National Shipping Board - SAGAR संवाद

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By

Directorate General of Maritime Administration

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

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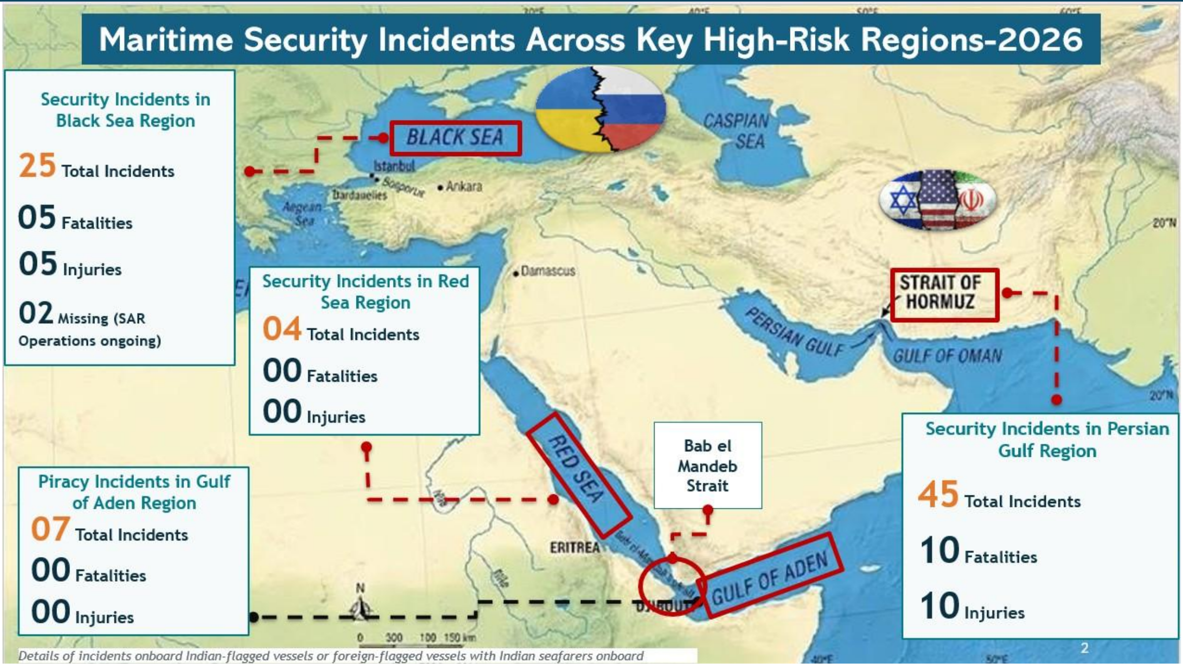
Present Geo political Context & relevance for India



The global maritime security environment has undergone a significant transformation due to ongoing geopolitical conflicts, regional instability, and disruptions in key maritime chokepoints. The slide highlights four critical regions of concern for international shipping: the Black Sea, Persian Gulf and Strait of Hormuz, Red Sea and Bab-el-Mandeb Strait, and the Gulf of Aden. Together, these regions form the principal maritime corridors through which a substantial portion of global trade, energy supplies, and strategic commodities are transported.

The Black Sea region continues to be affected by the Russia-Ukraine conflict, resulting in 25 reported maritime security incidents, including fatalities, injuries, and missing persons. The conflict has led to elevated risks for merchant shipping, disruptions to trade routes, challenges in vessel insurance, and increased operational costs for shipowners. Given India's growing trade engagements with Europe and the Black Sea region, any disruption has direct implications for supply chains and freight costs affecting Indian importers and exporters.

The Persian Gulf and the Strait of Hormuz remain among the most strategically sensitive maritime regions in the world. The slide indicates 45 security incidents, making it the most affected region among those highlighted. Tensions involving regional powers and threats to commercial shipping have increased navigational risks. This region is of particular relevance to India because a significant proportion of the country's crude oil, LNG, and energy imports transit through the Strait of Hormuz. Any disruption in this corridor can have severe implications for India's energy security, inflation, and economic stability.

