, gas detection systems and fire protection measures.

For existing vessels, retrofit feasibility will depend on available space, tank configuration, engine compatibility, cost, remaining vessel life and operational requirements. For newbuild vessels, early design-stage decisions are important because fuel choice affects hull arrangement, cargo capacity, safety systems, machinery layout and future flexibility.

The transition should therefore encourage both retrofit solutions for the existing fleet and future-ready designs for new vessels.

Ports and Bunkering Infrastructure

Ports will play a central role in enabling alternative fuel adoption. Safe bunkering requires dedicated infrastructure for fuel receipt, storage, handling, transfer and emergency response. The infrastructure requirements vary significantly between fuels.

Ports may need to develop:

- Dedicated storage and handling facilities
- Fuel transfer systems and bunkering vessels
- Segregated safety zones
- Leak detection and monitoring systems
- Firefighting and emergency-response capability
- Trained personnel and operating procedures
- Coordination arrangements with terminal operators, fuel suppliers, shipowners and local authorities

Port readiness must be developed in a phased manner. Not every port may need to handle every fuel initially. Ports may be identified based on trade patterns, vessel traffic, industrial clusters, renewable-energy availability, proximity to fuel-production centres and potential bunkering demand.

Fuel Production and Supply Chains

The availability of alternative fuels at scale remains a major challenge. Green fuels need reliable production capacity, stable quality, competitive pricing and resilient supply chains. The transition cannot succeed if vessels are designed for cleaner fuels but the required fuel is unavailable, inconsistent in quality or commercially unviable.

Fuel production and supply-chain planning must address:

- Availability of feedstock or renewable-energy sources
- Production capacity and scalability
- Fuel certification and traceability
- Quality assurance and compatibility
- Storage and distribution arrangements
- Last-mile delivery to ports
- Long-term offtake arrangements
- Cost competitiveness and financial viability

A coordinated approach is required between the maritime sector, energy sector, ports, fuel producers, technology providers and financial institutions.

Regulatory and Safety Frameworks

Alternative fuels introduce new risks that require updated regulations, standards, guidelines and certification systems. Safety management must be risk-based and fuel-specific.

The regulatory framework should cover vessel design, fuel storage, handling, bunkering operations, emergency response, crew competence, port procedures, fuel quality, incident reporting and inspection requirements. It should also ensure alignment with international conventions, class requirements and evolving IMO instruments.

Clear procedures are necessary for:

- Fuel transfer and bunkering operations
- Ship-to-ship and shore-to-ship interfaces
- Hazard identification and risk assessment
- Emergency shutdown arrangements
- Leak detection and containment
- Firefighting and evacuation
- Incident reporting and investigation

- Inspection, audit and certification

A robust regulatory framework will provide confidence to shipowners, ports, fuel suppliers, financiers and insurers.

Maritime Training and Competency Development

Human capability is central to safe alternative fuel adoption. Seafarers, port personnel, bunker operators, surveyors, emergency responders and other maritime stakeholders will require specialised knowledge and practical training.

Training must cover the properties of each fuel, operational procedures, hazard recognition, personal protective equipment, emergency response, fuel containment, firefighting, leak management and communication during incidents.

Competency requirements should include:

- Fuel-specific familiarisation training
- Simulator-based and practical exercises
- Bunkering drills and emergency-response drills
- Certification of shipboard and shore-side personnel
- Refresher training and periodic assessment
- Training for surveyors, inspectors and port authorities
- Joint exercises involving ships, ports and emergency services

The development of a skilled and competent workforce is essential to ensure that safety standards keep pace with technological transition.

Fuel-Specific Challenges and Safety Considerations

LNG

LNG is relatively mature compared to several other alternative fuels and can provide emission benefits over conventional marine fuels. However, it requires cryogenic storage at extremely low temperatures and has a larger storage-volume requirement than conventional fuels.

Key challenges include methane slip, cryogenic storage requirements, higher tank volume, bunker availability and investment requirements.

Key safety concerns include low-temperature exposure, gas leakage, fire and explosion risks, ventilation requirements, containment systems and emergency shutdown arrangements.

Biofuels

Biofuels can offer a practical near-term pathway, particularly where they are compatible with existing engines and bunkering systems. Their sustainability depends on feedstock source, production method, lifecycle emissions and quality consistency.

Key challenges include feedstock availability, fuel-quality consistency, scalability, cost, storage stability and compatibility with existing engines.

Key safety concerns include oxidation, microbial growth, fuel degradation, contamination and storage-management issues. Proper fuel testing, segregation and monitoring are important.

Methanol

Methanol is increasingly being considered as a marine fuel because it can be stored in liquid form at ambient conditions and may be easier to handle than some gaseous fuels. However, it has lower energy density than conventional fuels, requiring larger storage capacity.

Key challenges include lower energy density, increased fuel-tank requirements, fuel cost, bunkering infrastructure and supply availability.

Key safety concerns include flammability, toxicity if ingested or inhaled, invisible or low-visibility flames and the need for suitable fire detection, containment and personal-protection measures.

Ammonia

Ammonia has potential as a zero-carbon fuel at the point of use when produced from renewable energy. However, it remains at an early stage of maritime application and poses significant toxicity concerns.

Key challenges include limited commercial availability, storage and distribution requirements, engine-technology development, bunkering readiness and uncertainty regarding wider deployment.

Key safety concerns include highly toxic vapours, personnel-exposure risks, leak detection, ventilation, protective equipment, emergency response and evacuation procedures. Safety systems for ammonia will need particularly strong attention.

Hydrogen

Hydrogen has strong long-term potential, particularly for selected vessel segments and applications. However, it has low volumetric energy density and requires substantial storage space. It may be stored as compressed gas, liquid hydrogen or converted into derivative fuels.

Key challenges include storage-volume requirements, high production cost, limited bunkering ecosystem, technology maturity and distribution constraints.

Key safety concerns include high flammability, low ignition energy, leakage through small openings, cryogenic hazards for liquid hydrogen, material embrittlement and the need for robust gas-detection systems.

End-to-End Safety Chain

Safety must be addressed throughout the entire value chain:

Production → Storage → Transportation → Bunkering → Shipboard Operations

At every stage, the system must ensure safe containment, controlled transfer, leak prevention, emergency preparedness and trained personnel. Any weakness in one part of the chain can affect the overall reliability and safety of maritime fuel transition.

The key operational requirements include:

- Temperature and pressure management systems
- Fuel containment and leak-detection mechanisms
- Safe bunkering procedures and emergency-response plans
- Fuel-specific training, drills and certification
- Continuous monitoring, inspection and risk management

27. National Green Hydrogen Mission – Green Hydrogen Hubs

The National Green Hydrogen Mission is a flagship initiative of the Government of India aimed at establishing a comprehensive ecosystem for **production, utilisation and export of green hydrogen and its derivatives**. The Mission is a critical pillar in India's transition towards a **low-carbon, energy-secure and self-reliant economy**, aligned with the national target of **Net Zero by 2070**.

The Mission recognises green hydrogen as a **strategic energy carrier**, capable of decarbonising hard-to-abate sectors such as refining, fertilisers, steel, shipping and heavy mobility, while also reducing dependence on imported fossil fuels.

Key Objectives

Position India as a **global hub for green hydrogen production, utilisation and export**

Achieve **at least 5 Million Metric Tonnes (MMT) annual production by 2030**, with potential scaling to 10 MMT

Enable **deep decarbonisation across industrial and transport sectors**

Promote **domestic manufacturing of electrolysers and related technologies**

Facilitate **development of export infrastructure and global trade linkages**

Strategic Approach

The Mission adopts an **integrated and phased approach**, combining:

Demand creation (domestic + export markets)

Supply-side incentives (electrolyser manufacturing and hydrogen production)

Infrastructure development (ports, pipelines, storage, refuelling)

Regulatory and policy framework

R&D, skilling and international collaboration

A key element of this strategy is the development of **Green Hydrogen Hubs**, based on a **cluster model**, to enable economies of scale and reduce logistical challenges.

Green Hydrogen Hubs – Port-led Development Model

Given the challenges in long-distance hydrogen transport, the Mission promotes **cluster-based hydrogen hubs**, particularly around ports, where production, storage, handling and export infrastructure can be co-located.

In the maritime sector, **three major ports have been identified as Green Hydrogen Hubs**:

Deendayal Port Authority (Kandla) – Western Hub

Paradip Port Authority – Eastern Hub

V.O. Chidambaranar Port Authority (Tuticorin) – Southern Hub

These hubs are designed to act as **anchors for green fuel production, bunkering, storage and export**, supporting India's emergence as a global green energy supplier.

Deendayal Port Authority (Kandla) – Western Hub

Deendayal Port is being developed as a **front-runner green fuel hub** on the western coast, with strong focus on production and bunkering ecosystem.

Key Developments:

1 MW electrolyser-based green hydrogen plant commissioned

~3,400 acres of land allocated for hydrogen and ammonia projects

3.5 MMTPA jetty infrastructure compatible with green ammonia handling

Achieved **Port Readiness Level (PRL) 6 (progressing to 7)** for methanol/green fuel bunkering

Active development of **methanol bunkering ecosystem and alternative fuel infrastructure**

Strategic Role:

Western gateway for **green fuel production, bunkering and export corridors**

Key node for **global green shipping routes and trade linkages**

Early mover in **fuel transition and port readiness for alternative fuels**

Paradip Port Authority – Eastern Hub

Paradip Port is being positioned as a **large-scale green energy logistics and export hub** on the eastern coast.

Key Developments:

₹797 crore Green Hydrogen / Green Ammonia jetty project approved

Planned **4.0 MTPA cargo handling capacity** for green energy fuels

Development includes **jetty, storage systems, pipelines and handling infrastructure**

Project being implemented under **PPP/BOT model**

Strategic Role:

Anchor hub for **bulk handling, storage and export logistics**

Designed to connect **eastern hydrogen clusters to global markets**

Critical node for **scaling export-oriented hydrogen economy**

V.O. Chidambaranar Port Authority (Tuticorin) – Southern Hub

VOC Port is emerging as a **pilot-driven innovation hub** for green hydrogen and derivative fuels in southern India.

Key Developments:

10 Nm^3/hr green hydrogen pilot plant commissioned (Apr 2025) at cost of ₹3.87 crore

Pilot supports **port operations including lighting and EV charging**

~205 acres of land allocated for hydrogen and ammonia projects

Development of **Green Methanol Bunkering Facility (2 × 750 m^3)**

Integration of **renewables, digital systems and green fuel infrastructure**

Strategic Role:

Southern hub for **pilot deployment, innovation and technology validation**

Emerging centre for **green fuel bunkering and integrated port operations**

Supports development of **green shipping corridors (Kandla–Tuticorin linkage)**

Strategic Significance of Port-based Hydrogen Hubs

The development of these hubs has multi-dimensional impact:

Decarbonisation of Maritime Sector

Enables adoption of **green ammonia, methanol and hydrogen-based fuels**

Supports IMO-aligned **net-zero transition in shipping**

Export Competitiveness

Ports act as **gateways for global hydrogen trade**

Strengthens India's role in **emerging green fuel supply chains**

Industrial and Energy Integration

Co-location of **production, storage and consumption ecosystems**

Enables **economies of scale and cost reduction**

Investment and Economic Growth

Attracts **large-scale investments in clean energy infrastructure**

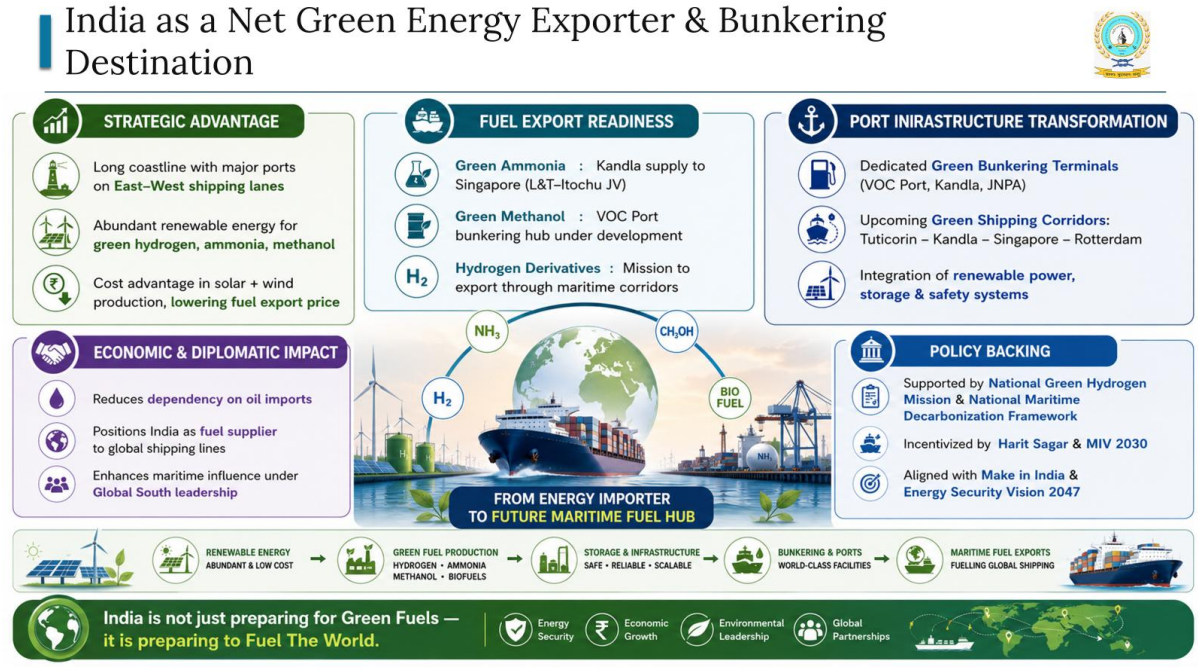
Creates employment across **energy, logistics and maritime sectors**

Alignment with National Vision

Supports **Aatmanirbhar Bharat and energy independence**

Integral to **Maritime INDIA @ Net Zero and NMDP framework**

India as a Net Green Energy Exporter & Bunkering Destination



India's positioning as a net green energy exporter and global bunkering destination should be viewed as a long-term strategic vision, rather than a reflection of current energy balances. Historically, India has been a net energy-importing and energy-deficit nation, with high dependence on imported fossil fuels to meet domestic and industrial demand, including for the maritime sector.

The emerging global transition towards low-carbon and zero-carbon fuels presents India with a structural opportunity to reverse this trajectory over the coming decades. By leveraging its renewable energy potential, coastline advantages and expanding port infrastructure, India aims to progressively transition from an energy-deficit economy to a net energy-surplus nation, capable of supplying green energy and green fuels not only for domestic consumption but also for international markets.

In the maritime context, this vision translates into India evolving from a fuel-import dependent shipping ecosystem to a producer, exporter and bunkering hub for green maritime fuels, including hydrogen-derived fuels such as green ammonia and green methanol. This shift is envisioned to occur in a phased manner, aligned with the maturation of fuel technologies, scaling of renewable energy capacity and development of safe port-based bunkering infrastructure.

Achieving net energy surplus status is therefore not an immediate outcome but a strategic end-state, underpinned by long-term national initiatives on renewable energy expansion, green hydrogen production, port modernisation and maritime decarbonisation. As these elements converge, India's maritime sector is expected to move from being a passive energy consumer to an active contributor to global green energy supply chains.

This future-oriented vision underpins India's policy approach to green shipping and bunkering and frames the country's ambition to play a system-level role in the global maritime energy transition, while strengthening long-term energy security and economic resilience.

28. Green Maritime Corridors

Green Maritime Corridors have emerged internationally as a pragmatic and implementation-oriented mechanism to advance maritime decarbonisation in a structured manner. Rather than attempting immediate sector-wide transformation, green corridors focus on specific routes, vessel segments and port pairs where coordinated action across the value chain can be demonstrated under real operating conditions.

The corridor approach enables regulators, ports, shipowners, fuel producers and technology providers to collectively address the key barriers to adoption of alternative marine fuels, including fuel availability, pricing, safety, operational reliability and regulatory readiness. By concentrating effort on defined corridors, early investments can be de-risked and lessons generated for wider replication.

In the Indian context, green maritime corridors form the core implementation pillar of the Green Voyage approach, translating long-term policy ambition on green shipping into route-based, evidence-driven and commercially grounded interventions.

29. Study on Potential Demand and Pricing of Alternative Marine Fuels in India

One of the foundational analytical inputs supporting India's Green Voyage strategy is the Study on Potential Demand and Pricing of Alternative Marine Fuels in India, undertaken under the aegis of the International Maritime Organization, in partnership with the Directorate General of Shipping and the Ministry of Ports Shipping and Waterways, with technical support from DNV.

The study evaluates India's prospects of developing into a regional bunkering hub for alternative marine fuels, examining demand drivers, pricing dynamics, operational constraints and competitive positioning. A central and policy-critical conclusion of the study is that:

India's strongest and most realistic bunkering opportunity lies with container vessels already calling at Indian ports for cargo operations or transshipment, rather than with vessels merely passing by along international shipping lanes.

This finding has important strategic implications. The study demonstrates that proximity to shipping lanes alone does not generate bunkering demand. Global shipping lines rarely deviate from established routes unless the bunkering proposition offers clear advantages in delivered fuel cost, operational reliability and turnaround efficiency. As a result, bunkering strategies premised on deviation-based demand are inherently weak.

Instead, the study underscores that cargo-linked demand, particularly from containerised liner services with regular port calls, provides a stable and predictable

foundation for early alternative fuel uptake. Transshipment hubs, where vessels already berth for cargo consolidation, offer especially strong potential, as bunkering can be integrated without additional operational disruption.

Key insights from the study include:

- Container vessels represent the most viable early adopters due to frequency of port calls and fleet standardisation
- Early demand for alternative fuels is likely to be led by biofuels, given cost and compatibility, with e-methanol and e-ammonia scaling over time
- Bunkering hub development should be selective and concentrated, rather than dispersed across multiple ports
- Policy certainty, targeted incentives and infrastructure readiness are decisive factors for market uptake

The study thus provides a market-grounded demand lens for India's green corridor planning.

30. Green Corridor Pre-Feasibility Study under the Indo-Danish Centre of Excellence

The India Green Corridors Pre-Feasibility Study represents an important early initiative under the India–Denmark Green Strategic Partnership to support India's transition towards a safe, sustainable and future-ready maritime sector.

The broader cooperation is anchored in the Green Strategic Partnership between India and Denmark, established in 2020, which provides a framework for deepening bilateral collaboration on green growth, renewable energy, sustainable development and climate action. Maritime cooperation and green shipping have emerged as key areas within this partnership, reflecting the shared objective of accelerating low-carbon transition in the maritime sector.

In June 2025, during the meeting between the Hon'ble Minister of Ports, Shipping and Waterways, Government of India and the Danish Minister of Industry, Business and Financial Affairs in Copenhagen, both sides reiterated their commitment to maritime cooperation under the India–Denmark framework. The discussions built upon the bilateral Memorandum of Understanding on maritime affairs signed in 2024 and highlighted the need to establish an Indo-Danish Centre of Excellence for Green Shipping in India.

The Centre of Excellence is envisaged as a platform to improve the quality and efficiency of maritime activities while supporting India's green transition. Its work is aligned with the Maritime Amrit Kaal Vision 2047 and India's aspiration to emerge as a global hub for safe, sustainable and green maritime operations. Development of Green Shipping Corridors was identified as one of the priority areas through which the Centre of Excellence could contribute to practical and measurable outcomes.

Accordingly, the India Green Corridors Pre-Feasibility Study was initiated as one of the first substantive technical deliverables under this collaboration. The study was undertaken between September 2025 and May 2026 by the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping, with support from Implement Consulting Group. It was carried out in collaboration with the Ministry of Ports, Shipping and Waterways, Directorate General of Shipping, Indian Ports Association, Danish Energy Agency and Danish Maritime Authority. The project was supported through Danish funding arrangements involving the Danish Maritime Authority, Danish Energy Agency and Ministry of Foreign Affairs of Denmark.

The study moves beyond broad policy intent and seeks to establish an evidence-based basis for identifying corridors that can support early deployment of lower and zero-emission maritime solutions. It assesses green corridors not merely as routes connecting two ports, but as integrated ecosystems involving vessels, fuel supply, renewable-energy availability, port infrastructure, bunkering systems, cargo demand, regulations, safety arrangements and stakeholder commitments.