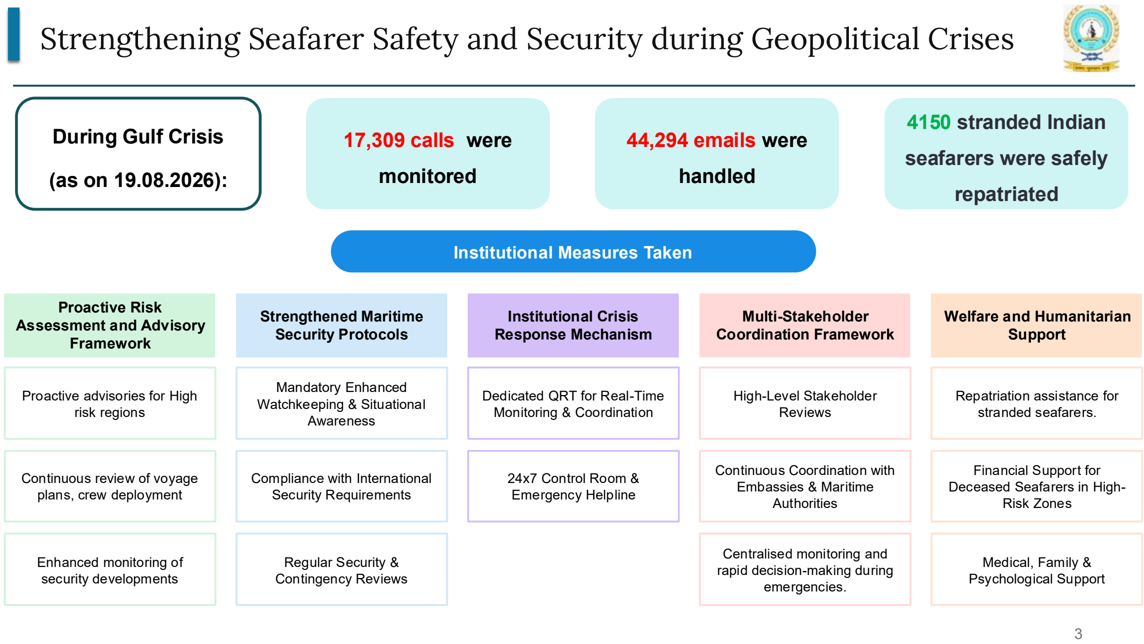
The Red Sea and Bab-el-Mandeb Strait have emerged as critical security hotspots due to attacks on merchant vessels and escalating regional conflicts. Although only a limited number of incidents are reflected in the slide, the strategic significance of the region far exceeds the numerical count. The Red Sea serves as a gateway to the Suez Canal, one of the world's most important maritime trade routes. Disruptions in this region have compelled shipping companies to reroute vessels around the Cape of Good Hope, increasing transit times, fuel consumption, freight rates, and overall logistics costs. As a major trading nation dependent on maritime transport, India is directly affected by such disruptions in global shipping networks.

The Gulf of Aden, despite showing comparatively fewer incidents, continues to face threats from piracy and maritime crime. The region remains an essential corridor connecting the Indian Ocean to the Red Sea and onward to Europe. India has historically played an active role in anti-piracy patrols and escort operations in this region to ensure the safety of merchant shipping and Indian seafarers.

For India, these developments underscore the importance of a robust maritime security architecture. More than 90% of India's trade by volume and a substantial portion of its energy imports move through sea routes. Consequently, geopolitical instability in these maritime chokepoints directly affects India's trade competitiveness, energy security, supply chain resilience, and shipping costs.

The increasing frequency of maritime security incidents also highlights the need for enhanced flag state oversight, seafarer protection measures, maritime domain awareness, port and vessel security frameworks, and international cooperation. It further reinforces the strategic importance of initiatives such as the Maritime India Vision 2030, strengthening the Indian merchant fleet, and enhancing national maritime capabilities.

2. Strengthening Seafarer Safety and Security during Geopolitical Crises



Strengthening Seafarer Safety and Security during Geopolitical Crises

The maritime sector has witnessed increasing security challenges arising from geopolitical tensions, regional conflicts, attacks on commercial shipping, and disruptions in critical international shipping routes. Recognizing the risks faced by Indian seafarers serving onboard merchant vessels across the world, DGMA adopted a proactive and coordinated approach to safeguard the welfare, security, and well-being of Indian seafarers deployed in affected regions. The slide highlights various measures undertaken during the Gulf crisis and demonstrates the Government's commitment to ensuring that no Indian seafarer is left unsupported during emergencies.

As of **19 August 2026**, DGMA and associated stakeholders maintained continuous monitoring and engagement with ships, shipowners, employers, maritime authorities, and seafarers operating in regions affected by heightened geopolitical tensions. During this period, approximately **17,309 calls were monitored**, **44,294 emails were handled**, and **4,150 stranded Indian seafarers were safely repatriated**, reflecting the scale and intensity of the response mechanism established to protect Indian seafarers and facilitate their safe return.

A key pillar of the response strategy was the implementation of a Proactive Risk Assessment and Advisory Framework. DGMA continuously assessed evolving security developments in high-risk regions and issued timely advisories to shipowners, operators, and seafarers. Voyage plans, crew deployment arrangements, and operational risks were regularly reviewed to ensure that informed decisions could be taken regarding vessel movements and crew safety. Continuous monitoring of regional security developments enabled authorities to identify emerging threats and take preventive action wherever required. (Image: Proactive Risk Assessment and Advisory Framework section)

To further enhance onboard safety, a series of **Strengthened Maritime Security Protocols** were implemented. Shipping companies and vessels were advised to maintain heightened vigilance, enhance watchkeeping arrangements, improve situational awareness, and comply with applicable international maritime security requirements. Regular security reviews and contingency planning exercises were encouraged to ensure preparedness for various emergency scenarios. These measures aimed to minimize operational risks while safeguarding crew members serving in sensitive maritime zones.

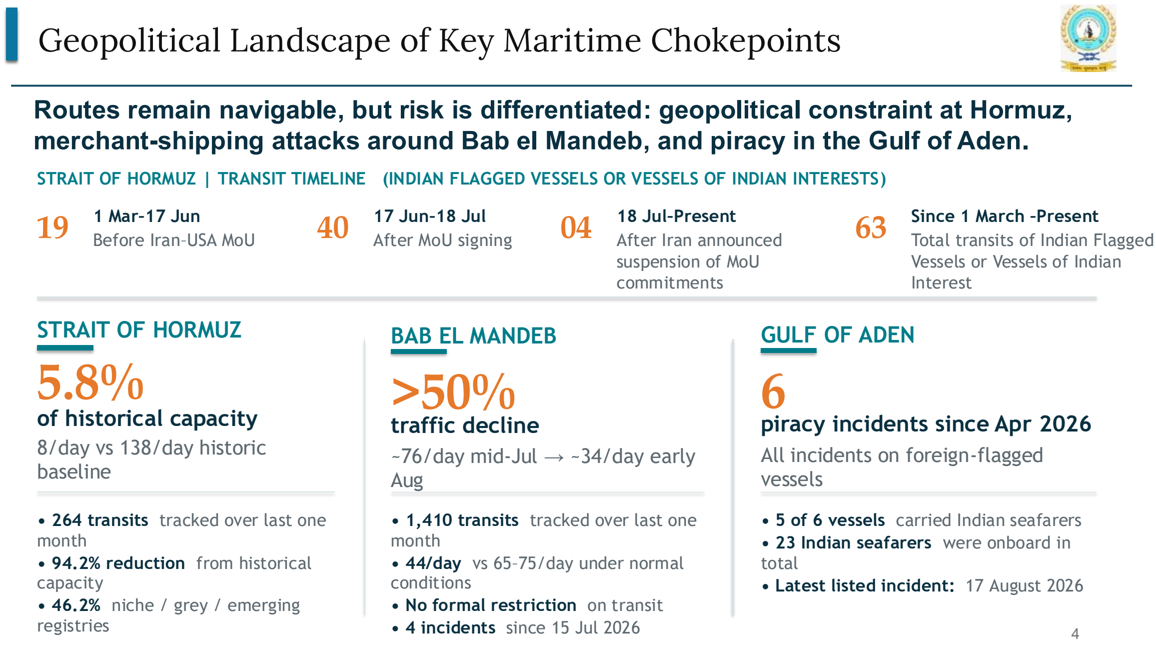
At the institutional level, DGMA activated a dedicated **Crisis Response Mechanism** to facilitate real-time monitoring and coordination of events as they unfolded. Dedicated operational teams were engaged for continuous monitoring, information gathering, stakeholder communication, and emergency response coordination. A 24x7 control room and emergency helpline framework ensured uninterrupted communication channels between seafarers, shipping companies, families, and government authorities. This enabled rapid response to distress situations and provided a platform for immediate escalation and intervention whenever required.