The assessment was undertaken through a structured methodology developed by the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. The methodology covered workstreams relating to alternative fuels, port and bunkering readiness, vessels and cargo, trade routes, regulatory frameworks, just and equitable transition considerations and corridor selection. The Indian institutions supported the process through data provision, port inputs, regulatory perspectives and stakeholder engagement, while the technical analysis and modelling were undertaken by the study consortium.

Key Outcomes

- **14 Indian ports were assessed** across inland waterways, coastal shipping and international trade segments.
- **More than 230 potential routes were screened** to identify a practical portfolio of corridor candidates.
- A **first suite of 40 Green Shipping Corridors** was identified for further prioritisation and maturity.
- The identified corridor portfolio includes:
    - **8 Inland Waterway Corridors**

    - **8 Coastal and Domestic Corridors**
    - **8 Deep-Sea International Corridors**
    - **8 Strategic Opportunity Corridors**
    - **8 Emerging Corridors**

- **E-ammonia was identified as the most credible scalable fuel pathway for early corridor deployment**, especially for larger vessels and long-distance bulk, tanker and energy-related trades.
- **V.O. Chidambaranar Port, Kandla, Paradip and Mundra were identified as leading corridor anchor ports**, based on alternative-fuel readiness, likely fuel availability, strategic location, trade patterns and associated industrial ecosystems.
- **Gujarat and Odisha emerged as key potential green-fuel production hubs** that could support future corridor development, particularly in relation to green hydrogen and green ammonia pathways.
- A **Consortium Incubation Workshop was conducted on 28 May 2026 in New Delhi** to discuss the findings, identify priority stakeholders and facilitate the next stage of corridor maturation.

The categorisation of corridors reflects different levels of readiness. Inland and coastal corridors can provide a practical pathway for early pilots involving harbour craft, tugs, ferries, barges and selected coastal vessels, where distances are shorter, operations are more predictable and fuel or charging arrangements can be managed more easily. These segments may be suitable for electrification, hybridisation, biofuels and other near-term lower-emission solutions.

Deep-sea corridors are more complex and are intended to support larger vessel categories such as tankers, bulk carriers, container vessels and general cargo vessels. These corridors will require greater convergence between fuel production, international partner-port readiness, commercial offtake, vessel availability, bunkering systems, safety standards and regulatory alignment. For such segments, scalable fuels such as e-ammonia and e-methanol are likely to be more relevant than battery-electric solutions.

The study also highlights that fuel transition cannot be approached through a uniform pathway. The suitability of fuels will depend on vessel type, voyage length, cargo profile, fuel availability, storage requirement, engine technology, port infrastructure and safety considerations. While e-ammonia appears to be a strong pathway for early scalable deployment, biofuels, electrification and hybrid systems may remain important for shorter-range and operationally controlled applications.

The identification of Kandla, Mundra, Paradip and V.O. Chidambaranar Port as anchor ports is significant because it indicates that early corridor development may be concentrated around a limited number of regional clusters rather than being distributed evenly across the country. These clusters can combine port infrastructure, renewable-energy potential, industrial demand, green-fuel projects, bunkering potential and shipping activity to create viable early ecosystems.

The study further underlines that port readiness alone will not be sufficient for successful corridor implementation. Green corridors will require coordinated commitments from shipping companies, cargo owners, fuel producers, ports, terminal operators, technology providers, financial institutions, regulators and training institutions. The next phase must therefore focus on detailed feasibility studies, commercial structuring, fuel supply arrangements, vessel deployment plans, safety and regulatory requirements, financing models and stakeholder commitments.

Overall, the India Green Corridors Pre-Feasibility Study provides a structured foundation for India to move from high-level green-shipping ambition towards practical, phased and evidence-led implementation. It supports the larger objective of building a resilient maritime ecosystem that strengthens energy security, develops green industrial capability, improves maritime competitiveness and enables progressive decarbonisation of domestic and international shipping.

31. Nuclear Propulsion for Merchant Shipping

International shipping requires propulsion systems capable of delivering high power continuously over long distances while maintaining vessel speed, cargo capacity and operational reliability. At the same time, the sector is under increasing pressure to reduce greenhouse gas emissions and transition away from conventional marine fuels.

Most current decarbonisation pathways rely on energy-efficiency measures and alternative fuels such as methanol, ammonia, hydrogen, biofuels and synthetic fuels. However, these options may involve lower energy density, additional storage requirements, uncertain global availability, higher production costs and the need for extensive new bunkering infrastructure. Nuclear propulsion is therefore being reconsidered as a potential long-term option, particularly for large, energy-intensive and deep-sea vessels.

Nuclear marine propulsion is not a new technology. It has been successfully applied for several decades in naval vessels and icebreakers, while a limited number of civilian demonstration and merchant vessels have also been developed. The technology is therefore proven in marine operation, although its use in international commercial shipping remains constrained by high capital costs, specialised infrastructure, regulatory gaps, port-access concerns and public acceptance.

Principle of Nuclear Marine Propulsion

A nuclear-powered vessel uses heat generated through controlled nuclear fission rather than combustion of marine fuel.

In a conventional marine nuclear propulsion arrangement:

1. The reactor generates heat through nuclear fission.
2. A primary coolant removes heat from the reactor core.
3. The heat is transferred to a secondary system, which produces steam or drives another power-conversion cycle.
4. The steam operates a turbine.
5. The turbine may:
    - directly drive the propeller shaft through gearing, or
    - drive an electrical generator that supplies propulsion motors and onboard systems.
6. The steam is condensed, recirculated and reused.

Pressurised Water Reactors have historically been the dominant technology in naval propulsion because of their established reliability, compact configuration and operational experience. However, their high-pressure systems, weight and complexity have encouraged examination of alternative technologies such as SMRs, high-temperature gas-cooled reactors, molten salt reactors and liquid metal-cooled reactors for future civilian applications.

32. Strategic Rationale for Nuclear Marine Propulsion

32.1. Near-Zero Operational Emissions

Nuclear propulsion does not require combustion of conventional marine fuels. It can therefore achieve near-zero tank-to-wake emissions of carbon dioxide, sulphur oxides

and particulate matter, while also substantially reducing nitrogen oxide emissions associated with combustion.

Lifecycle emissions are not entirely zero because uranium mining, enrichment, fuel fabrication, ship construction, reactor servicing and decommissioning consume energy. Nevertheless, nuclear power generally offers significantly lower lifecycle greenhouse gas emissions than fossil-fuel-based propulsion.

This makes nuclear propulsion relevant to the long-term decarbonisation of vessels for which energy-efficiency improvements alone may be insufficient.

32.2. Exceptional Energy Density

Nuclear fuel contains vastly more energy per unit mass than conventional marine fuel. A relatively small quantity of nuclear fuel can support several years of operation, depending on reactor and fuel design.

This can reduce the requirement for:

- large fuel tanks
- frequent bunkering
- fuel-transfer systems
- combustion-air intakes
- exhaust systems
- associated fuel-treatment machinery

The released space and weight may be used for cargo, additional safety systems or other operational requirements. However, part of this benefit is offset by the weight and space required for the reactor compartment, containment, shielding and auxiliary safety systems.

32.3. Long Endurance

Long reactor fuel cycles could allow vessels to operate for years without conventional refuelling. This may be particularly beneficial for:

- long-distance container shipping
- bulk carriers on fixed deep-sea routes
- specialised cargo vessels
- Arctic or remote-area operations
- vessels requiring prolonged operation away from bunkering hubs

Nuclear icebreakers have demonstrated the operational value of long endurance in remote and demanding environments where conventional refuelling logistics are difficult.

32.4. Continuous High-Power Availability

Large merchant vessels require dependable propulsion power over sustained periods. Nuclear reactors can provide continuous baseload power for:

- main propulsion
- cargo-handling systems
- refrigeration
- hotel loads
- pumps and compressors
- desalination
- onboard electrical systems

This characteristic may make nuclear propulsion more relevant to large container ships, bulk carriers, tankers, gas carriers, cruise ships and specialised vessels than to smaller ships with lower and more variable energy demand.

32.5. Reduced Dependence on Bunkering Networks

Alternative marine fuels will require substantial investment in production, storage, transportation and bunkering facilities across major global trade routes.

A nuclear-powered vessel would still require specialised refuelling and servicing facilities, but these interventions would occur far less frequently than conventional bunkering. The technology could therefore reduce dependence on:

- global marine-fuel supply chains
- fuel availability at intermediate ports
- price fluctuations
- compatibility of fuel specifications across regions
- repeated fuel-transfer operations

32.6. Greater Predictability of Energy Costs

Nuclear-powered vessels would have high initial capital and infrastructure costs, but the nuclear fuel component generally represents a smaller share of total lifecycle cost than fuel expenditure for conventional vessels.

Long fuel cycles could reduce exposure to:

- oil-price volatility
- carbon pricing
- future fuel mandates
- supply constraints for hydrogen-derived fuels
- regional variation in alternative-fuel prices

However, potential fuel-cost stability must be assessed together with the costs of nuclear specialists, maintenance, licensing, insurance, security, waste management and decommissioning.

32.7. Historical Civilian Experience

Several civilian nuclear-powered vessels were developed during the twentieth century to demonstrate the feasibility of commercial nuclear propulsion.

NS Savannah

The United States developed the first nuclear powered vessel , *NS Savannah* as a demonstration cargo-passenger vessel. It successfully demonstrated nuclear propulsion but was commercially constrained by high operating costs, specialised shore-support requirements and limited cargo capacity.

Otto Hahn

Germany's *Otto Hahn* was developed as a nuclear-powered research and cargo vessel. It operated successfully from a technical standpoint but faced high operating costs and restrictions on access to certain ports.

Mutsu

Japan's *Mutsu* was developed as an experimental nuclear-powered cargo vessel and training platform. The programme faced technical, political and public-acceptance challenges, including concerns following a radiation-leak incident.

Sevmorput

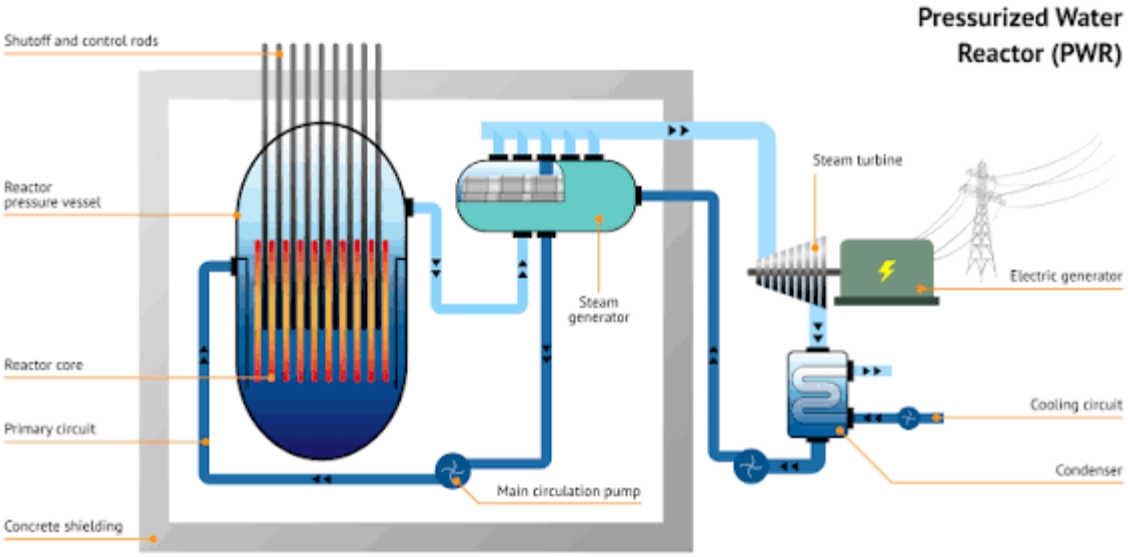
The Russian *Sevmorput*, a nuclear-powered lighter-aboard-ship and icebreaking cargo vessel, is the most prominent example of a nuclear-powered merchant vessel achieving sustained operational service. Its experience indicates that nuclear propulsion can be

viable in specialised routes where endurance and icebreaking capability justify the additional cost and institutional requirements.

The historical experience demonstrates that the fundamental technology is workable. The principal limitations were not limited to reactor performance; they included economics, route restrictions, port acceptance, regulation and the absence of a sufficiently large fleet over which common infrastructure costs could be distributed.

Nuclear Reactor Technology Options

Pressurised Water Reactors



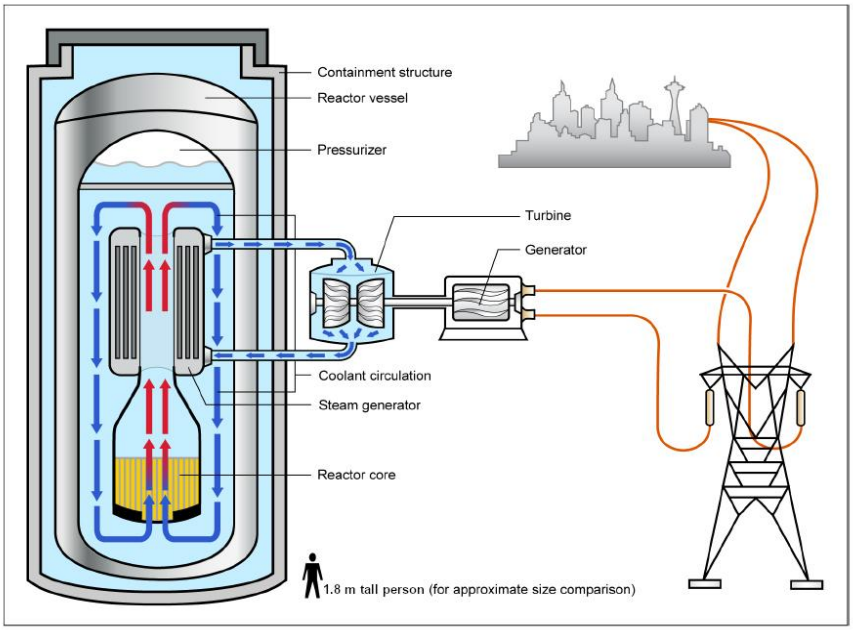
PWRs have the most extensive marine operating history. Their advantages include technological maturity, established safety experience and a well-understood power-conversion system.

Challenges include:

- high system pressure
- large and heavy reactor components
- extensive shielding
- complex maintenance requirements

- limited commercial suitability at lower power ratings

Small Modular Reactors (SMR)



Source: GAO, based on Department of Energy documentation. | GAO-15-652

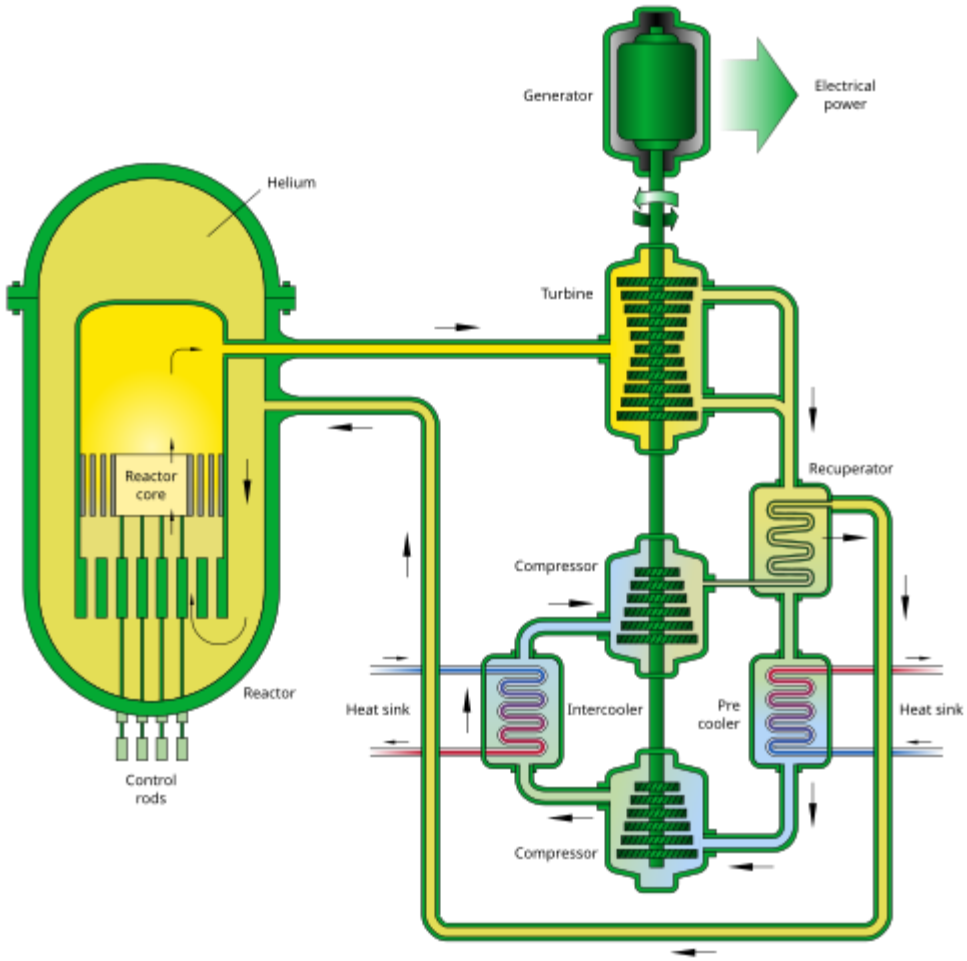
SMRs are advanced reactors generally designed to generate up to 300 MWe per module. Their compact size, modular construction and factory-manufacturing potential make them particularly relevant to future maritime applications.

Potential advantages include:

- smaller footprint
- standardised modules
- passive safety features
- longer fuel cycles
- flexible power ratings
- replacement or servicing of complete modules at specialised facilities

Water-cooled SMRs are likely to be more suitable for nearer-term consideration because they build upon established reactor technology. More advanced SMR concepts may become relevant over the longer term. The IAEA recognises transportable SMRs, including nuclear-propelled ships and floating nuclear power units, as potential sources of reliable energy for international shipping and net-zero objectives.

High-Temperature Gas-Cooled Reactors



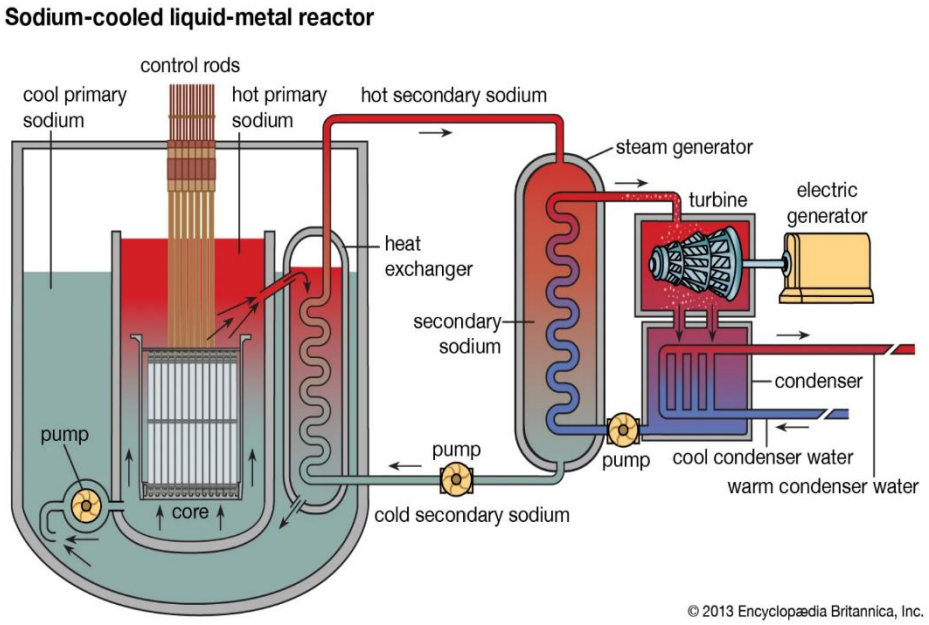
HTGRs use gas, generally helium, as coolant and can operate at higher temperatures. They may offer improved thermal efficiency and passive safety characteristics.