Effective crisis management required extensive collaboration among various stakeholders. Accordingly, a **Multi-Stakeholder Coordination Framework** was established involving maritime administrations, shipping companies, Indian missions abroad, embassies, port authorities, and other relevant agencies. Regular high-level reviews were conducted to assess the evolving situation, while continuous coordination ensured centralized monitoring, information sharing, and timely decision-making. This collaborative approach enabled authorities to address operational challenges efficiently and respond rapidly to emerging emergencies affecting Indian seafarers.

Beyond operational and security measures, significant emphasis was placed on **Welfare and Humanitarian Support**. Repatriation assistance was provided to stranded seafarers affected by disruptions arising from the crisis. Financial assistance mechanisms were activated for families of deceased seafarers in high-risk areas. In addition, medical support, psychological assistance, family counselling, and welfare interventions were made available wherever required. These initiatives ensured that humanitarian considerations remained at the center of the crisis response effort.

The response to the Gulf crisis demonstrates the evolution of India's maritime governance framework towards a proactive, technology-enabled, and seafarer-centric model. Through continuous monitoring, inter-agency coordination, enhanced security measures, and targeted welfare interventions, DGMA successfully ensured the safety and welfare of thousands of Indian seafarers operating in challenging and uncertain environments. The experience also reinforced the importance of real-time monitoring systems, stakeholder coordination mechanisms, emergency response capabilities, and dedicated welfare frameworks in protecting Indian seafarers during periods of geopolitical instability and maritime security disruptions.

3. Geopolitical Landscape of Key Maritime Chokepoints



The contemporary maritime environment is increasingly shaped by geopolitical tensions, regional conflicts, and security threats concentrated around strategic maritime chokepoints. For India, whose trade and energy supplies are heavily dependent on uninterrupted maritime transportation, developments in the **Strait of Hormuz, Bab-el-Mandeb Strait, and Gulf of Aden** carry significant economic and strategic implications. While these routes remain operational, the nature of risks across them has become highly differentiated, requiring enhanced monitoring, risk assessment, and maritime preparedness.

4. Strait of Hormuz: Energy Security Under Geopolitical Pressure

The Strait of Hormuz remains one of the world's most critical energy corridors, linking the Persian Gulf with global markets. Recent geopolitical developments, particularly tensions involving Iran and major global powers, have resulted in a substantial reduction in commercial vessel traffic through the strait. The data indicates that traffic is presently operating at approximately **5.8% of historical capacity**, with only around **8 vessel transits per day compared to a historical average of 138 transits per day**. During the last month alone, **264 vessel transits** were monitored, representing a **94.2% reduction from historical capacity levels**.

Despite these constraints, Indian maritime interests continue to maintain a presence in the region. Since March 2026, **63 transits involving Indian-flagged vessels or vessels**

of Indian interest have been recorded. The transit pattern reflects changing geopolitical circumstances, with varying movement levels before and after developments relating to the Iran-United States understanding and subsequent changes in regional policy positions.

For India, the Strait of Hormuz is of exceptional strategic importance as a substantial share of crude oil, LNG, and petroleum imports transit through this route. Any prolonged disruption could affect energy availability, increase transportation costs, and contribute to broader economic pressures. Consequently, continuous monitoring and contingency planning remain essential components of India's maritime security strategy.

5. Bab-el-Mandeb Strait: Impact of Maritime Security Incidents on Global Trade

The Bab-el-Mandeb Strait serves as the gateway between the Indian Ocean and the Red Sea, connecting Asia with Europe through the Suez Canal. Recent attacks on merchant vessels and increasing regional instability have adversely affected traffic through this corridor. The slide indicates a **traffic decline exceeding 50%**, with average daily transits reducing from approximately **76 vessels per day in mid-July to around 34 vessels per day in early August**.