Their application may support:

- electric propulsion
- high-efficiency power generation
- hydrogen production
- process heat

However, maritime integration, fuel handling, safeguards and technology maturity require further assessment.

Liquid Metal-Cooled Reactors

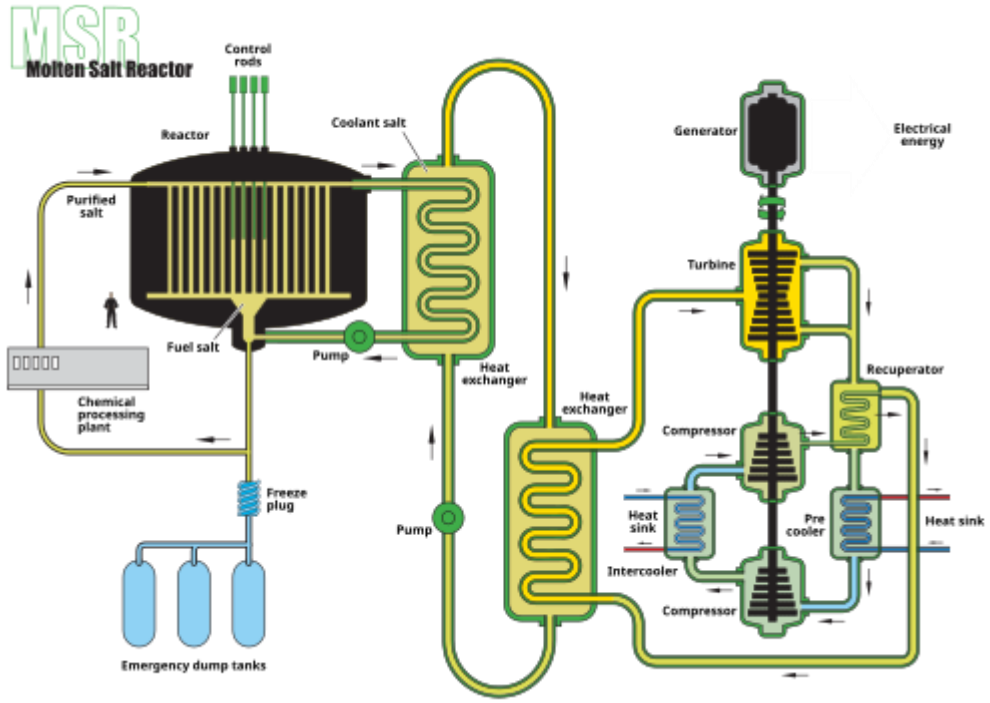


Sodium, lead or lead-bismuth may be used as reactor coolants. These technologies can provide:

- high heat-transfer performance
- high power density
- high-temperature operation
- low-pressure cooling systems
- potential for long fuel cycles

Challenges include sodium reactivity, corrosion, coolant freezing, radioactive activation products, inspection difficulty and, in the case of lead systems, considerable weight.

Molten Salt Reactors



Molten salt reactor concepts can use molten salt as coolant or as a medium containing the nuclear fuel. Potential advantages include high-temperature and low-pressure operation, passive safety characteristics and compact arrangements.

However, commercial maturity, materials performance, corrosion management, fuel processing and licensing remain unresolved for maritime use.

33. India's Strength for Nuclear Marine Propulsion

India possesses a significant technical, institutional and resource base for examining the future application of nuclear energy in the maritime sector. This foundation arises from the country's established civil nuclear programme, indigenous fast breeder reactor capability, long-standing thorium fuel-cycle research, emerging Small Modular Reactor programme and limited publicly documented experience with nuclear-powered naval platforms.

This provides a credible base for undertaking technical studies, reactor-technology assessment, vessel-integration research and development of an appropriate safety and regulatory framework for civilian maritime use.

India's strengths may be examined under four broad areas:

1. Established nuclear energy and fuel-cycle capability
2. Strategic thorium resources and thorium-technology development
3. Emerging advanced reactor and SMR programme
4. Existing experience with nuclear-powered naval platforms

Established Nuclear Energy Programme

India has developed a substantial domestic nuclear energy programme over several decades. PIB factsheet records an installed nuclear power capacity of **8.78 GW**. During 2024–25, nuclear power plants generated **56,681 million units of electricity**, accounting for approximately **3.1% of India's total electricity generation**. The installed capacity is projected to increase to **22.38 GW by 2031–32**.

The importance of this established programme for a possible marine nuclear initiative lies not merely in installed generating capacity, but in the broader capabilities developed through the nuclear fuel cycle and reactor programme.

Indian capability in areas including:

- design and development of nuclear reactors
- fabrication of nuclear fuels

- operation of nuclear power systems
- reprocessing of spent nuclear fuel
- recycling of recovered fissile material
- development of fast breeder reactor technology
- management of radioactive materials and nuclear waste
- research into thorium utilisation

India's nuclear programme follows a **closed nuclear fuel-cycle approach**, under which fissile materials recovered from spent fuel are reprocessed and reused in subsequent stages of the programme.

For a future nuclear marine programme, such experience would be relevant to the development of:

- long-life reactor fuel
- reactor servicing and refuelling arrangements
- spent-fuel management
- radiation protection
- specialised maintenance systems
- end-of-life and decommissioning arrangements

These possible maritime applications are analytical areas for future assessment.

India's Three-Stage Nuclear Power Programme

India's nuclear power programme was formulated to address the country's relatively limited uranium resources and substantial thorium resources. The programme is structured in three interconnected stages and is based on progressive utilisation and multiplication of domestic fissile resources.

Stage One: Pressurised Heavy Water Reactors

In the first stage, natural uranium is used as fuel in Pressurised Heavy Water Reactors. During operation, plutonium is produced in the spent fuel. This plutonium is recovered through reprocessing and becomes an important fuel input for the second stage.

Stage Two: Fast Breeder Reactors

The second stage uses plutonium recovered from the first-stage reactors as fuel in fast breeder reactors. These reactors are designed to produce more fissile material than they consume.

The **500 MWe Prototype Fast Breeder Reactor at Kalpakkam** attained first criticality on **6 April 2026**. The reactor was indigenously designed and constructed, and its technology was developed by the Indira Gandhi Centre for Atomic Research. The achievement marks India's entry into the second stage of its three-stage nuclear programme.

The PFBR uses uranium-plutonium mixed oxide fuel. Its core is surrounded by a uranium-238 blanket, in which fast neutrons convert uranium-238 into fissile plutonium-239. The reactor is also designed to provide a future pathway for conversion of thorium-232 into uranium-233. The spent fuel is intended to be reprocessed and recycled as part of the closed fuel cycle.

Once fully operational, India would become the second country after Russia to operate a commercial fast breeder reactor.

Stage Three: Thorium-Based Reactors

The third stage is intended to use uranium-233 produced from thorium-232. This stage seeks to enable large-scale utilisation of India's thorium resources and provide a long-term domestic energy resource.

Relevance to Marine Applications

The existing three-stage programme is designed primarily for land-based nuclear energy development.

However, the programme has created research capability in:

- fast-neutron systems
- advanced nuclear fuels
- fuel reprocessing and recycling
- high-temperature coolant systems
- reactor materials
- long-term thorium utilisation

These competencies may support future research into compact or marine-specific reactor technologies, subject to dedicated design, safety and regulatory assessment.

Fast Breeder Reactor Capability

The PFBR milestone is relevant because it demonstrates India's ability to undertake indigenous research, engineering, construction and commissioning of an advanced reactor system.

The PFBR programme establishes experience in:

- fast-reactor physics
- uranium-plutonium mixed oxide fuel
- breeding of fissile material
- reprocessing and recycling
- closed fuel-cycle management
- advanced reactor materials
- high-temperature heat-transfer systems

The reactor is a land-based, 500 MWe sodium-cooled fast breeder reactor.

Liquid-metal-cooled reactors are among the advanced reactor concepts being studied internationally for future maritime use. The IAEA's categorisation of SMR technology lines includes liquid-metal-cooled fast reactors, alongside water-cooled reactors, molten salt reactors and high-temperature gas-cooled reactors.

Maritime use would require separate work on:

- reactor miniaturisation
- vessel motion and vibration
- shielding and weight
- collision and grounding protection
- coolant behaviour in a marine environment
- maintenance at sea
- port entry and emergency response

The EMSA study states that detailed reactor-to-vessel integration studies and vessel-specific risk assessments would be required before individual marine applications could be evaluated.

33.1. Strategic Thorium Resource Base

India has a substantial identified thorium-bearing mineral resource.

The Atomic Minerals Directorate for Exploration and Research had established **11.93 million tonnes of in-situ monazite resources** as of September 2014. These resources were estimated to contain approximately **1.07 million tonnes of thorium**.

The state-wise monazite resources include:

State	Monazite resources
Andhra Pradesh	3.72 million tonnes
Tamil Nadu	2.46 million tonnes
Odisha	2.41 million tonnes
Kerala	1.90 million tonnes
West Bengal	1.22 million tonnes
Jharkhand	0.22 million tonnes
Total	**11.93 million tonnes**

Thorium is a fertile material and cannot be used directly as fissile nuclear fuel. It must first be converted into uranium-233 through irradiation in a reactor. The PIB release specifically states that sustainable utilisation of thorium depends on progression through the second stage of fast breeder reactors and that thorium is not a short-term solution to immediate power requirements.

Accordingly, India's thorium resources should be described as a **long-term strategic advantage**, not as a readily available fuel for present-day merchant vessels.

Thorium Fuel-Cycle Capability

BARC states that work on thorium has been undertaken from the beginning of India's nuclear programme. Research and development have covered:

- mining and extraction
- production of nuclear-grade thoria
- fuel fabrication
- irradiation in research and power reactors
- evaluation of fuel properties and irradiation behaviour
- post-irradiation examination
- reprocessing
- recovery of uranium-233
- recycling of recovered material

BARC records that several tonnes of nuclear-grade thoria powder have been produced and that thoria-based fuel has been fabricated at BARC and the Nuclear Fuel Complex. Thorium-based fuel has been irradiated in research reactors, PHWRs and the Fast Breeder Test Reactor.

- thoria fuel rods irradiated in CIRUS were reprocessed at BARC
- recovered uranium-233 was fabricated as fuel for the KAMINI reactor
- thoria blanket assemblies irradiated in FBTR were reprocessed at IGCAR
- recovered uranium-233 was used for experimental irradiation of a PFBR-type fuel assembly in FBTR

These activities demonstrate experience across several parts of the thorium fuel cycle.

Relevance to Nuclear Marine Propulsion

Some advanced reactor concepts considered internationally for long-term maritime application may use thorium-bearing fuels or uranium-233. This is particularly discussed in relation to certain molten salt and advanced reactor systems.

India's thorium capability could therefore support future research on:

- long-life nuclear fuels
- advanced reactor fuels
- closed-cycle fuel management
- thorium-based molten salt concepts
- uranium-233 utilisation

33.2. Advanced Heavy Water Reactor Development

BARC has designed the **Advanced Heavy Water Reactor** and the **AHWR-LEU** to support development of technologies required for thorium utilisation.

Advanced Heavy Water Reactor

The BARC describes the AHWR as:

- a 300 MWe reactor
- a vertical pressure-tube design
- boiling light-water cooled
- heavy-water moderated

- intended as a technology-demonstration reactor for thorium utilisation
- designed to use thorium-plutonium and thorium–uranium-233 mixed oxide fuels

A co-located fuel-cycle facility is planned to support fuel fabrication, reprocessing and waste management.

AHWR-LEU

The AHWR-LEU is also described as a 300 MWe vertical pressure-tube reactor using thorium and low-enriched uranium mixed oxide fuel. It is based on a once-through fuel cycle, with provisions for long-term storage, monitoring and retrieval of spent fuel.

Relevance to Marine Applications

The AHWR and AHWR-LEU are land-based reactor concepts. Its importance to the present assessment lies in demonstrating India's ability to develop advanced reactor designs around:

- thorium fuel
- passive and advanced safety approaches
- fuel-cycle integration
- uranium-233 utilisation
- long-term spent-fuel management

33.3. Nuclear Energy Mission and Emerging SMR Programme

India's Nuclear Energy Mission, announced under the Union Budget 2025–26, marks a major step towards the development and deployment of advanced nuclear technologies. As per the PIB material, a budgetary provision of **₹20,000 crore** has been made for research, design, development and deployment of Small Modular Reactors, with a target of making at least **five indigenously designed SMRs operational by 2033**.

The indigenous reactor initiatives being taken forward include:

- **220 MWe Bharat Small Modular Reactor — BSMR-200**
- **55 MWe Small Modular Reactor — SMR-55**
- **High-Temperature Gas-Cooled Reactor of up to 5 MWth** for hydrogen generation

In-principle approval has been received for all three reactor programmes. The lead units of BSMR-200 and SMR-55 are proposed to be established at the Tarapur Atomic Power Station site, while the High-Temperature Gas-Cooled Reactor is proposed at BARC Vizag.

India has also developed important enabling technologies indigenously, including advanced reactor-vessel alloy, forging technology for reactor pressure vessels and control-rod drive mechanisms. A majority of the required equipment is stated to be within the manufacturing capability of Indian industry, with technological support from BARC.

Relevance of SMRs to Maritime Applications

The IAEA describes SMRs as advanced reactors typically producing up to **300 MWe per module**, with an emphasis on compact design, modular construction and factory-based manufacturing. Transportable SMRs may be deployed as floating nuclear power units or adapted for nuclear-propelled ships.

The key characteristics relevant to maritime use include:

- compact reactor architecture
- modular and standardised construction
- factory fabrication and controlled quality assurance
- smaller physical footprint
- flexible power ratings
- potential for longer operating cycles
- incorporation of inherent and passive safety features
- suitability for integration with electric propulsion and onboard power systems

The IAEA notes that most established marine-reactor concepts are based on pressurised water reactor technology. Water-cooled SMRs are generally regarded as suitable for nearer-term development, while advanced concepts such as molten salt reactors and high-temperature gas-cooled reactors are being explored for longer-term applications.

India's indigenous SMR programme can therefore strengthen the national knowledge, manufacturing and regulatory base required for future assessment of marine propulsion and floating nuclear power systems. The transition from a land-based design to a maritime application would involve specialised engineering for vessel motion, vibration, collision protection, marine corrosion, compact shielding, variable shipboard power demand and servicing at designated facilities.

33.4. High-Temperature Reactor and Hydrogen Development

As per PIB, BARC is developing a **High-Temperature Gas-Cooled Reactor of up to 5 MWth** for hydrogen generation.

High-temperature gas-cooled reactors operate at higher outlet temperatures than conventional water-cooled reactors. The IAEA identifies these systems as particularly suitable for cogeneration and industrial process-heat applications.

Their relevance to the maritime sector may arise through two complementary pathways.

Marine Power and Propulsion

Over the longer term, high-temperature reactor concepts may be assessed for:

- marine-based electricity generation
- integrated electric propulsion
- floating nuclear power platforms
- offshore and coastal energy systems

Production of Low-Carbon Maritime Fuels

Nuclear-generated heat and electricity may also support the production of:

- hydrogen
- ammonia
- synthetic fuels
- other low-carbon energy carriers

Such fuels can be supplied to conventionally powered vessels and can support the development of low-carbon bunkering ecosystems at ports.

The indigenous HTGCR programme therefore has significance not only for advanced reactor development, but also for the wider maritime energy transition through its potential contribution to clean-fuel production and port-based industrial applications.

33.5. Nuclear Legal and Regulatory Development

The **Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India framework** represents an important step towards modernising India's nuclear governance architecture.

the framework seeks to:

- consolidate and modernise the legal provisions governing nuclear energy
- enable limited private participation under regulatory oversight
- provide for licensing and safety authorisation
- grant statutory recognition to the Atomic Energy Regulatory Board
- strengthen nuclear safety, security and safeguards
- establish provisions relating to liability and compensation
- improve emergency preparedness and institutional coordination
- support India's objective of achieving **100 GW of nuclear capacity by 2047**

Sensitive activities such as specified enrichment, spent-fuel reprocessing, recycling and high-level radioactive-waste management continue to remain under the control of the Central Government or its wholly owned institutions.

Relevance to Marine Nuclear Development

A modern and enabling nuclear framework can support:

- research and development of advanced reactors
- participation of specialised industries and equipment manufacturers
- indigenous manufacturing of nuclear-grade components
- development of new business and deployment models
- strengthening of regulatory and safety institutions
- collaboration among government, research organisations and industry

For marine applications, this nuclear framework would need to be complemented by maritime-specific provisions covering:

- design and construction of nuclear-powered vessels
- classification and statutory certification
- Flag State oversight
- Port-entry and port-acceptance procedures
- crew competency and certification
- nuclear safety and security at sea
- emergency preparedness

- civil liability and insurance
- refuelling and servicing
- radioactive-waste management
- decommissioning and end-of-life arrangements

The development of such a framework would require coordinated participation by the Department of Atomic Energy, AERB, DGMA, classification societies, shipyards, ports, security agencies and other relevant institutions.

34. India's Strategic Strength for Nuclear Marine Propulsion

India's strength for examining nuclear marine propulsion arises from the convergence of several established national capabilities.

Established Nuclear Programme

India has an operational nuclear power programme with an installed capacity of **8.78 GW**, supported by experience in reactor operation, fuel fabrication, reprocessing, recycling and radioactive-waste management.

Advanced Fast-Reactor Development

The **500 MWe Prototype Fast Breeder Reactor at Kalpakkam** attained first criticality in April 2026. This milestone demonstrates indigenous capability in advanced reactor research, engineering, construction and the closed nuclear fuel cycle.

Strategic Thorium Resource Base

India has **11.93 million tonnes of identified monazite resources**, containing approximately **1.07 million tonnes of thorium**, as per the official estimate of September 2014.

Thorium Fuel-Cycle Research

India has undertaken work across extraction, fuel fabrication, irradiation, reprocessing, uranium-233 recovery and recycling of thorium-based materials.

Advanced Reactor Design Capability

BARC has developed advanced thorium-oriented reactor concepts, including the AHWR and AHWR-LEU, and is leading the development of indigenous SMRs and high-temperature reactor systems.

National SMR Mission

The allocation of **₹20,000 crore** for SMR research and deployment, together with the target of at least five indigenous SMRs by 2033, creates a strong policy and technology base for compact reactor development.

Marine Nuclear Experience

India's experience with nuclear-powered naval platforms provides an existing marine reference for the operation and integration of nuclear systems at sea.

Indigenous Manufacturing Base

Important nuclear materials, reactor-vessel technologies and control systems have been developed indigenously. Indian industry is expected to participate in manufacturing a majority of equipment required for the indigenous SMR programme.

Evolving Governance Framework

India's modernising nuclear legal and regulatory framework is intended to support advanced technology development, wider industrial participation and stronger regulatory oversight.

International Engagement

Civil nuclear cooperation with 18 countries provides a platform for technical partnerships, research collaboration, regulatory dialogue and development of internationally acceptable systems.

Taken together, these capabilities provide India with a credible foundation for studying nuclear propulsion for merchant vessels, floating nuclear power platforms and nuclear-supported port and coastal energy applications.

Priority Areas for Future Development

Building on India's existing strengths, a structured programme for nuclear marine applications may focus on the following priority areas:

Marine Reactor Technology

- selection of suitable reactor technology
- compact and modular reactor design
- long-life civilian nuclear fuel
- passive safety and containment
- marine-qualified materials and equipment

Vessel Design and Integration

- reactor location and shielding
- stability and structural protection
- electric propulsion architecture
- collision and grounding protection
- cooling and emergency power systems

Safety and Risk Assessment

- marine hazard identification
- nuclear safety analysis
- fire, flooding and loss-of-cooling scenarios
- radiation-protection arrangements
- security and safeguards by design

Classification and Regulation

- dedicated classification rules
- statutory certification requirements
- flag-State and port-State procedures
- port-entry and port-acceptance frameworks
- civil liability and insurance arrangements

Infrastructure

- specialised construction and servicing facilities
- refuelling arrangements
- spent-fuel and radioactive-waste management
- emergency-response infrastructure
- decommissioning facilities

Human Resources

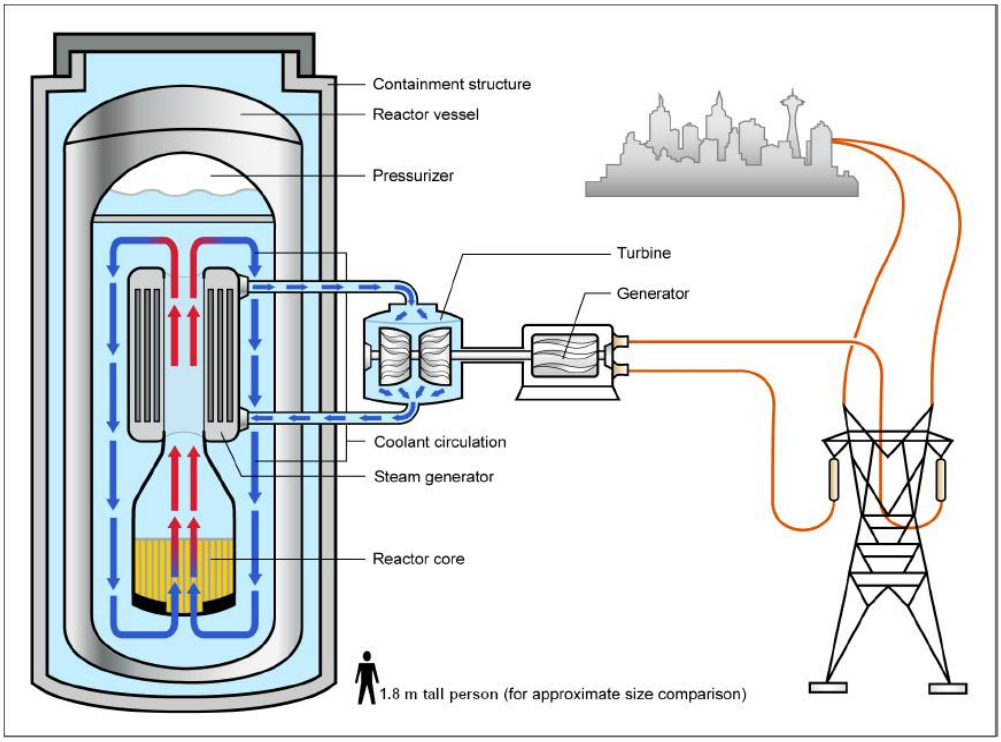
- civilian nuclear-marine competency standards
- training and certification of reactor operators
- specialised training for marine engineers and deck officers
- training of surveyors, port personnel and emergency responders

Demonstration and Deployment

- technology-readiness assessment
- identification of suitable vessel or floating-platform applications
- preliminary design and Approval in Principle
- controlled pilot or demonstration project
- phased movement towards commercial application

The EMSA study identifies radiation safety, marine accidents, external threats, regulation, licensing, design requirements, capable shipyards and safeguards as central considerations for future marine nuclear applications. These areas provide a useful framework for structuring India's research and regulatory roadmap.

Small Modular Reactors (SMRs): Emerging Pathway for Maritime Applications



Source: GAO, based on Department of Energy documentation. | GAO-15-652

Small Modular Reactors (SMRs) represent one of the most significant developments in advanced nuclear technology and are increasingly being viewed as a practical pathway for expanding the use of nuclear energy beyond conventional grid-based electricity generation. As per the International Atomic Energy Agency (IAEA), SMRs are advanced nuclear reactors with an electrical output of **up to 300 MWe per module**, designed using modular construction principles and factory-based manufacturing techniques. Unlike conventional gigawatt-scale nuclear power plants, SMRs can be deployed individually or as multi-module plants depending on the required power output.

The growing interest in SMRs is driven by their ability to provide reliable, low-carbon and flexible power generation while reducing construction timelines, improving affordability and incorporating advanced safety features. Their compact size and modular configuration also make them suitable for applications beyond conventional electricity generation, including industrial process heat, hydrogen production, district heating, desalination, floating nuclear power plants and, potentially, maritime propulsion.

Evolution of Small Modular Reactors

Although the term **Small Modular Reactor** has gained prominence only during the past decade, the underlying concept is not new. Nuclear reactors designed for submarines, aircraft carriers and icebreakers have demonstrated for several decades that compact

nuclear reactors can safely operate in confined spaces while providing high power output and long operating endurance.

Modern SMRs build upon this experience by integrating advances in reactor design, digital instrumentation, passive safety systems, modular construction techniques and advanced materials. Instead of constructing large nuclear power plants entirely at site, SMRs are designed so that major components or complete reactor modules can be manufactured under factory-controlled conditions, transported to the installation site and assembled with significantly reduced construction time and complexity.

Worldwide, more than **80 SMR designs and concepts** are currently under development, representing a broad range of reactor technologies and applications. These include light-water reactors, heavy-water reactors, high-temperature gas-cooled reactors, liquid-metal fast reactors, molten salt reactors and microreactors.

Key Characteristics of SMRs

SMRs combine several engineering characteristics that distinguish them from conventional large nuclear reactors.

Compact and Modular Design

SMRs occupy a significantly smaller physical footprint than conventional reactors, enabling deployment where land availability or space constraints limit construction of large nuclear power plants. Their compact dimensions also make them attractive for offshore installations, floating nuclear power platforms and future marine propulsion systems.

Factory-Based Manufacturing

One of the defining characteristics of SMRs is modular construction. Major reactor components can be manufactured, tested and quality-assured in dedicated factories before being transported to the installation site. This approach is expected to improve manufacturing consistency, reduce construction risks and shorten project schedules.

Flexible Deployment

SMRs may be deployed as single modules or multiple modules operating together. Capacity can therefore be increased progressively as demand grows without constructing an entirely new power plant.

Enhanced Safety Features

Many SMR designs incorporate **passive safety systems**, relying on natural circulation, gravity, convection and stored energy instead of active pumps or external power

supplies. These features simplify emergency cooling arrangements and improve overall plant resilience. It should be noted that passive safety is a feature of many modern reactor designs and is not exclusive to SMRs.

Long Operating Cycles

Many SMR concepts are designed for extended fuel cycles, allowing operation for several years before refuelling. This characteristic is particularly attractive for remote installations and marine applications where frequent refuelling may be operationally difficult.

Multi-Purpose Applications

Beyond electricity generation, SMRs can simultaneously provide:

- industrial process heat
- hydrogen production
- ammonia and synthetic fuel production
- desalination
- district heating
- offshore energy supply
- electric propulsion systems

This flexibility significantly broadens the potential role of SMRs within future low-carbon energy systems.

Types of SMRs

SMRs are **not a single reactor technology** but rather a family of reactor designs characterised by their size and modularity. Different SMRs employ different reactor technologies depending on their intended application.

The principal reactor families include:

- Pressurised Water Reactors (PWR)
- Boiling Water Reactors (BWR)
- Pressurised Heavy Water Reactors (PHWR)
- High-Temperature Gas-Cooled Reactors (HTGR)
- Liquid Metal Fast Reactors (LMFR)

- Molten Salt Reactors (MSR)

Among these, **light-water SMRs based on Pressurised Water Reactor technology are considered the most mature and are expected to see the earliest commercial deployment**. Advanced Generation-IV concepts such as molten salt reactors and high-temperature gas-cooled reactors are expected to mature over a longer timeframe.

Indian Context

India has identified nuclear energy as a key component of its long-term clean energy and energy security strategy. As part of the **Nuclear Energy Mission** announced under the Union Budget 2025–26, the Government has provided **₹20,000 crore** for the research, development and deployment of Small Modular Reactors (SMRs), with a target of making at least **five indigenously designed SMRs operational by 2033**. The programme aims to accelerate indigenous reactor technology, strengthen domestic manufacturing capability and support the country's objective of achieving **100 GW of nuclear power capacity by 2047**.

India's indigenous SMR programme presently comprises three major initiatives:

- **220 MWe Bharat Small Modular Reactor (BSMR-200)**
- **55 MWe Small Modular Reactor (SMR-55)**
- **High-Temperature Gas-Cooled Reactor (HTGR) of up to 5 MWth** for hydrogen production

In-principle approval has been accorded for all three reactor programmes. The lead units of BSMR-200 and SMR-55 are proposed to be established at **Tarapur Atomic Power Station**, while the HTGR demonstration unit is proposed at **BARC, Visakhapatnam**.

An important feature of the programme is the emphasis on **indigenous technology development**. BARC has developed key reactor technologies, including advanced reactor-vessel materials, forging technologies and control systems. The PIB further states that a majority of the equipment required for these reactors can be manufactured by Indian industry with technological support from BARC, creating opportunities for expansion of the domestic nuclear manufacturing ecosystem.

The SMR programme complements India's broader three-stage nuclear power programme, ongoing fast breeder reactor development, thorium fuel-cycle research and the national objective of expanding clean, reliable and dispatchable energy sources. Although the current programme is primarily intended for land-based deployment, the technologies and industrial capabilities developed through these

initiatives provide a strong foundation for examining future maritime applications of compact nuclear reactors.

35. Potential Maritime Applications of SMRs

The compact size, modular construction and flexible operating characteristics of Small Modular Reactors make them suitable for a wide range of maritime and offshore applications. International studies by the IAEA and EMSA recognise SMRs as one of the most promising reactor technologies for extending the use of nuclear energy into the maritime domain.

Merchant Ship Propulsion

SMRs are being actively evaluated as potential propulsion systems for future merchant vessels. Their high energy density and long fuel cycles could enable ships to operate for extended periods without refuelling, while significantly reducing greenhouse gas emissions and dependence on conventional marine fuels. They are particularly attractive for vessels operating on long international routes where endurance and cargo capacity are important considerations.

Floating Nuclear Power Plants

Floating Nuclear Power Plants (FNPPs) employ compact SMRs mounted on floating platforms or barges to provide reliable electricity and heat to coastal regions, islands, offshore facilities and industrial clusters. The IAEA identifies FNPPs as an emerging application capable of supplying clean baseload power while avoiding many of the site constraints associated with land-based nuclear power plants.

Port and Offshore Power Supply

SMRs can provide continuous low-carbon electricity to ports, shipyards, offshore platforms and coastal industrial zones. Such installations can support shore power (cold ironing), electrified cargo handling equipment, port operations and future green-fuel production while reducing dependence on fossil-fuel-based grid electricity.

Remote Coastal and Island Energy Systems

Many coastal communities and island territories rely on imported fossil fuels for electricity generation. SMRs offer a potential long-term solution by supplying stable baseload power with minimal fuel logistics and reduced greenhouse gas emissions. Their modular design also enables deployment where conventional large nuclear power plants may not be feasible.

Desalination

SMRs can simultaneously generate electricity and process heat, making them suitable for large-scale seawater desalination. Nuclear-powered desalination can support freshwater requirements of ports, island territories, offshore installations and water-stressed coastal regions.

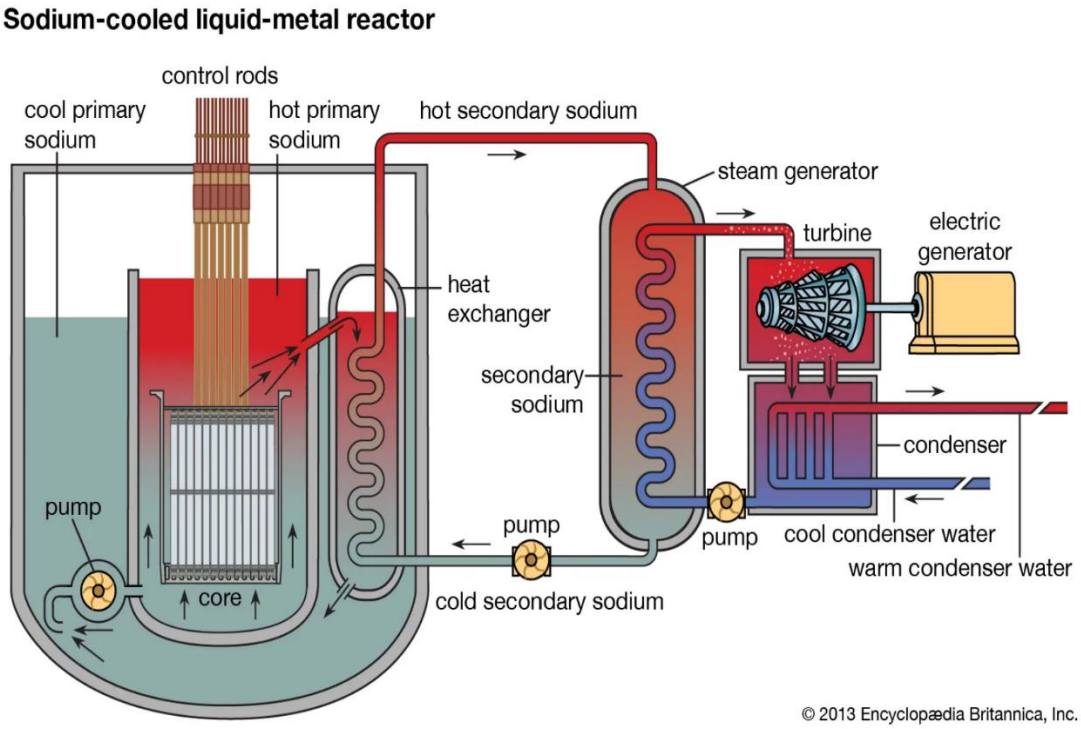
Hydrogen, Ammonia and Synthetic Fuel Production

SMRs can provide both electricity and high-temperature process heat required for production of hydrogen and hydrogen-derived fuels such as ammonia and synthetic fuels. These fuels are expected to play an important role in the decarbonisation of international shipping. Nuclear-assisted fuel production can therefore complement the development of future green maritime fuel hubs.

Integrated Maritime Energy Systems

Beyond individual applications, SMRs offer the possibility of developing integrated maritime energy ecosystems in which a single reactor installation simultaneously supplies electricity for ports, shore power for ships, desalination facilities, hydrogen production plants and nearby coastal industries. Such integrated systems could enhance energy security, improve infrastructure resilience and support the transition towards low-carbon maritime operations.

Molten-Metal-Based Reactors (Liquid Metal-Cooled Reactors)



Molten-metal-based reactors, more commonly referred to as **Liquid Metal-Cooled Reactors (LMRs)**, are nuclear reactors in which a liquid metal is used as the primary coolant instead of water. The most commonly used liquid metals include **sodium, lead and lead-bismuth eutectic**, although other metals have also been investigated. Most liquid-metal-cooled reactors operate with a **fast neutron spectrum** and are therefore classified as **Liquid Metal Fast Reactors (LMFRs)**. These reactors have attracted considerable international interest because of their ability to operate at high temperatures while maintaining relatively low system pressure, making them suitable for compact, high-power and long-endurance applications.

Liquid-metal-cooled reactors have been developed primarily for fast breeder reactor programmes and have also been employed in certain nuclear-powered submarines and experimental naval propulsion systems. Their high power density, excellent heat-transfer characteristics and long fuel cycles make them one of the advanced reactor technologies being evaluated for future marine nuclear applications.

Working Principle

Unlike conventional pressurised water reactors, which use water as both coolant and moderator, liquid-metal reactors circulate molten metal through the reactor core to remove the heat generated during nuclear fission.

The heated liquid metal transfers thermal energy through intermediate heat exchangers to a secondary circuit, where steam is generated to drive turbines for electricity

generation or marine propulsion. Because liquid metals possess very high boiling points, the primary coolant remains in the liquid phase even at temperatures significantly higher than those encountered in water-cooled reactors. This enables reactor operation at **near-atmospheric pressure**, thereby reducing the need for heavily pressurised coolant systems.

Most liquid-metal reactors are designed as **fast-spectrum reactors**, where neutrons are not slowed by a moderator. This allows efficient utilisation of nuclear fuel and supports breeder reactor configurations capable of generating additional fissile material from fertile isotopes such as uranium-238 or thorium-derived fuel cycles.

Principal Types of Liquid Metal-Cooled Reactors

Liquid-metal reactors are generally classified according to the coolant employed.

Sodium-Cooled Fast Reactors (SFR)

Sodium is the most mature and widely deployed liquid-metal coolant. It possesses excellent thermal conductivity, low neutron absorption and favourable heat-transfer characteristics. Sodium-cooled fast reactors have been extensively developed in several countries and form the basis of many existing fast breeder reactor programmes.

Lead-Cooled Fast Reactors (LFR)

Lead offers high boiling temperature, excellent radiation shielding characteristics and chemical stability with water and air. These properties make lead-cooled reactors attractive for future advanced reactor concepts, although their higher density introduces additional engineering considerations for pumps, structures and materials.

Lead-Bismuth Eutectic Reactors (LBE)

Lead-bismuth eutectic has a lower melting point than pure lead while retaining many of its thermal characteristics. It has been used in certain naval propulsion applications and is being studied for advanced reactor systems requiring compact configurations and extended operating life. Material compatibility and corrosion control remain important areas of research.

Key Features

Liquid-metal-cooled reactors possess several engineering characteristics that distinguish them from conventional water-cooled reactors.

High Heat-Transfer Capability

Liquid metals exhibit significantly higher thermal conductivity than water, enabling rapid removal of heat from the reactor core and supporting compact reactor configurations.

High-Temperature, Low-Pressure Operation

The high boiling points of sodium, lead and lead-bismuth permit reactor operation at elevated temperatures while maintaining relatively low operating pressure. This improves thermal efficiency and reduces the complexity associated with highly pressurised coolant systems.

High Power Density

Efficient heat removal allows greater power generation within a relatively small reactor volume, an important consideration where space and weight are constrained, such as onboard ships and submarines.

Long Fuel Cycles

Fast reactors are capable of operating for extended periods between refuelling, making them suitable for applications requiring long operational endurance.

Efficient Fuel Utilisation

Fast neutron reactors make more effective use of available nuclear fuel and can support breeder configurations that generate additional fissile material, thereby improving long-term fuel utilisation.

Indian Context

India has developed substantial expertise in **sodium-cooled fast reactor technology** through the implementation of the second stage of its three-stage nuclear power programme.

The country's principal facilities include:

- **Fast Breeder Test Reactor (FBTR), Kalpakkam**
- **500 MWe Prototype Fast Breeder Reactor (PFBR), Kalpakkam**

The Prototype Fast Breeder Reactor attained **first criticality in April 2026**, marking an important milestone in India's fast-reactor programme and the transition towards Stage II of the national nuclear strategy. As highlighted in the PIB factsheet, the PFBR strengthens India's indigenous capability in reactor engineering, sodium coolant technology, advanced materials, fuel-cycle management and fast-reactor operation.

The experience gained through FBTR and PFBR contributes to national capability in:

- sodium coolant technology
- fast-reactor physics
- reactor design and systems engineering
- high-temperature materials
- heat-transfer systems
- closed nuclear fuel cycle
- reactor operation and maintenance
- advanced nuclear manufacturing

Although these facilities are land-based power reactors, the technological knowledge generated through India's fast-reactor programme provides an important foundation for evaluating compact liquid-metal reactor concepts for future maritime applications.

Potential Maritime Applications

Liquid-metal-cooled reactors are considered one of the advanced reactor technologies with potential relevance for future maritime applications, particularly where compact size, high power density and extended operating endurance are important requirements.

Potential applications include:

Nuclear Propulsion for Long-Endurance Merchant Vessels

Compact fast reactors could support propulsion of specialised merchant vessels operating on long international routes with minimal refuelling requirements.

Floating Nuclear Power Platforms

Liquid-metal reactors may be employed in floating nuclear power stations supplying electricity and heat to ports, islands, offshore installations and remote coastal regions.

Offshore Energy Systems

Compact reactors may provide continuous low-carbon electricity for offshore industrial facilities, offshore energy hubs and remote marine infrastructure.

Port and Coastal Energy Supply

High-temperature reactor systems could support reliable electricity generation, industrial process heat, desalination and future hydrogen production for maritime decarbonisation.

Engineering Considerations for Marine Deployment

While liquid-metal reactors possess several characteristics favourable for marine applications, adapting them for civilian merchant vessels would require specialised engineering beyond existing land-based reactor technology.