Although there is currently **no formal restriction on vessel transit**, security concerns continue to influence commercial shipping decisions. Around **1,410 vessel transits** were recorded during the last month, averaging approximately **44 vessels per day compared to a normal range of 65 to 75 vessels per day**. The region has experienced **four reported maritime incidents since 15 July 2026**, demonstrating the continued vulnerability of commercial shipping operations.

The significance of Bab-el-Mandeb for India extends beyond immediate trade considerations. A large proportion of India's exports to Europe, Mediterranean countries, and the Atlantic basin pass through this route. Security disruptions often compel shipping companies to divert vessels around the Cape of Good Hope, resulting in longer voyages, higher fuel consumption, increased freight rates, and disruptions in supply chains. Such developments ultimately affect trade competitiveness and logistics costs for Indian businesses.

6. Gulf of Aden: Continuing Piracy Concerns

The Gulf of Aden remains a critical maritime corridor connecting the Arabian Sea with the Red Sea. While large-scale piracy incidents have declined compared to previous decades, piracy continues to present an ongoing threat to commercial shipping operations. The slide highlights **six piracy incidents reported since April 2026**, all involving foreign-flagged vessels.

A notable aspect is the significant presence of Indian seafarers aboard the affected vessels. **Five of the six vessels involved in piracy incidents carried Indian seafarers**, with a total of **23 Indian seafarers onboard these vessels**. The latest reported incident occurred on **17 August 2026**.

These developments reinforce the continued necessity of anti-piracy operations, naval deployments, and coordinated maritime security measures. India has historically maintained a strong presence in the Gulf of Aden through naval patrols and escort missions, contributing significantly to the protection of international shipping and the safety of seafarers operating in the region.

7. Relevance for India

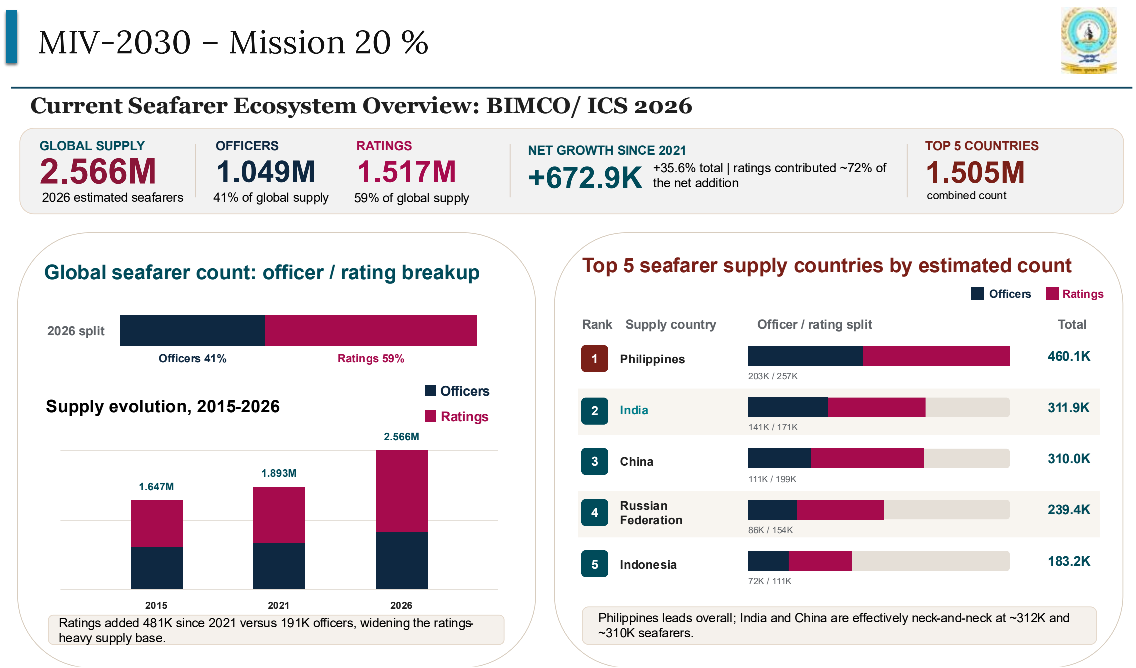
The evolving security environment across these maritime chokepoints underscores the direct relationship between global geopolitics and India's maritime interests. More than ninety percent of India's trade by volume is transported by sea, while critical energy imports transit through regions such as the Strait of Hormuz and the Gulf of Aden. Consequently, geopolitical developments in these areas have immediate implications for India's energy security, trade flows, maritime insurance costs, supply chain resilience, and overall economic stability.