Key areas include:

- reactor miniaturisation
- compact biological shielding
- shipboard integration
- vibration and motion tolerance
- corrosion management in marine environments
- coolant chemistry control
- passive safety systems
- emergency cooling arrangements
- classification and certification
- nuclear safety and licensing for civilian maritime operations

These considerations represent engineering development areas rather than fundamental technological barriers and would form part of the design process for any future marine liquid-metal reactor.

Liquid-metal-cooled reactors represent one of the most advanced reactor technologies currently under development for high-performance nuclear applications. Their ability to combine **high power density, efficient heat transfer, high-temperature operation**

and extended fuel cycles makes them attractive candidates for future marine propulsion, floating nuclear power platforms and offshore energy systems.

India's experience with sodium-cooled fast reactors through the **FBTR** and **PFBR** has established important indigenous capabilities in fast-reactor technology, coolant management, advanced materials and closed fuel-cycle engineering. While dedicated marine reactor development would require further engineering and regulatory work, these capabilities provide a strong technological foundation for evaluating liquid-metal-based reactors as part of future civilian maritime nuclear applications.

36. Floating Nuclear Power Platforms (Floating Nuclear Power Plants - FNPPs)

Floating Nuclear Power Plants (FNPPs) are nuclear power generation facilities installed on floating structures such as barges, ships or offshore platforms. Unlike nuclear-powered ships, where the reactor is intended primarily for propulsion, the principal purpose of an FNPP is to generate electricity, heat and other energy products for shore-based or offshore users. Electricity is transmitted to the onshore grid through subsea cables, while thermal energy may be utilised for district heating, industrial processes or seawater desalination.

The concept combines proven marine engineering with mature nuclear reactor technology to provide reliable, low-carbon energy in locations where construction of conventional land-based nuclear power plants is technically difficult, economically unviable or environmentally constrained. Floating deployment also enables reactors to be manufactured in shipyards, transported to the operating site by sea, and relocated or decommissioned when required.

Interest in FNPPs has increased significantly in recent years due to global decarbonisation efforts, growing electricity demand in coastal regions, expansion of offshore industries and advances in Small Modular Reactor (SMR) technologies. The IAEA recognises transportable and floating SMRs as a potential solution for reliable clean energy while supporting net-zero emission objectives.

Evolution of Floating Nuclear Power Plants

The concept of floating nuclear power generation is not new. Early work dates back to the 1960s when the United States developed the **MH-1A Sturgis**, a floating nuclear power station built on a converted Liberty Ship. Although technically successful, widespread commercial deployment did not materialise due to economic factors and the availability of inexpensive fossil fuels.

Interest revived during the past decade owing to advances in modular reactor technologies and increasing emphasis on low-carbon energy systems. At present, **Russia remains the only country operating a commercial floating nuclear power plant**, while several countries and technology developers are investigating next-generation floating SMRs.

Basic Configuration and Working Principle

An FNPP generally consists of a compact nuclear reactor installed on a specially designed floating platform. The reactor produces heat through nuclear fission, which is converted into electricity using conventional steam turbine technology.

The floating unit is permanently moored or berthed at a coastal location and connected to shore through electrical transmission cables and thermal distribution systems. Depending on the design, the plant may simultaneously provide:

- Electricity
- Industrial process heat
- District heating
- Seawater desalination
- Hydrogen production
- Ammonia production
- Steam for industrial applications

Unlike merchant vessels, these platforms normally remain stationary throughout their operational life, requiring only periodic towing for maintenance, refuelling or decommissioning.

Key Characteristics and Advantages

Floating nuclear power plants combine several advantages of modular nuclear reactors with those of marine engineering.

Modular and Factory-Based Construction

Most floating plants are designed to be constructed in shipyards under controlled manufacturing conditions before being transported to their deployment site. This approach reduces on-site civil construction, improves quality control and shortens project schedules.

Minimal Land Requirement

Since the reactor is installed offshore or alongside existing port infrastructure, extensive land acquisition, excavation and large-scale site preparation are avoided. This is particularly beneficial for densely populated coastal regions.

Relocatable Infrastructure

Unlike conventional nuclear plants, floating units can be relocated to another site if regional electricity demand changes or after completion of a project's operational life.

Continuous Low-Carbon Power

FNPPs provide uninterrupted baseload electricity independent of weather conditions, complementing renewable energy sources such as wind and solar.

Marine Cooling

The surrounding seawater offers an abundant heat sink for condenser cooling, improving thermal efficiency and supporting both active and passive heat removal systems.

Centralised Maintenance

Major maintenance activities, reactor refuelling and eventual decommissioning may be undertaken at specialised shipyards rather than at every deployment site, reducing operational complexity.

Demonstrated Commercial Example – Akademik Lomonosov

The world's first commercial floating nuclear power plant is **Akademik Lomonosov**, developed by Russia's state nuclear corporation Rosatom.

It is a **non-self-propelled floating power barge** permanently stationed at **Pevek**, in Russia's Chukotka region. Commercial operation commenced in **May 2020**, making it the first operational floating nuclear power plant supplying electricity and district heating to a civilian population.

Key characteristics include:

- Two modified **KLT-40S pressurised water reactors**, derived from Russian nuclear icebreaker technology.
- Approximately **70 MWe electrical output** (35 MWe per reactor) and about **300 MW thermal output**.
- Supplies electricity to the regional grid while simultaneously providing heat to the town of Pevek.
- Intended to replace ageing coal-fired and land-based nuclear generation in the region.
- Demonstrates the technical feasibility of long-term commercial operation of floating nuclear power infrastructure under Arctic conditions.

The project has established a practical reference for future FNPP development, although subsequent designs are expected to employ newer reactor technologies with higher power output and enhanced passive safety features.

Global Development Trends

The IAEA notes that increasing interest in floating nuclear platforms is being driven by the transition towards net-zero energy systems and the maturation of SMR technologies.

Several advanced concepts are under development internationally, including:

- Floating SMRs based on pressurised water reactors.
- High-temperature gas-cooled reactors.
- Molten salt reactors.
- Advanced liquid-metal-cooled reactors.
- Multi-module floating energy platforms capable of producing electricity, hydrogen, desalinated water and industrial heat simultaneously.

Several private developers are also evaluating floating nuclear systems for supplying energy to offshore industries, mining operations, isolated islands and maritime industrial clusters.

Potential Applications

Floating nuclear power platforms can support a wide range of civilian maritime and coastal applications.

Reliable Power for Islands and Remote Coastal Communities

Many islands and remote coastal settlements depend on expensive diesel-based generation. FNPPs can provide continuous low-carbon electricity without requiring extensive transmission infrastructure.

Port Electrification

Major commercial ports require significant electrical power for container handling equipment, cold ironing (shore power), warehouses and logistics operations. Floating nuclear plants could supply dependable low-carbon electricity while reducing dependence on fossil-fuel-based grids.

Offshore Energy Infrastructure

Oil and gas platforms, offshore wind integration hubs, subsea processing facilities and future offshore industrial clusters require reliable power supplies that are often difficult to provide using conventional generation.

Green Hydrogen and Green Ammonia Production

Continuous nuclear electricity and high-temperature process heat can improve utilisation rates of electrolysers, supporting large-scale production of hydrogen, ammonia and synthetic maritime fuels.

Seawater Desalination

Floating nuclear plants can simultaneously produce electricity and desalinated water, offering an integrated solution for water-scarce coastal regions.

Emergency or Temporary Power Supply

FNPPs can be deployed following natural disasters or during infrastructure shortages to restore electricity and essential services without constructing permanent generation facilities.

Challenges

Despite their advantages, floating nuclear power plants present several technical, regulatory and societal challenges.

Regulatory Framework

Existing international nuclear regulations were largely developed for land-based reactors. Deployment of floating reactors requires harmonisation between nuclear safety regulations, maritime law, port regulations and flag-state responsibilities.

Nuclear Security

Protection against sabotage, piracy, terrorism and cyber threats assumes greater importance for offshore nuclear installations.

Environmental Protection

Although floating plants minimise land impacts, careful assessment is required regarding marine ecology, thermal discharge, emergency planning and spent fuel management.

Public Acceptance

As with all nuclear technologies, successful deployment depends upon public confidence, transparent regulation and demonstrable safety performance.

Insurance and Liability

International conventions governing nuclear liability and marine operations require further evolution to accommodate floating nuclear infrastructure.

Port Infrastructure

Suitable mooring systems, electrical transmission facilities, emergency response capability and long-term servicing infrastructure are essential prerequisites for deployment.

Relevance for India

Although India has not announced a floating nuclear power plant programme, several ongoing national initiatives provide an enabling technological foundation.

India is expanding its nuclear sector through the **Nuclear Energy Mission**, with a target of achieving **100 GW of nuclear capacity by 2047**, including the development of indigenous Small Modular Reactors. Simultaneously, the country possesses extensive experience in nuclear engineering, marine engineering and shipbuilding, creating opportunities to evaluate floating nuclear technologies in the future.

Potential long-term applications in the Indian context include:

- Reliable electricity for island territories such as Andaman & Nicobar and Lakshadweep.
- Low-carbon power supply for major ports and maritime industrial clusters.
- Offshore energy support for future offshore infrastructure.
- Dedicated electricity and process heat for green hydrogen and green ammonia production.
- Large-scale desalination for water-stressed coastal cities and industrial zones.
- Integration with India's future SMR programme, advanced nuclear technologies and indigenous shipbuilding capabilities.

Any future deployment would require development of a dedicated regulatory framework, maritime nuclear safety standards, specialised port infrastructure and comprehensive emergency preparedness arrangements.

37. Nuclear Power Applications for Port Decarbonization

Ports are rapidly evolving from conventional cargo-handling facilities into integrated energy, logistics and industrial hubs. In addition to supporting shipping operations, modern ports supply electricity to terminals, warehouses, cold-storage facilities, shipyards, industrial clusters and transport infrastructure. They are also expected to become production and bunkering centres for future low-carbon fuels such as hydrogen, ammonia and synthetic fuels.

Meeting these growing energy demands while simultaneously reducing greenhouse gas emissions presents a significant challenge. Although renewable energy sources such as solar and wind are expected to play an important role, their intermittent nature necessitates complementary sources of reliable, dispatchable and low-carbon electricity. In this context, international organisations have identified **Small Modular Reactors (SMRs)** and **Floating Nuclear Power Plants (FNPPs)** as potential options for providing continuous clean electricity and process heat to ports and surrounding industrial ecosystems.

Unlike conventional large nuclear power plants that primarily supply national electricity grids, coastal SMRs or floating nuclear platforms could be deployed closer to major ports, enabling direct supply of electricity, heat and other energy products to maritime infrastructure while supporting long-term decarbonisation objectives.

Nuclear Energy and Port Decarbonization

Nuclear power offers several characteristics that make it attractive for future port energy systems.

- Continuous 24×7 low-carbon electricity independent of weather conditions.
- High energy density requiring comparatively small land footprint.
- Capability to simultaneously produce electricity, steam and industrial process heat.
- Reliable power for energy-intensive port operations.
- Integration with hydrogen, ammonia and synthetic fuel production.

- Long operating cycles with high availability.

These characteristics allow nuclear energy to complement renewable energy sources while supporting reliable operation of ports, shipyards and maritime industrial clusters.

Contribution towards Scope 1 Emission Reduction

Scope 1 emissions arise directly from sources owned or controlled by the port authority or terminal operator.

Nuclear-generated electricity can contribute to reducing these emissions by enabling electrification of equipment traditionally powered by diesel or other fossil fuels.

Potential applications include:

- Electrification of quay cranes, rubber-tyred gantry cranes and material-handling equipment.
- Replacement of diesel generators used for backup and auxiliary power.
- Electrification of port vehicles, trucks, buses and operational support equipment.
- Charging infrastructure for electric harbour craft, tugs and pilot boats.
- Clean electricity and heat for port administration buildings, maintenance workshops and engineering facilities.
- Electrified cargo-handling systems and automated terminal equipment.

The availability of continuous nuclear-generated electricity enables these systems to operate reliably without dependence on fossil-fuel-based generation.

Contribution towards Scope 2 Emission Reduction

Scope 2 emissions arise from purchased electricity consumed by ports and associated facilities.

A dedicated coastal SMR or floating nuclear power platform could provide continuous low-carbon electricity directly to port infrastructure, thereby reducing dependence on carbon-intensive grid electricity.

Potential beneficiaries include:

- Container and bulk cargo terminals.
- Warehouses and cold-storage facilities.
- Shipbuilding and ship repair yards.
- Lighting systems and digital infrastructure.
- Shore power (Cold Ironing) systems supplying electricity to ships alongside.
- Port administration complexes and logistics facilities.

Reliable nuclear electricity can also improve resilience of critical port infrastructure by providing stable baseload power throughout the year.

Contribution towards Scope 3 Emission Reduction

Scope 3 emissions encompass indirect emissions across the wider maritime value chain, including shipping, logistics and industrial activities associated with the port.

Nuclear energy can support reduction of these emissions through:

- Production of low-carbon hydrogen.
- Production of green ammonia and synthetic maritime fuels.
- Electrification of privately operated terminals.
- Clean electricity for rail freight and inland logistics systems.
- Low-carbon energy supply to port-based industrial clusters.
- Charging or power supply for electric coastal vessels and future battery-electric shipping.
- Supply of industrial process heat for manufacturing activities within the port ecosystem.

By supporting production of alternative marine fuels and decarbonisation of associated industries, nuclear energy contributes beyond the physical boundaries of the port itself.

Integrated Maritime Energy Hubs

One of the emerging concepts internationally is the development of **Integrated Maritime Energy Hubs**, where ports function simultaneously as logistics centres, clean-energy producers and industrial clusters.

Within such a framework, a coastal SMR or floating nuclear platform could provide:

- Continuous electricity for port operations.
- Shore power for berthed vessels.
- Process heat for industries.
- Hydrogen production through electrolysis.
- Ammonia and synthetic fuel production.
- Desalinated water for industrial and municipal use.
- Electricity for surrounding industrial parks and coastal communities.

Such integrated systems improve overall energy efficiency while supporting maritime decarbonisation and regional economic development.

Relevance for India

India is undertaking large-scale modernisation of its ports under initiatives such as the **Harit Sagar Green Port Guidelines**, expansion of shore power infrastructure, green hydrogen development, maritime decarbonisation and establishment of green maritime industrial clusters.

As India's nuclear programme expands through indigenous SMRs and the **Nuclear Energy Mission**, compact coastal nuclear energy systems could, in the long term, complement renewable energy by supplying reliable low-carbon electricity to major ports, shipyards and maritime industrial regions.

Potential long-term applications include:

- Decarbonisation of major commercial ports.
- Reliable power for shipbuilding and ship-repair facilities.
- Green hydrogen and green ammonia production.
- Electrification of future shore-power systems.
- Power supply to coastal industrial corridors.

- Desalination facilities supporting water security in coastal regions.

Any future implementation would require comprehensive techno-economic studies, environmental assessment, regulatory approvals and integration with national nuclear and maritime policies.

38. Green Ports

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.

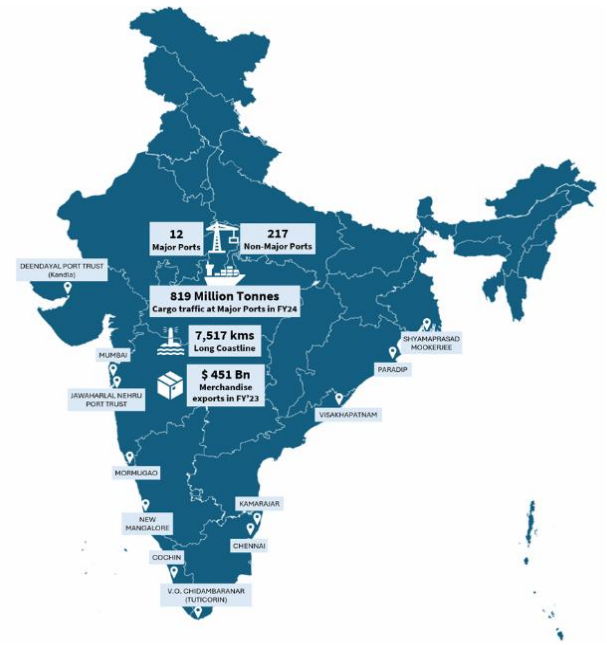


Figure 1 Ports of India

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**.

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 Maritime Decarbonization Policy Framework 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.

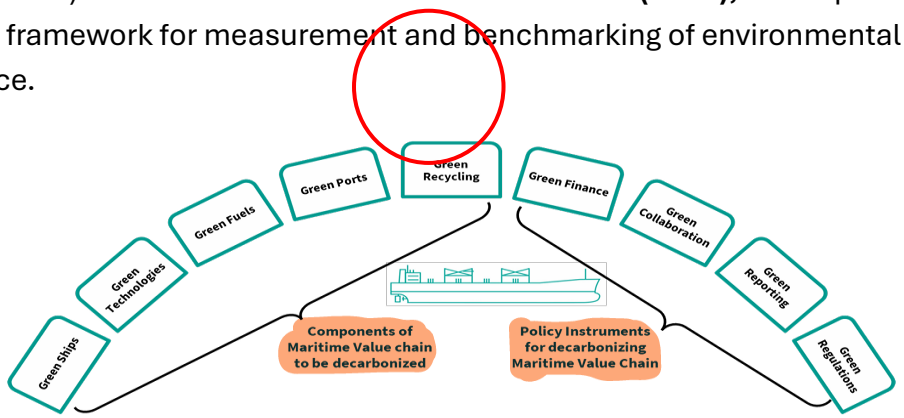


Figure 2 Core areas of NGSP

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

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

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 Solution and Key opportunities in green ports

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."

39. Sustainable Indicators Framework for Indian Ports

As part of India's broader transition towards sustainable maritime development, a structured framework of measurable sustainability indicators is being institutionalized for Indian ports. The objective is not merely to adopt isolated environmental measures, but to establish a coherent system through which port performance can be evaluated, benchmarked and progressively improved.

The proposed framework rests on four interlinked indicators:

1. Green Port Index (GPI)

The Green Port Index serves as a comprehensive evaluation tool to assess the overall environmental performance of ports. It measures parameters such as:

- Carbon footprint and greenhouse gas emissions
- Adoption of alternative fuels
- Energy efficiency measures
- Sustainable logistics practices
- Waste management systems

The intent of GPI is to move beyond project-based interventions and bring sustainability into routine port operations. By quantifying environmental performance across multiple dimensions, ports can identify specific gaps and prioritize targeted improvements. Over time, the index will enable benchmarking across ports and support evidence-based decision-making.

2. Port Readiness Level (PRL)

The Port Readiness Level indicator evaluates the preparedness of ports for the ongoing energy transition and digital transformation.

PRL examines:

- Infrastructure readiness for alternative fuels
- Compliance alignment with evolving international environmental regulations
- Digital systems supporting operational efficiency
- Integration of sustainability into planning and governance

As global shipping moves toward low-carbon fuels and stricter environmental standards, ports must adapt accordingly. PRL provides a structured method to assess whether ports are capable of supporting next-generation vessels and future regulatory requirements. This indicator ensures that ports are not reactive, but forward-prepared.

3. Shore Power Readiness Indicator

Shore power, or cold ironing, is increasingly recognized as a critical intervention to reduce emissions from ships at berth. The Shore Power Readiness Indicator evaluates:

- Availability of onshore power supply infrastructure
- Capacity to integrate renewable energy sources
- Grid stability and connection systems
- Operational protocols for ship–shore interface

Emissions from berthed vessels contribute significantly to local air pollution. By measuring infrastructure readiness and operational capability, this indicator supports phased implementation of shore-to-ship power systems across Indian ports. It also aligns with international decarbonization pathways and improves air quality in port cities.

4. **Environmental Ship Index (ESI)**

The Environmental Ship Index focuses on incentivizing ship operators to reduce emissions. It evaluates vessels based on emissions performance, including:

- Nitrogen oxides (NOx)
- Sulphur oxides (SOx)
- Carbon dioxide (CO_2)

Ports may integrate ESI-based incentives such as differential port dues or priority berthing for higher-rated vessels. This creates a market-based mechanism encouraging cleaner ship operations and aligns port policy with vessel-level environmental performance.

Integrated Impact of the Framework

Individually, each indicator addresses a specific dimension of port sustainability. Collectively, they create a robust governance framework that integrates infrastructure, operations, compliance and incentives.

Institutionalizing these indicators will:

- Enable measurable tracking of environmental performance across Indian ports
- Support structured transition toward low-carbon port operations

- Strengthen India's credibility in global green maritime logistics
- Facilitate participation in international green shipping corridors
- Contribute to long-term net-zero objectives

Rather than relying solely on regulatory mandates, this framework introduces performance measurement and benchmarking into port governance. Over time, it will support standardization of sustainability practices across both major and non-major ports.

By embedding these indicators within policy and operational systems, India positions its ports not only as trade gateways, but as active enablers of the global maritime energy transition.

40. GHG Emission Scopes

Effective decarbonisation of the port sector requires a **clear understanding of emission sources across the port ecosystem**. Ports are complex, multi-actor environments where emissions arise not only from port-owned assets but also from energy consumption and broader logistics activities.

To enable **standardised measurement, reporting and mitigation**, port emissions are classified into **three internationally recognised scopes - Scope 1, Scope 2 and Scope 3**, aligned with global frameworks such as the GHG Protocol.

This classification allows ports to transition from **fragmented emission management to a holistic, system-wide decarbonisation approach**.

Scope 1 – Direct Emissions

Scope 1 emissions refer to **direct greenhouse gas emissions from sources owned or controlled by the port authority or terminal operators**.

Key Sources

- Diesel generators
- Cargo handling equipment (cranes, RTGs, forklifts)
- Dredgers and tugboats
- Port-owned vehicles
- Fuel-based machinery within port premises

Characteristics

- Fully under **operational control of port authorities**
- Most straightforward to **measure, monitor and regulate**
- Typically dependent on fossil fuel consumption

Strategic Importance

- Represents the **starting point for decarbonisation interventions**
- Offers **immediate emission reduction opportunities**

Scope 2 – Indirect Emissions (Electricity Consumption)

Scope 2 emissions arise from **electricity purchased and consumed by port operations but generated externally**, typically from the grid.

Key Sources

- Terminal lighting systems
- Pumping operations
- Reefer container power supply
- Administrative and operational buildings
- Electrified equipment and terminal infrastructure

Characteristics

- Emissions are **indirect but energy-linked**
- Strongly influenced by **grid emission intensity**
- High contribution in regions with **coal-dominated power generation**

Strategic Importance

- Increasing relevance due to **electrification of port operations**
- Critical lever for decarbonisation through **clean energy transition**

Scope 3 – Other Indirect Emissions (Value Chain Emissions)

Scope 3 emissions encompass **all other indirect emissions occurring across the port value chain**, outside direct ownership or control of the port.

Key Sources

- Ships at berth using auxiliary engines
- Cargo transport via trucks, rail and barges
- Hinterland logistics operations
- Waste treatment and disposal
- Business travel and associated activities
- Upstream and downstream supply chain emissions

Characteristics

- **Largest and most complex emission category**
- Occurs beyond the physical boundary of the port
- Requires **multi-stakeholder coordination**

Strategic Importance

- Represents the **dominant share of total port-related emissions**
- Central to achieving **deep decarbonisation outcomes**

Integrated Understanding of Port Emissions

The three scopes together provide a **comprehensive view of emissions across the port ecosystem**:

- Scope 1 → Operational emissions within direct control
- Scope 2 → Energy-linked emissions influenced by power systems
- Scope 3 → Value chain emissions requiring collaborative action

This integrated classification enables:

- End-to-end emissions mapping
- Prioritisation of mitigation strategies
- Alignment with international reporting standards

41. Gujarat's Green Ports Journey – Engagement with India's National Maritime Decarbonisation Policy Framework (NMDP)

Gujarat has one of India's most significant maritime and port ecosystems, comprising major and non-major ports, large industrial and logistics clusters and growing renewable-energy and green-fuel capabilities. As India advances towards a low-carbon maritime economy, Gujarat is well positioned to serve as an important implementation geography for the Green Ports pillar of the National Maritime Decarbonisation Policy (NMDP) Framework.

The Green Ports pillar provides the national policy direction for reducing emissions associated with port and maritime operations while simultaneously improving energy efficiency, environmental performance, climate resilience and operational efficiency. The approach extends beyond the physical boundary of ports and covers Scope 1, Scope 2 and Scope 3 emissions, technology and digitalisation, research and innovation, international cooperation and maritime diplomacy and institutional governance.

The objective is to progressively transition ports from conventional infrastructure and logistics nodes into integrated green maritime ecosystems, capable of supporting low- and zero-emission shipping, alternative fuels, renewable energy, efficient logistics and environmentally responsible coastal development.

Scope 1 – Port Operations and Equipment

Scope 1 covers emissions arising directly from activities and assets under the operational control of ports. These include cargo-handling equipment, internal vehicles, diesel generators, tugs, dredgers, pilot boats and other harbour craft.

The transition under NMDP envisages progressive electrification and decarbonisation of port equipment, vehicles and harbour craft, supported by systematic measurement and reporting of emissions. Replacement of conventional diesel-powered equipment with electric or other low/zero-emission alternatives can significantly reduce both greenhouse-gas emissions and local air pollutants within port areas.

The Green Tug Transition Programme provides an important pathway for transitioning harbour tugs towards greener propulsion systems. Going forward, its principles can be extended to dredgers and other harbour craft, creating a broader pathway for decarbonisation of port-controlled marine assets.

The transition is also expected to be supported by port-level emissions inventories and monitoring systems so that reductions achieved through electrification and operational improvements can be measured against established baselines.

Scope 2 – Port Energy and Infrastructure

Scope 2 addresses emissions associated with the electricity and energy consumed by port infrastructure and operations. The principal interventions include renewable-energy integration, shore-to-ship power and improvements in overall energy efficiency.

Gujarat already provides a strong foundation for this transition. A 1,000 MWp ground-mounted solar PV project is underway at Deendayal Port, demonstrating the potential for large-scale renewable-energy deployment within the port ecosystem.

Increasing the renewable-energy share of ports can progressively decarbonise electricity used for cargo-handling systems, buildings, terminals, lighting, cold-chain infrastructure and other port operations. Energy-efficiency measures can complement this transition by reducing overall energy demand.

A further priority is the scaling of shore power infrastructure. Shore-to-ship power enables vessels to switch off their auxiliary engines while at berth and draw electricity from the shore, thereby reducing fuel consumption, emissions and local air pollution.

Large-scale adoption will require adequate grid capacity, port-side electrical infrastructure, vessel compatibility, common technical standards and appropriate financing arrangements. Development of a dedicated shore-power financing framework can therefore facilitate wider deployment across major and non-major ports.

Scope 3 – Vessels, Value Chain and Coastal Environment

Scope 3 expands the decarbonisation approach beyond emissions directly controlled by ports and addresses emissions and environmental impacts associated with the wider maritime and logistics value chain.

This includes emissions arising from vessels calling at ports, anchorage and waiting periods, cargo evacuation, logistics operations and hinterland connectivity. Measures such as Just-in-Time (JIT) vessel arrivals can reduce unnecessary waiting and anchorage time by enabling vessels to optimise their sailing speed and coordinate arrival with actual berth availability.

Better integration between vessel traffic management, port community systems, terminal operations and hinterland logistics can further improve efficiency across the maritime value chain and reduce avoidable emissions.

Scope 3 also recognises the relationship between port activity and the coastal environment. Gujarat's coastline combines intensive maritime and industrial activity with environmentally sensitive areas, particularly around the Gulf of Kutch. Port decarbonisation therefore needs to be accompanied by protection and restoration of coastal ecosystems.

At Mundra, 4,240 hectares of mangroves have been planted and approximately 189 hectares of greenbelt developed. Such interventions can be expanded through larger mangrove and coastal ecosystem restoration programmes, contributing to biodiversity conservation, carbon sequestration and coastal resilience.

The adoption of eco-sensitive vessel traffic management around the Gulf of Kutch can further support the balancing of growing maritime traffic with protection of sensitive marine and coastal ecosystems.

Technology and Digitalisation

Digitalisation is a cross-cutting enabler for the Green Ports transition. Effective decarbonisation requires reliable data on emissions, energy consumption, vessel movements, equipment utilisation and environmental performance.

The development of digital platforms and Monitoring, Reporting and Verification (MRV) systems can establish a common mechanism for tracking green-port performance. Onboarding Gujarat's ports onto the proposed National Green Port Digital Platform would enable standardised emissions reporting, benchmarking and monitoring of progress against national targets.

IoT-enabled monitoring, smart-port applications and integrated dashboards can support real-time assessment of equipment and energy performance. Digitalisation can also enable JIT vessel arrivals, optimise berth and terminal operations and improve vessel traffic management.

Over time, technologies such as digital twins and advanced data analytics can provide ports with the capability to model operational and emissions scenarios, identify inefficiencies and evaluate the impact of proposed decarbonisation interventions before implementation.

Research and Innovation

A number of technologies required for maritime decarbonisation are still evolving in terms of technical maturity, commercial viability and operational standards. Ports therefore have an important role as demonstration environments for emerging green technologies.

Gujarat's combination of large ports, industrial clusters, renewable-energy resources and maritime traffic provides a suitable ecosystem for pilots relating to green fuels, shore power, energy storage, electric equipment, low/zero-emission harbour craft, smart-grid solutions and digital port technologies.

Successful pilots can subsequently be evaluated for technical feasibility, safety, commercial viability and scalability, enabling proven solutions to be expanded across the State and replicated nationally.

Partnerships with academic institutions, research organisations, technology providers, classification societies and industry can further support indigenous research and adaptation of global technologies to Indian operating conditions.

International Cooperation and Maritime Diplomacy

The maritime energy transition is global in nature and requires collaboration across governments, ports, shipping companies, technology providers and international organisations. International cooperation can accelerate the transition through technology transfer, joint demonstration projects, knowledge partnerships and exchange of international best practices.

Engagement with IMO-led initiatives and other international programmes can support Gujarat's ports in areas such as alternative fuels, green shipping corridors, shore power, port emissions management, green-port standards and capacity building.

Gujarat's existing industrial and renewable-energy ecosystem also creates an opportunity to participate in international partnerships relating to green maritime fuels. Such partnerships can support technology localisation, development of common standards and creation of commercially viable green-fuel supply chains.

In this context, ports can increasingly function as instruments of maritime diplomacy, connecting India's domestic decarbonisation initiatives with international green shipping and energy-transition programmes.

Governance and Institutional Framework

The transition to Green Ports requires a structured governance framework that converts individual initiatives into measurable and standardised outcomes.

The Green Port Policy/Guidelines (GPPI) and Harit Sagar provide important mechanisms for strengthening environmental performance and benchmarking of ports. Gujarat's non-major ports can progressively pursue GPPI and Harit Sagar Green Port Certification, enabling a common sustainability framework to be applied across the wider State port network.

Implementation will require coordination among national maritime authorities, the State Government, port authorities, terminal operators, energy agencies, industry and other relevant stakeholders. Common standards for emissions measurement and MRV will also be necessary to ensure consistency and transparency in reporting.

Strengthened institutional coordination can therefore enable green-port projects relating to energy, fuels, infrastructure, environment and digitalisation to be implemented as components of an integrated transition rather than as isolated initiatives.

Gujarat – Existing Green Port Initiatives

Gujarat has already initiated a number of measures that align with the Green Ports transition.

India's first MW-scale green hydrogen facility at Deendayal Port, commissioned in 2025, represents an important step towards integrating green-hydrogen production with the maritime and port ecosystem.

The **shore-to-ship methanol bunkering trial at Kandla**, together with achievement of Level 6 IAPH Port Readiness rating for bunkering, demonstrates emerging capability for supporting alternative maritime fuels.

The **1,000 MWp ground-mounted solar PV project at Deendayal Port** provides a substantial renewable-energy base capable of supporting the wider transition towards green port operations and potentially future green-fuel production.

Environmental interventions at Mundra, including **4,240 hectares of mangrove plantation and 189 hectares of greenbelt development**, demonstrate the integration of coastal ecosystem protection with port and industrial development.

The **Adani Mundra Cluster is being positioned to become one of the world's largest green hydrogen hubs**, creating the potential for integration of renewable-energy generation, green-fuel production, industrial demand, bunkering infrastructure and international maritime supply chains.

These initiatives provide Gujarat with an existing base upon which the wider requirements of the NMDP can be progressively implemented.

Priority Areas under the National Framework

The next phase would require moving from individual projects and pilots towards a State-wide and integrated Green Port transition.

Priority may be accorded to scaling shore-power infrastructure across suitable ports and developing green hydrogen and ammonia bunkering infrastructure. This would enable Gujarat's ports to progressively support the changing fuel requirements of domestic and international shipping.

The GPPI and Harit Sagar Green Port Certification framework can be extended across Gujarat's non-major ports, thereby bringing a larger proportion of the State's maritime infrastructure within a common environmental-performance framework.

The transition of harbour craft can be expanded by extending the Green Tug Transition Programme to dredgers and other harbour craft.

Considering the ecological importance of the Gulf of Kutch, eco-sensitive vessel traffic management can be strengthened through digital monitoring, traffic optimisation and environmentally responsive operational practices.

Existing initiatives relating to mangrove plantation can be expanded into broader mangrove and coastal ecosystem restoration programmes, strengthening both environmental protection and climate resilience.

Simultaneously, Gujarat's ports can be progressively onboarded onto the National Green Port Digital Platform for MRV reporting, providing a common mechanism for measuring emissions and tracking implementation of Green Port interventions.

Phased Implementation under NMDPF

The implementation pathway can be structured across **short-, medium- and long-term horizons**.

Short Term – 0 to 6 months:

The initial phase would focus on establishing the regulatory and implementation architecture, including notification of phased electrification timelines and strengthening of the GPPI framework. Ports can simultaneously establish emissions baselines and identify assets and operations requiring transition.

Medium Term – 6 months to 2 years:

The focus would progressively shift towards infrastructure and energy transition. Key objectives include moving towards a 50% renewable-energy share and establishing a shore-power financing framework to facilitate deployment across ports.

Long Term – 2 to 5 years:

The longer-term objective is to progress towards universal shore-power coverage and mandatory GPPI certification, supported by mature MRV systems, renewable-energy integration, cleaner harbour craft and increasingly low/zero-emission port operations.

Way Forward

Gujarat has the potential to emerge as a leading implementation geography for India's Green Ports transition by integrating its existing strengths in ports, renewable energy, green hydrogen, industrial development and maritime logistics with the national framework provided under NMDPF.

The progression should be from individual green initiatives to an integrated port decarbonisation ecosystem covering Scope 1, Scope 2 and Scope 3 emissions. Electrification of port operations, renewable-energy integration, shore power, green bunkering infrastructure, efficient vessel and logistics operations, digital MRV, ecosystem restoration, technology demonstration, international partnerships and strong institutional governance need to advance as mutually reinforcing components of the transition.

The existing initiatives at Deendayal Port, Kandla and Mundra provide a substantive foundation for this approach. Their systematic scaling across Gujarat's wider port network can position the State as a national demonstration model for green and future-ready ports, while contributing to India's wider maritime decarbonisation objectives under the NMDPF.

42. National Port Sustainability Council (NPSC) - Proposed

India's port sector is entering a phase where sustainability can no longer be treated as a peripheral issue. With more than 200 ports, including 12 major ports and with increasing pressure from global decarbonisation rules, ESG-linked trade expectations and the need for climate-resilient infrastructure, Indian ports require a more structured and measurable approach to sustainability. The concept note therefore proposes the creation of a **National Port Sustainability Council (NPSC)** as a central institutional

mechanism to guide, monitor and standardise sustainability efforts across both major and non-major ports.

The note is built around the idea that sustainability at ports must be assessed through a defined set of indicators rather than through isolated projects. For this reason, it brings together frameworks such as **Green Port Indexing (GPI)**, **Green Port Readiness Level / Port Readiness Level (GPRL/PRL)**, **Smart Port Shore Power Index (SPSPI)**, **Environmental Ship Indexing (ESI)** and an institutionalised **GHG emissions inventory**.

Need for a National Institutional Mechanism

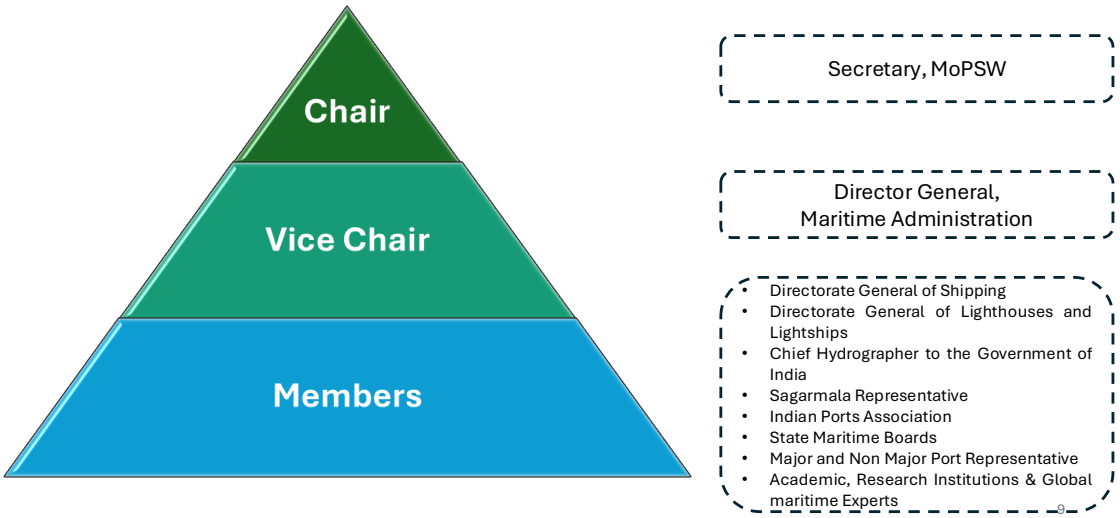
The central argument of the concept note is that India presently has policy intent, individual initiatives and broad sustainability ambitions, but does not yet have a unified national framework that can consistently assess readiness, compare port performance and link sustainability with compliance, investment and global competitiveness. The proposed NPSC is therefore conceived as an apex regulatory and advisory body under the Ministry of Ports, Shipping and Waterways to bring coherence to these efforts.

The note also places this proposal in the context of the expected transition from DG Shipping to the **Directorate General of Maritime Administration (DGMA)** under the forthcoming Merchant Shipping Bill / Maritime Services Bill framework. In the concept note, DGMA is visualised as a broader authority with responsibilities extending beyond vessel and seafarer regulation into port sustainability, alternative fuel readiness, digital governance and environmental compliance.

In practical terms, the NPSC is meant to provide national direction on issues such as emissions monitoring, electrification, alternative fuel readiness, digital port systems, green financing signals and harmonisation with global standards such as the IMO Revised GHG Strategy, EU Fit-for-55 and Maritime Vision 2030.

National Port Sustainability Council – Proposed Role

The NPSC is presented not as a symbolic committee but as a working governance structure that would monitor, evaluate and facilitate the implementation of sustainability and readiness frameworks across Indian ports. Its proposed role includes standard setting, benchmarking, compliance oversight, coordination with central and state-level bodies and support for digital platforms needed for real-time monitoring.



The proposed governing structure is chaired by the Secretary, MoPSW, with the DGMA as Vice-Chairperson. The membership is broad-based and includes the Chief Hydrographer, DGLL, DG Shipping representative, Sagarmala representative, Indian Ports Association, State Maritime Boards, port authorities, private port operators, academic institutions and global maritime experts. This reflects the note's view that port sustainability cannot be managed only through a single regulator and requires operational, technical and policy coordination.

The concept note further proposes specialised technical committees within the NPSC dealing with port safety and navigation, GHG emissions and energy transition, digitalisation and smart ports, sustainable infrastructure and policy and compliance. This is useful because it breaks down sustainability from a broad concept into operational workstreams.

Integration of Navigational Safety and Sustainability

A major point in the note is that sustainability and safety should not be treated as separate verticals. The document therefore links the modernization of the **Navigational Safety at Ports Committee (NSPC)** with the creation of the NPSC. The NSPC, constituted in 1997, has traditionally focused on navigational safety, emergency preparedness, environmental protection and compliance with conventions such as SOLAS, MARPOL and the ISPS Code.