The present situation highlights the importance of strengthening India's maritime domain awareness capabilities, ensuring the safety and welfare of Indian seafarers, enhancing emergency response mechanisms, and promoting a robust Indian merchant fleet capable of supporting national strategic requirements during periods of international uncertainty.

8. Conclusion

The current geopolitical environment demonstrates that while key maritime routes remain navigable, the risks associated with them have increased considerably. The Strait of Hormuz faces challenges arising from geopolitical tensions, Bab-el-Mandeb continues to experience disruptions from attacks on commercial shipping, and the Gulf of Aden remains vulnerable to piracy. These developments emphasize the need for sustained vigilance, enhanced maritime security cooperation, and continued strengthening of India's maritime capabilities to safeguard national economic and strategic interests.

4. MIV-2030 - Mission 20 %



4.1. Mission 20%

Mission 20% is India's national strategy to increase its share of the global seafaring workforce to 20% by 2030. At present, India is one of the world's largest suppliers of seafarers, accounting for approximately 3.23 lakh seafarers and 12.2% of the global seafaring workforce. The mission seeks to increase this figure to approximately 5.44 lakh Indian seafarers by 2030, thereby establishing India as the leading source of skilled maritime manpower globally.

The initiative is driven by growing international demand for maritime professionals, India's demographic advantage, and the need to create high-quality employment opportunities for Indian youth while strengthening the country's maritime sector.

1.1 Current Global Seafarer Ecosystem: BIMCO/ICS 2026

The **BIMCO/ICS Seafarer Workforce Report 2026** estimates the global seafaring workforce at **2.566 million seafarers**, comprising:

- **1.049 million officers (41%)**
- **1.517 million ratings (59%)**

GLOBAL SUPPLY	OFFICERS	RATINGS
2.566M	1.049M	1.517M
2026 estimated seafarers	41% of global supply	59% of global supply

Since 2021, the global seafarer workforce has grown by approximately **672,900 seafarers**, representing a growth of **35.6%**. Ratings account for nearly **72% of this net increase**, indicating that global demand growth has been particularly strong for operational and support crew positions.

NET GROWTH SINCE 2021	TOP 5 COUNTRIES
+672.9K — +35.6% total | ratings contributed ~72% of the net addition	1.505M combined count

This continued growth reflects:

- Expansion of global shipping trade.
- Increasing fleet sizes worldwide.
- Rising maritime logistics requirements.
- Replacement demand arising from retirements and attrition.
- Growing need for technically skilled personnel on modern, technologically advanced vessels.