The note argues that port safety today must evolve to include digital systems, emissions considerations, shore power, alternative fuels and climate-related resilience. For that reason, it recommends strategic integration of the NSPC within the broader NPSC framework so that safety, readiness and sustainability are assessed together. The reasons given include holistic port governance, regulatory synergy, better use of resources, stronger crisis preparedness and improvement in India's global competitiveness.

This is one of the stronger ideas in the note because it avoids creating parallel structures for safety on one side and green transition on the other. Instead, it suggests a single institutional architecture where navigation, environment, infrastructure and digital systems are viewed together.

Sustainable Indicators for Indian Ports

The note makes it clear that sustainability must be measurable. It therefore proposes a set of indicators that can be used to assess ports on environmental performance, infrastructure preparedness and operational transition. It specifically highlights GPI, PRL, SPSPI and ESI as the core tools through which Indian ports can be benchmarked and guided.

The need for such indicators is linked to several factors. First, international regulations such as IMO's carbon-related measures and the EU's Fit-for-55 package are creating real commercial pressure on ports and supply chains. Second, India's own port modernisation ambitions under Maritime Vision 2030 require ports to become low-emission and digitally integrated hubs. Third, participation in future green shipping corridors will require ports to demonstrate readiness in a structured and internationally understandable form.

The note also refers to the need for an institutionalised mechanism for port emissions assessment so that green initiatives can actually be tracked and verified rather than only announced. This includes the use of real-time digital emissions monitoring systems and formal carbon accounting tools.

Green Port Indexing (GPI)

The Green Port Index is described as a framework to evaluate the environmental performance of ports in a structured way. The document identifies the main objectives of GPI as benchmarking sustainability performance, encouraging best practices, informing policy, supporting stakeholder engagement and attracting investment into eco-friendly infrastructure.

For India, the GPI framework is linked with national environmental regulation as well as Harit Sagar-type environmental indicators. The note groups assessment into management indices, operational indices and condition indices. It also lists pollution-related parameters covering air, water, noise, effluent and waste-related metrics.

The note proposes a multi-tier institutional structure for GPI implementation. At the national level, MoPSW would provide the policy framework. The NPSC would standardise criteria and ensure regulatory alignment. The Indian Ports Association would act as an executing authority, including through annual reporting, digital emissions platforms and pilot implementation at selected ports such as JNPT, Chennai and Visakhapatnam.

The key assessment parameters proposed for Indian ports under GPI include carbon footprint and GHG emissions, renewable energy and electrification, sustainable cargo handling and logistics, waste management and marine pollution control and digitalisation / smart port initiatives.

Green Port Readiness Level (GPRL / PRL)

The note draws on the IAPH's Port Readiness Level approach to assess how prepared ports are for the energy transition, digitalisation and future regulatory requirements. The readiness assessment is built across dimensions such as alternative fuel readiness, shore power integration, digital and smart port systems, regulatory compliance and net-zero infrastructure transition.

The readiness levels range from basic recognition of sustainability needs at lower levels to global sustainability leadership at the highest level, where ports are fully digitalised and effectively carbon-neutral. The note also mentions global examples such as Rotterdam, Singapore, Los Angeles and Hamburg as leading references.

For Indian application, the note proposes a National Port Readiness Framework supported by MoPSW, with the NPSC acting as the regulatory body and IPA as the executing authority. It recommends annual readiness reports, digital dashboards and pilot implementation at ports such as JNPT, Chennai and Deendayal. Assessment dimensions for India include decarbonisation and alternative fuels, digitalisation and smart readiness, regulatory compliance, net-zero infrastructure readiness and sustainable cargo and logistics efficiency.

Smart Port Shore Power Index (SPSPI)

The concept note gives separate importance to shore power through the proposed Smart Port Shore Power Index. This is significant because emissions from berthed ships are increasingly becoming a major focus in global port decarbonisation. The SPSPI is intended to assess port readiness for shore-to-ship power, renewable energy integration, smart grid preparedness, regulatory compliance and economic viability.

The note goes a step further by proposing a certification framework for ships that use shore power at Indian ports. Under this proposal, calibrated metering, auditable data systems, grid-based emission factor calculations and digital access to certificates would allow vessels to demonstrate verified emission reductions. The note also suggests that such certification could support reduced port charges and potential carbon credit eligibility.

Institutionally, the SPSPI framework again follows a multi-tier model: MoPSW for national policy, NPSC for regulatory standards and IPA for dashboards, rankings and capacity building. Pilot ports suggested include JNPT, Chennai and Deendayal.

Environmental Ship Indexing (ESI)

The note includes the Environmental Ship Index as a way to align ship-side environmental performance with port-side incentives. It describes ESI as a voluntary global system developed by IAPH that scores ships on emissions performance, fuel efficiency, shore power compatibility and alternative fuel adoption.

The relevance for India lies in using ESI to support greener shipping practices at Indian ports by linking incentives such as reduced port dues or priority treatment to better-performing vessels. The note also sees ESI as complementary to mandatory IMO measures such as CII, EEXI and SEEMP, thereby allowing ports to use one framework for incentive design while remaining aligned with international regulatory systems.

This is an important idea because it shifts the role of ports from passive infrastructure providers to active participants in shaping cleaner fleet behaviour.

GHG Emissions Inventory

One of the strongest and most practical portions of the note is its emphasis on creating a formal GHG emissions inventory for Indian ports. The document argues that without a structured inventory of energy users and emission sources, it is not possible to understand the baseline, identify hotspots or build cost-effective reduction strategies.

The note recommends a centralised institutional mechanism for emissions monitoring, reporting and mitigation. Suggested elements include emission inventories, air quality monitoring systems, use of emission factors, carbon accounting software, eco-efficiency indicators, ISO 14001-based environmental management systems and third-party audits. It also refers to international best practices such as AI-based monitoring and real-time reporting using IoT and blockchain.

The value of this part of the note is that it moves from a broad sustainability narrative to the actual systems needed for measurement, reporting and verification.

43. Harit Sagar – Green Port Guidelines

The **“Harit Sagar” Green Port Guidelines**, issued by the Ministry of Ports, Shipping and Waterways in May 2023, provide the broad framework for Major Ports in India to reduce carbon intensity and move towards environmentally sustainable port development and operations. The guidelines were circulated through an Office Memorandum dated 11 May 2023 for further action by all Major Ports.

The document has been positioned as a practical guidance framework for ports to prepare action plans, adopt green technologies, reduce wastage and monitor measurable outcomes over defined timelines. It is also linked to the broader national context of **COP-26 commitments**, **Panchamrit targets**, **Maritime India Vision 2030** and India's long-term objective of reaching **net zero by 2070**. The introductory section of the guidelines clearly states that ports are expected to contribute to de-carbonisation by reducing carbon emissions per ton of cargo handled and by promoting a sustainable ecosystem around port operations.

Vision of the Guidelines

The central vision of the document is to reduce carbon intensity and develop an environment-friendly ecosystem at Major Ports through participation of all stakeholders, including terminal operators, logistics service providers, partner government agencies and shipping lines. The broader intent is to position Major Ports not just as cargo gateways, but as sustainable hubs of economic growth and development. This is to be achieved through optimization of procedures, adoption of green technologies, reduction of wastages and measurable decarbonisation benchmarks. The vision statement is set out explicitly in the guideline document and is also highlighted visually on the vision page.

Policy Context and Importance

The guidelines derive importance from three connected policy drivers.

First, the maritime sector has a major role in national trade. The guidelines note that the sector accounts for **95 percent of trade by volume and 65 percent by value**, which means that any sustainability transition in ports has a large impact on the economy as a whole. Second, India's climate commitments require a reduction in emission intensity and increased use of non-fossil energy sources by 2030. Third, ports are recognized as critical points where energy use, vessel interface, cargo handling, water use, waste generation and local environmental impacts converge.

The document therefore treats ports as a major lever for achieving environmental goals, rather than only as operational infrastructure. It also makes it clear that the purpose is not limited to carbon accounting alone; the framework covers air, water, waste, noise, ecology, resource efficiency and reporting.

Principles Underlying Harit Sagar

The guidelines are based on a set of broad principles that shape the rest of the document. These include ensuring environmental, economic and social sustainability in port development, adopting environmentally compatible designs, promoting clean and green energy, minimizing carbon and other harmful emissions through the **Eliminate, Reduce and Control (ERC)** approach, minimizing waste through the **5R**

concept, conducting appropriate environmental impact assessments and strengthening continuous monitoring and reporting. The document also emphasizes the concept of **“Working with Nature”**, linking port development with ecosystem sensitivity rather than only engineering expansion.

This is important because the guidelines are not drafted as a narrow engineering manual. They are framed as a management and governance instrument that asks ports to integrate sustainability into planning, operation, maintenance and reporting.

Applicability

The guidelines are explicitly applicable to **all Major Ports of India**. At the same time, the message from the Secretary in the front portion of the document indicates that the framework could also be recommended to State Governments and State Maritime Boards for adoption in ports other than Major Ports. This shows that while the legal applicability is limited to Major Ports at present, the document is intended to serve as a broader model for the wider port sector.

Focus Areas for Implementation

The main strength of the Harit Sagar document is that it converts the sustainability agenda into concrete implementation areas.

Green Cover

Ports are required to increase green area cover in order to capture fugitive emissions, attenuate noise and support biodiversity. The target is to increase green belt area to **more than 20 percent by 2030** and **33 percent by 2047** of port area. The document links this not only to visual greening but also to soil moisture retention, erosion control, groundwater recharge and carbon sink creation.

Electrification of Port Equipment and Vehicles

Ports are asked to move progressively towards electrification of vehicles and equipment, targeting **more than 50 percent electrification by 2030** and **more than 90 percent by 2047**. Existing diesel-powered equipment is to be retrofitted or converted in a phased manner and future procurement is expected to favour electric systems or compatibility with greener fuels such as methanol, ethanol, ammonia, hydrogen fuel cell and CNG.

Port Crafts

The guidelines extend beyond landside equipment and also cover port crafts such as tugs, pilot boats, mooring boats and survey boats. Ports are expected to prepare action plans for retrofitting these with cleaner propulsion technologies and for creating infrastructure under the National Green Hydrogen Mission. The document specifically

states that **green ammonia bunkers and refuelling facilities are to be established at all Major Ports by 2035**.

Renewable Energy

Renewable energy is one of the most explicit targets in the guidelines. Ports are expected to ensure that the share of renewable energy exceeds **60 percent by 2030** and **90 percent by 2047**. The guidelines also provide for **at least one LNG bunkering station by 2030** and adequate EV charging stations in port campuses or nearby areas by 2025. In addition, select ports are expected to support offshore wind energy development. The document specifically mentions V.O. Chidambaranar Port as a pilot port for offshore wind-linked activity.

Shore to Ship Power Supply

All ports are required to develop infrastructure for shore power in a phased manner, beginning with port crafts, then extending to Coast Guard / Navy / small coastal vessels and finally to EXIM vessels. The phased timelines given are **2023, 2024 and 2025** respectively. This is significant because it shows that the guidelines were not only aspirational but provided a sequence for implementation.

Resource Utilisation

The guidelines address water efficiency in a fairly detailed way. Ports are required to increase treatment capacity, use treated water, reduce fresh water consumption per ton of cargo by **more than 20 percent by 2030** and achieve **100 percent recycle and reuse of consumed water**. The document also encourages installation of STPs, rainwater harvesting, desalination plants and even utilisation of condensed water from LNG terminal chilling plants.

Energy-Efficient Equipment and Green Buildings

Ports are directed to use energy-efficient equipment and materials such as LED smart lighting and highly rated appliances, reduce energy consumption per ton of cargo by **more than 20 percent by 2030** and adopt green building concepts for all new buildings. The document also encourages use of digital systems such as Sagar Setu, NLP-Marine, EBS and RFID to improve efficiency and thereby reduce carbon footprint.

Promotion of Coastal Shipping

The guidelines recognise coastal shipping as a cost-effective and energy-efficient alternative mode of transport and ask ports to facilitate it through infrastructure and viable mechanisms. This reflects an important systems-level view: decarbonisation is not only about what happens inside the port boundary, but also about improving cargo movement choices.

Effluent, Marine Ecosystem and Waste Management

The document includes explicit directions regarding effluent discharge, monitoring of waste from ships under MARPOL, prohibition of wastewater and bilge discharge into port waters, declaration of waste by ships, protection of mangroves and shore ecosystems, oil spill preparedness under NOS-DCP, ballast water management and shore reception facilities. These provisions show that the guidelines treat sustainability as wider than only carbon reduction.

Environmental Management and Incentives

Each port is expected to have approved Environment Management Guidelines, an Environment Management Plan and a dedicated Environment Cell. Independent annual environmental audits are required and the audit reports are to be uploaded on the port website before **30 April every year**. The guidelines also encourage ports to earn carbon credits and introduce green incentives for ships, private craft operators, concessionaires, truck operators and other port users adopting cleaner fuels or shore power-compatible systems. They further direct ports to incorporate green and sustainability aspects into DPRs and PPP projects.

Methodology for Implementation and Compliance

The Harit Sagar document is notable because it does not stop at listing areas of intervention. It also prescribes a method for implementation.

All ports are required to prepare an action plan within **two months** of launch of the guidelines, in reference to the listed Environment Performance Indicators. Ports are expected to establish real-time **Continuous Ambient Air Quality Monitoring Stations (CAAQMS)**, **Continuous Marine Water Quality Monitoring Stations (CMWQMS)** and **Online Continuous Effluent Monitoring Systems (OCEMS)**, all linked to digital dashboards and to the MoPSW server / portal / Sagarmanthan dashboard for real-time monitoring and feedback. Different timelines are prescribed depending on the type of port operations.

The guidelines further provide that until these real-time systems are installed, regular reports should be prepared by independent environment auditors and uploaded annually on port websites. In addition, all ports are required to undertake a **baseline study using FY 2022–23 as the base year** within three months, including GHG emissions, carbon footprint and annual emissions of pollutants from all relevant port-related sources such as vessels, harbour crafts, cargo handling equipment and trucks.

This makes the document more implementation-oriented than many broad policy guidelines, because it links targets with baseline data and monitoring architecture.

Environmental Performance Indicators and Targets

The annexures are one of the most useful parts of the document because they convert broad sustainability language into measurable parameters.

Legal Compliance Framework

Annexure-A lists applicable laws relating to air, noise, DG set noise, water, hazardous waste, e-waste, solid waste, biomedical waste, plastic waste, battery waste, construction and demolition waste and environmental clearance. This makes clear that Harit Sagar is not a standalone framework outside the legal system, but is intended to operate in conjunction with existing environmental law and regulatory rules.

Environmental Performance Indicators

Annexure-B lists indicators for air, water, noise and effluent. These include parameters such as SO_2, NO_2, PM10, PM2.5, ozone, lead, ammonia, benzene, arsenic, mercury, dissolved oxygen, BOD, COD, turbidity, salinity, noise levels and effluent discharge parameters. Annexure-C provides a reporting format for waste management across hazardous waste, e-waste, solid waste, plastic waste, battery waste, construction and demolition waste and biomedical waste.

Sustainability Targets

Annexure-D sets out specific sustainability targets. These include:

- Renewable energy share at ports: **more than 60 percent by 2030** and **more than 90 percent by 2047**
- Electrified port equipment / vehicles: **more than 50 percent by 2030** and **more than 90 percent by 2047**
- Area under green belt: **more than 20 percent by 2030** and **more than 33 percent by 2047**
- Reduction in CO_2 emission per ton of cargo: **more than 30 percent by 2030** and **more than 70 percent by 2047**
- Reduction in GHG emissions in coastal / EXIM vessels: **more than 10 percent by 2030** and **more than 50 percent by 2047**
- Reduction in fresh water consumption per ton of cargo: **more than 20 percent by 2030**
- Recycle and reuse of consumed water: **more than 100 percent by 2030**
- Reduction in energy consumption per ton of cargo: **more than 20 percent by 2030**
- One LNG bunkering station: **by 2030**
- Green hydrogen / ammonia bunkering and refuelling facilities: **by 2035**
- Adequate number of EV charging stations: **by 2025**.

These annexed targets are perhaps the most important operational takeaway from the document because they provide benchmarks that ports can actually monitor and report.

Reporting, Review and Recognition

The guidelines also stress reporting and communication. Ports are encouraged to adopt the **Green Reporting Initiative (GRI)** as a global standard for communicating accountability with regard to impacts on environment, economy and people. The Ministry also reserves the power to interpret, clarify and relax provisions in public interest and may amend the guidelines from time to time.

An important provision is that the Ministry will recognize and award the **best three green performing ports of the year** based on evaluation criteria. This gives the guidelines a performance-based character rather than merely a compliance-based one.

44. Green Tug Transition Program (GTTP)

Harbour tugs play a critical role in port operations, particularly in berthing, unberthing and ship-assist functions. However, these vessels are typically powered by diesel engines and operate continuously within port limits, making them a concentrated source of greenhouse gas (GHG) emissions as well as local air pollutants such as NOx, SOx and particulate matter.

With increasing emphasis on maritime decarbonisation under national and global commitments, port-based emissions have emerged as a priority area for intervention. In this context, the Government of India has introduced the **Green Tug Transition Program (GTTP)** as a focused initiative to transition harbour tug fleets towards cleaner and low-emission alternatives.

The program forms part of the broader sustainability agenda under maritime sector reforms and aligns with national frameworks such as Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047.

The GTTP is designed to facilitate the phased replacement of conventional diesel-powered harbour tugs with environmentally sustainable alternatives using zero-emission or low-emission technologies.

The program envisages a structured transition pathway, supported by standardized design specifications, phased implementation and institutional oversight.

As per the official launch, Phase 1 of the program will be implemented from **October 2024 to December 2027**, with an estimated investment of approximately **INR 1000 crore** for development and deployment of green tugs .

Implementation Framework

Phase 1 (2024–2027)

The initial phase focuses on early adoption and demonstration across select major ports. The following four ports have been identified:

- Jawaharlal Nehru Port Authority (JNPA)
- Deendayal Port Authority (DPA)
- Paradip Port Authority
- V.O. Chidambaranar Port Authority

Each port is expected to procure or charter a minimum of two green tugs, based on standardized designs developed by the **Standing Specification Committee (SSC)** .

The first set of tugs will primarily be **battery-electric**, with provision for adoption of other emerging propulsion technologies such as hybrid systems, methanol and green hydrogen as technology maturity improves.

Technology Approach

The GTTP adopts a **technology-neutral but future-ready approach**, enabling ports to adopt suitable propulsion systems based on operational requirements and infrastructure readiness.

Key technology pathways include:

- Battery-electric propulsion for short-duration harbour operations
- Hybrid propulsion combining battery and fuel-based systems
- Alternative fuels such as methanol and green hydrogen
- Provision for retrofitting and modular upgrades as technologies evolve

This approach ensures flexibility while maintaining alignment with long-term decarbonisation objectives.

Standardization and Compliance

A key feature of the GTTP is the development of **Approved Standard Tug Designs and Specifications (ASTDS)** to ensure:

- Uniformity in design and performance benchmarks
- Safety and operational reliability
- Ease of procurement and scalability
- Alignment with environmental performance standards

Further, it has been envisaged that:

- By **2033**, all new tugs built for Indian ports will be required to comply with GTTP standards
- By **2040**, all tugs operating in major ports are targeted to transition to green alternatives

Strategic Alignment

The GTTP is closely aligned with national maritime and climate objectives:

Maritime India Vision 2030 (MIV 2030)

- Target of **30% reduction in carbon emissions per ton of cargo**
- Increased adoption of renewable energy across ports

Maritime Amrit Kaal Vision 2047

- Long-term decarbonisation of port operations
- Reduction in emissions from port-owned vessels

The transition of harbour tugs represents a **high-impact, low-complexity intervention**, as these vessels operate within controlled port environments and are well-suited for electrification and alternative fuels.

Industrial and Economic Impact

The GTTP is also positioned as an industrial development initiative:

- All tugs under the program are to be constructed in Indian shipyards under the **Make in India** initiative
- Expected to generate demand in shipbuilding, design and marine engineering sectors

- Creation of employment across manufacturing and ancillary industries
- Development of domestic capabilities in green vessel technologies

Environmental Significance

The transition to green tugs is expected to deliver measurable environmental benefits:

- Reduction in direct (Scope 1) emissions from port-owned vessels
- Improvement in air quality in port cities
- Contribution towards national GHG reduction commitments
- Demonstration effect for wider adoption of green technologies in maritime sector

Given the high utilisation rates of harbour tugs, even limited fleet replacement can result in **disproportionately high emission reductions**.

Key Challenges and Considerations

While the program is well structured, certain implementation challenges need to be addressed:

- High upfront capital cost of green technologies
- Charging or fuel infrastructure readiness at ports
- Technology maturity, particularly for hydrogen-based systems
- Operational reliability and lifecycle performance
- Need for capacity building among port operators and crew

Addressing these will be critical for scaling beyond the initial phase.

45. Integrated Vessel Traffic Management System (iVTMS)

The Integrated Vessel Traffic Management System (iVTMS) has been implemented in accordance with Chapter V of the International Convention for the Safety of Life at Sea (SOLAS), which deals with safety of navigation. The system aligns with relevant IMO guidelines and circulars governing vessel traffic services and navigational safety standards.

The primary objective of iVTMS is to ensure standardized vessel traffic monitoring in high-density maritime areas, port approaches and sensitive coastal zones. By institutionalising real-time surveillance and control mechanisms, the system strengthens India's compliance posture under international maritime safety obligations.

The regulatory basis of iVTMS ensures that its deployment is not discretionary or project-based, but anchored within an established global maritime safety framework.

Coverage and Deployment

iVTMS has been implemented across all Major Ports in India, creating a uniform navigational safety architecture across the country's principal maritime gateways.

In addition, the Directorate General of Lighthouses and Lightships (DGLL) operates iVTMS in the Gulf of Kutch region, one of India's most sensitive and high-density maritime corridors. This region handles significant volumes of crude oil traffic and large tankers, requiring enhanced surveillance and traffic coordination.

The system therefore provides integrated monitoring in both port-specific and broader coastal maritime zones. This layered deployment enhances oversight in congested approaches, narrow channels and environmentally sensitive areas.

System Architecture and Technical Integration

iVTMS is a centrally integrated command-and-control platform developed by IIT Madras through the National Technology Centre for Ports, Waterways and Coasts (NTCPWC).

The system integrates multiple real-time data sources, including:

- Automatic Identification System (AIS)
- Radar surveillance
- VHF communication channels
- Meteorological and oceanographic inputs
- CCTV-based visual monitoring

These inputs are consolidated into a unified operational dashboard, enabling maritime authorities to maintain real-time situational awareness.

The integration of navigational, meteorological and communication systems into a single interface significantly reduces response time during abnormal situations and improves traffic sequencing efficiency.

Operational Significance

The operational value of iVTMS extends beyond passive vessel tracking.

It enables:

- Collision avoidance through proactive traffic regulation
- Structured channel traffic management in constrained waterways
- Coordinated emergency response in case of mechanical failure, grounding or collision
- Optimised vessel sequencing to reduce waiting time
- Congestion management in port approaches

By providing predictive and real-time visibility of vessel movements, iVTMS reduces uncertainty in navigation and enhances overall maritime safety.

Environmental Governance Dimension

While iVTMS is primarily a navigational safety system, its environmental implications are equally significant.

First, optimized vessel sequencing reduces unnecessary anchorage time. Prolonged anchorage leads to continuous operation of auxiliary engines, resulting in avoidable emissions. By enabling Just-in-Time (JIT) arrival practices, iVTMS contributes indirectly to emission reduction.

Second, traffic regulation supports speed optimization. Controlled speed adjustments during approach reduce fuel consumption and associated GHG emissions.

Third, in the event of maritime incidents such as oil spills or collisions, real-time surveillance supports rapid response coordination, thereby limiting environmental damage.

In this manner, iVTMS serves as both a safety and environmental governance tool.

Strategic Importance for India

India's maritime traffic density is increasing, with rising cargo volumes, crude imports and containerized trade. As port capacity expands, navigational complexity correspondingly increases.

iVTMS provides the digital backbone required to manage this complexity. It enhances India's credibility as a safe maritime destination and aligns with global best practices in vessel traffic services.

Furthermore, integration of iVTMS with future digital initiatives such as digital twins, Just-in-Time arrival systems and port community platforms can create a seamless operational ecosystem.

In the long term, iVTMS strengthens three core pillars:

- Navigational Safety
- Operational Efficiency
- Environmental Responsiveness

It therefore represents a foundational infrastructure element in India's broader maritime modernization strategy.

46. Just-in-Time Arrival and Digital Twin for Ports

Just-in-Time (JIT) Vessel Arrival – Eliminating Anchorage Inefficiencies

One of the persistent inefficiencies in port operations globally is excessive anchorage waiting. Vessels often arrive at port approaches ahead of berth availability and remain at anchor with auxiliary engines running, leading to avoidable fuel consumption, congestion and emissions.

The Just-in-Time (JIT) arrival framework seeks to address this structural inefficiency by synchronizing vessel speed with real-time berth readiness.

Objective

The core objective of JIT is to align vessel arrival with confirmed berth availability so that ships can reduce speed during voyage and avoid idle waiting at anchorage.

Operational Principle

Instead of vessels rushing to port and waiting, dynamic scheduling information is shared in advance. Based on real-time berth status, crane availability, pilotage inputs and channel conditions, vessels adjust speed to arrive precisely when required.

Benefits

- Reduced fuel consumption at sea through speed optimization
- Lower congestion in port approaches
- Improved berth utilization
- Elimination or reduction of emissions from idling vessels at anchorage

Speed optimization has an immediate impact on carbon dioxide emissions. Even modest reductions in sailing speed can produce measurable emission savings due to the non-linear relationship between speed and fuel consumption.

JIT is therefore not merely an operational improvement — it is a decarbonization intervention embedded in voyage planning.

Digital Twin Architecture for Ports

JIT cannot function effectively without an integrated digital data environment. This is where the Digital Twin concept becomes foundational.

A Digital Twin of a port is a dynamic virtual representation of the physical port ecosystem, continuously updated through automated real-time data exchange.

Integrated Operational Data Layer

For a Digital Twin to function effectively, it must integrate multiple real-time inputs:

- AIS vessel tracking data
- Weather and oceanographic conditions
- Berth occupancy status
- Terminal equipment data including cranes and yard operations
- Pilotage and tug scheduling inputs
- Hinterland connectivity visibility (rail and truck flows)

The system must enable bi-directional real-time data exchange between physical infrastructure and digital platforms. It is not merely a visualization tool but a decision-support architecture.

Capabilities of a Port Digital Twin

When fully functional, a Digital Twin can enable:

- Simulation of berth allocation scenarios
- Crane and yard scheduling optimization
- Congestion prediction in yard and gate operations
- Emission modelling under different traffic scenarios

- Scenario testing for weather disruptions, peak traffic or operational delays

This shifts port management from reactive intervention to predictive planning.

Governance Implication

A well-designed Digital Twin supports:

- Situational awareness
- Intelligent decision support
- Multi-stakeholder coordination across port authority, terminal operators, pilots and shipping lines

It creates a unified operational picture, reducing information asymmetry between stakeholders.

47. Digital Twin Pilot – VOCPA Tuticorin

The Digital Twin initiative at VO Chidambaranar Port Authority (VOCPA), Tuticorin represents India's first structured implementation of this next-generation port management architecture.

The project was executed in record time and commissioned within six months at an approximate cost of ₹24.62 crore. It was executed by IPRCL and inaugurated by the Hon'ble Minister of Ports, Shipping and Waterways on 23 February 2026.

Key Features of the VOCPA Digital Twin

1. Complete 3D Port Visualization

The entire port ecosystem is rendered in real-time 3D format through an interactive visualization platform. This enables immersive and intuitive operational monitoring across berths, yards and channel approaches.

This visualization capability is not cosmetic; it enhances comprehension of spatial relationships between vessel movements, equipment positions and yard occupancy.

2. Integrated CCTV Surveillance (~400 Cameras)

Nearly 400 CCTV cameras across the port are mapped to their exact physical coordinates within the digital environment. This allows location-specific monitoring and centralised oversight of activities.

Operators can transition from a macro port view to micro-level surveillance instantly.

3. VTMS Integration – Real-Time Vessel Intelligence

The Vessel Traffic Management System is fully integrated with the digital twin. Vessel movement details, cargo status and navigational information are accessible through a single operational interface.

This integration strengthens navigational oversight and supports synchronized berth planning.

4. Integrated Weather Monitoring

Live weather systems are embedded within the platform, enabling proactive monitoring of rainfall, cyclonic activity and atmospheric disturbances.

This capability supports early-warning based decision-making and improves resilience against extreme weather events.

Strategic Significance of the VOCPA Pilot

The VOCPA Digital Twin is not an isolated technology demonstration. It establishes a proof-of-concept for:

- JIT-enabled berth synchronization
- Data-driven emission reduction
- Predictive congestion management
- Integrated maritime safety and environmental governance

By linking vessel traffic intelligence, equipment data and weather inputs into a unified platform, the pilot demonstrates how digital infrastructure can directly support operational efficiency and decarbonisation objectives.

The next logical step would involve scaling such platforms across major ports, integrating them with JIT frameworks and aligning them with Green Port Index parameters.

Shore-to-Ship Power (SPS) – Decarbonising Emissions at Berth

Shore-to-Ship Power (SPS), also referred to as cold ironing or Onshore Power Supply (OPS), involves supplying electricity from the shore grid to a vessel while it is berthed at port. During this period, the ship's auxiliary engines and diesel generators are switched off, thereby eliminating onboard fuel combustion for hoteling loads.

Under conventional operations, even when ships are stationary at berth, auxiliary engines continue to run to support lighting, ventilation, refrigeration, cargo operations and other onboard systems. These engines consume marine fuel and emit carbon dioxide (CO_2), nitrogen oxides (NOx), sulphur oxides (SOx) and particulate matter (PM), contributing to localized air pollution within port areas.

SPS replaces this combustion-based generation with shore-based electricity, significantly reducing emissions at berth.

Environmental and Regulatory Significance

The introduction of SPS directly addresses one of the most visible sources of port-area emissions — emissions from berthed vessels.

Its environmental impact includes:

- Reduction in CO_2 emissions during hoteling period
- Elimination of NOx and SOx emissions at berth
- Significant reduction in particulate matter in port zones
- Improvement in ambient air quality in port-adjacent urban areas

From a regulatory standpoint, SPS contributes to:

- Compliance alignment with IMO's Carbon Intensity Indicator (CII) framework
- Support to GHG reduction commitments
- Strengthening of Green Port Index parameters
- Enhancement of ESG metrics for Indian ports

As global shipping transitions toward decarbonisation, ports that provide SPS infrastructure become more attractive to environmentally compliant ship operators.

Strategic Importance for Indian Ports

For India, SPS has three distinct strategic implications:

First, it improves local air quality. Many Indian ports are located near dense urban populations. Reduction of emissions at berth has direct public health benefits.

Second, it strengthens India's positioning in green shipping corridors. Several international green corridor initiatives now incorporate shore power as a baseline infrastructure requirement.

Third, it enhances competitiveness. As shipping lines increasingly report Scope 1 and Scope 3 emissions, availability of SPS allows vessel operators to reduce emissions during port calls, improving their sustainability performance.

SPS therefore shifts ports from being passive infrastructure providers to active contributors in maritime decarbonisation.

Implementation Status in Indian Ports

- **Kamarajar Port** has implemented 500 kW, 400V, 50–60 Hz SPS systems at Coal Berths 1 and 2.
- **VO Chidambaranar Port** has installed 305 kW, 400V, 60 Hz systems at VOC Berths 2 and 3.
- **Jawaharlal Nehru Port Authority (JNPA)** has deployed SPS for tug operations and has planned full-scale deployment across all terminals with an estimated 45 MVA capacity and projected investment of approximately INR 600 crore.
- **Paradip Port** has recently commissioned SPS facilities and delivered full load power to vessels at CB1 berth.

These early deployments indicate proof-of-concept and operational viability. However, large-scale adoption across cargo terminals will require capacity augmentation, grid integration and financial structuring.

Technical and Infrastructure Considerations

Implementation of SPS requires careful technical planning:

- Grid capacity and substation upgrades
- Frequency compatibility (50/60 Hz considerations)
- High-voltage connection systems for large container and cruise vessels
- Cable management systems and automated connection interfaces

- Safety interlocks and harmonised standards for ship–shore interface

Vessels must also be SPS-ready, meaning onboard electrical systems must be configured for shore connection. Therefore, adoption requires coordination between ports, ship operators and classification societies.

Financial Structuring and Investment Models

SPS infrastructure involves significant capital expenditure, especially for high-capacity berths. To scale deployment, diversified financing models may be required.

Possible approaches include:

- **Blended finance models**, combining government support, multilateral development banks and private investment.
- **Green or blue bonds**, specifically earmarked for shore power and decarbonisation infrastructure.
- **Public–Private Partnership (PPP) models**, where terminal operators co-invest in SPS infrastructure.

Given the long asset life and public-good environmental benefits, concessional finance mechanisms may improve viability.

Challenges and Way Forward

While SPS offers clear environmental benefits, certain practical challenges remain:

- High upfront capital costs
- Tariff competitiveness versus onboard fuel generation
- Standardisation across vessel categories
- Grid stability and renewable energy integration

To address these challenges, a phased expansion approach may be adopted:

1. Prioritisation of high-traffic container and cruise terminals.
2. Integration with renewable energy sources to maximize decarbonisation benefit.
3. Development of uniform national technical standards.
4. Incentivization mechanisms for vessels that utilise SPS.

Long-term viability will depend on coordinated policy support, tariff rationalisation and integration within broader port decarbonisation strategies.

Swachh Sagar Portal

The Swachh Sagar Portal is India's unified digital platform for maritime environmental compliance, developed to support clean seas, transparent reporting and decarbonisation efforts. It consolidates all pollution control and sustainability mandates under a single national system, enabling ships, ports and regulatory authorities to operate within a structured, real-time governance framework. Each module within the portal addresses a specific environmental obligation under MARPOL and IMO conventions, ensuring data integrity, traceability and enforcement consistency.

Port Reception Facility (PRF) Module

The Port Reception Facility module establishes a structured digital system for vessels to declare ship-generated waste prior to port arrival. It links ships with authorised waste collection vendors and enables real-time approval, tracking and disposal coordination, reducing delays and eliminating informal handling. By digitally recording every waste transaction, it ensures full transparency under MARPOL Annex V and prevents sea dumping. This module supports State Maritime Boards, Port Authorities and Pollution Control Boards in monitoring compliance, while creating auditable records for IMO and port State control inspections.

Fuel Consumption Reporting

This module captures fuel consumption data for all vessels required to report under DGS regulations, including those below the IMO's global Data Collection System threshold of 5,000 GT. It enables national compliance with MARPOL Annex VI carbon intensity and energy efficiency requirements. All operational fuel data, type, quantity, voyage consumption, is digitally lodged, enabling India to build a national emissions database. This data will support policy development for future MBM mechanisms and ensure readiness for IMO's Net-Zero Framework implementation.

Single Use Plastics (SUP) Module

The Single Use Plastics module operationalises DGS Order No. 05 of 2019 by mandating ships to submit a Ship Execution Plan (SEP) identifying plastic items onboard, their phase-out measures and disposal methods. It enables tracking of plastic usage, recycling and substitution with sustainable alternatives. By capturing ship-level data, this module enforces India's national ban on certain plastic categories and contributes to IMO's Action Plan on Marine Litter. It shifts plastic control from advisory to mandatory digital reporting, enhancing accountability.

e-BDN & Bunker Supplier Information System

This module creates a national registry of licensed bunker suppliers and mandates issuance of electronic Bunker Delivery Notes (e-BDN) for every fuel transaction. Each e-BDN is time-stamped, digitally signed and serialised, preventing manipulation or use of unregistered suppliers. It improves traceability of marine fuels and helps detect off-spec or adulterated bunkers. By integrating supplier verification and fuel documentation, the portal strengthens maritime fuel governance and directly supports enforcement of fuel quality standards under MARPOL Annex VI.

Ballast Water Reporting Module (BWM Convention Alignment)

The Ballast Water module requires all ships, Indian and Foreign Flagged, to electronically report ballast operations upon every arrival and departure. It captures data on ballast uptake, exchange, treatment and discharge, enabling continuous monitoring in line with IMO's experience-building phase. This allows authorities to assess invasive species risk, treatment plant functionality and compliance behaviour. By linking with GISIS reporting, it elevates India's oversight role under the Ballast Water Management Convention and prepares ports for future biological discharge standards.

Together, these five modules establish India's first end-to-end maritime environmental registry , shifting compliance from manual declarations to auditable, technology-driven oversight. By integrating reporting on waste, fuel, plastics, bunkers and ballast water, the portal strengthens India's role in global maritime regulation and positions the country to lead international initiatives on green shipping corridors, blue economy and marine pollution control. Swachh Sagar is not just a compliance tool, but a strategic instrument for India's transition to a cleaner, future-ready maritime ecosystem.

Just Transition in Maritime

Putting People at the Core of Decarbonisation

The global maritime sector is undergoing a structural transformation driven by decarbonisation commitments, alternative fuel adoption and digitalisation. However, decarbonisation is not merely a technological or fuel transition — it represents a workforce transition.

For maritime economies such as India, this dimension assumes critical importance. With approximately 3.23 lakh Indian seafarers as of 2025 — accounting for nearly 12% of the global maritime workforce — India plays a pivotal role in shaping the human dimension of maritime transition.

A green transition that does not account for employment continuity, skills upgrading and safety risks would create structural imbalances. Therefore, the principle of a Just Transition seeks to ensure that environmental progress does not come at the cost of workforce vulnerability.

Workforce Implications of Fuel Transition

The shift toward alternative marine fuels such as green ammonia, hydrogen, methanol and other low-flashpoint fuels introduces new technical and operational complexities.

These fuels:

- Present distinct toxicity and flammability risks
- Require modified onboard storage and handling systems
- Demand new emergency response protocols
- Necessitate revised competency standards

This implies that decarbonisation will require new competencies across engineering, deck operations, safety management and port handling systems.

A structured upskilling strategy is therefore essential to ensure that the maritime workforce transitions alongside technological change.

Skills and Training Ecosystem

A Just Transition framework must prioritize large-scale capacity building.

Key areas include:

- Structured upskilling for handling green fuels
- Modernization of STCW-aligned training modules
- Investment in simulator-based training for ammonia, hydrogen and hybrid propulsion systems
- Upgradation of maritime training infrastructure

India's maritime training institutions must progressively integrate green fuel modules into curricula. This is not a short-term training exercise but a phased institutional transformation.

The emphasis must be on competency-based certification aligned with emerging IMO standards and future regulatory frameworks.

Safety and Standards

Alternative fuels introduce unfamiliar safety risks. For example:

- Ammonia exposure risks
- Hydrogen storage complexities
- Low flashpoint fuel handling hazards

A Just Transition requires a safety-first approach.

This includes:

- Strengthening onboard safety protocols
- Revising emergency preparedness standards
- Aligning operational practices with evolving IMO IGF Code provisions
- Ensuring compliance with the Maritime Labour Convention (MLC 2006) and international labour norms

Safety cannot be compromised in pursuit of decarbonisation targets. Technological adoption must be matched by risk mitigation frameworks.

Equity and Inclusion

The maritime workforce is globally distributed, with developing nations supplying a significant share of seafarers. Without coordinated support, the transition to green fuels risks widening global skills gaps.

A Just Transition approach must therefore:

- Avoid marginalization of seafarers from developing maritime nations
- Promote equal access to new training pathways
- Encourage gender inclusion and diversity within maritime professions
- Support global knowledge-sharing mechanisms

India, as a leading supplier of maritime manpower, has both an opportunity and responsibility to advocate for inclusive transition pathways.

Policy Direction for India

India’s maritime decarbonisation roadmap must embed workforce considerations within broader sustainability initiatives.

Key policy directions may include:

1. Integration of green fuel competencies within national maritime training frameworks.
2. Structured collaboration between DGS, training institutes and industry stakeholders.
3. Development of standardized certification pathways for alternative fuel operations.
4. Incorporation of Just Transition principles within National Maritime Decarbonization Policy Framework frameworks.

The objective should be to ensure that environmental ambition is matched with human resilience.


सागरः सुपन्थानः सन्तु