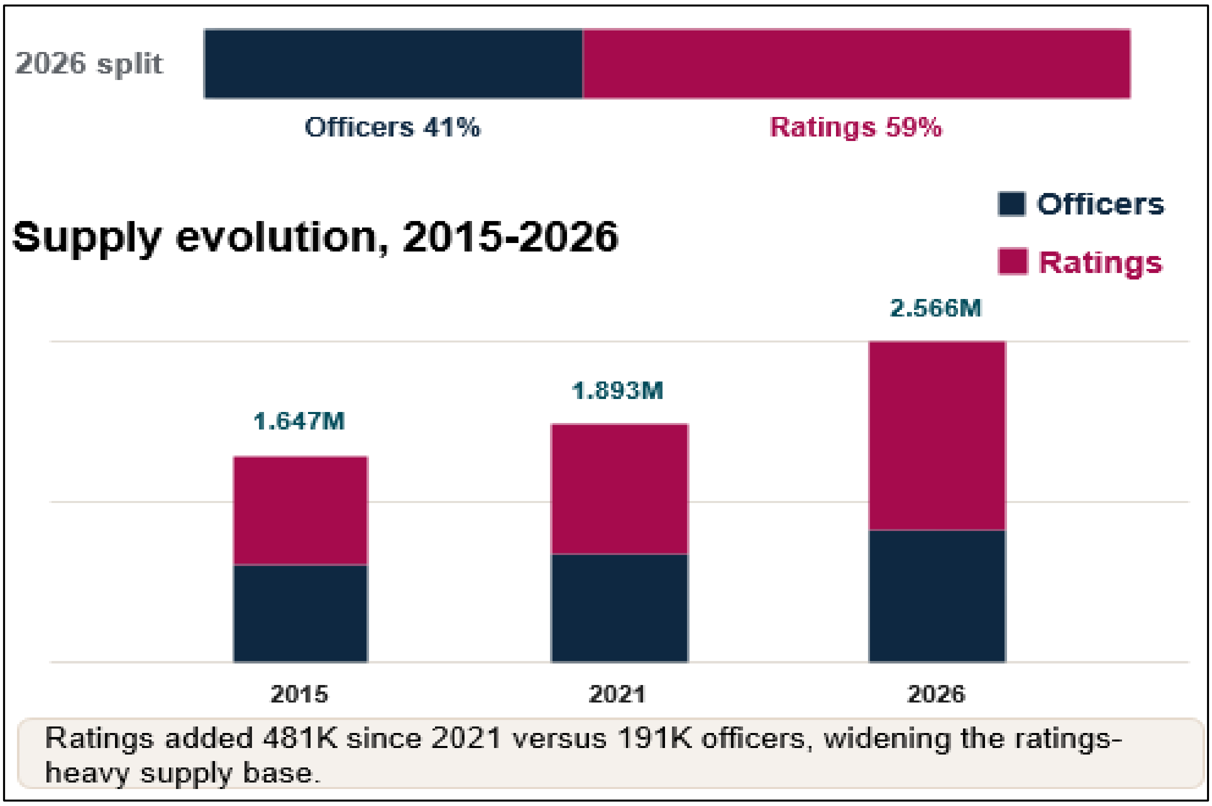
Global Supply Trends

The global seafarer pool has expanded significantly over the past decade:

Year	Estimated Seafarers
2015	1.647 Million
2021	1.893 Million
2026	2.566 Million

Between 2021 and 2026:

- Ratings increased by approximately **481,000 personnel**.
- Officers increased by approximately **191,000 personnel**.
- The worldwide seafarer workforce therefore remains heavily dependent on a robust ratings pipeline to meet shipping demand.



This trend demonstrates that countries capable of producing trained ratings and subsequently upgrading them into officers hold a significant competitive advantage in global shipping.

Leading Seafarer Supply Nations

The top five seafarer-supplying countries collectively contribute approximately **1.505 million seafarers**, accounting for nearly **59% of the world's maritime workforce**.

Top 5 seafarer supply countries by estimated count

Officers | Ratings

Rank	Supply country	Officer / rating split	Total
1	Philippines	203K / 257K	460.1K
2	India	141K / 171K	311.9K
3	China	111K / 199K	310.0K
4	Russian Federation	86K / 154K	239.4K
5	Indonesia	72K / 111K	183.2K

Philippines

- Continues to retain global leadership.
- Strong international recruitment network.
- Well-established maritime education ecosystem.
- Long-standing reputation among global shipowners.

India

- Second-largest supplier globally.
- Produces a large number of English-speaking, STCW-compliant seafarers.
- Strong technical, engineering and officer training capabilities.
- Well positioned to attract greater global demand.

China

- Nearly equal to India in overall numbers.
- Large domestic maritime industry contributes significantly to workforce generation.

Russian Federation & Indonesia

- Continue to contribute sizeable maritime manpower.
- Maintain strong ratings segments and regional recruitment advantages.

India's Strategic Position

India presently supplies approximately **311,900 seafarers**, comprising:

- **141,000 Officers**
- **171,000 Ratings**

India's officer-to-rating ratio is among the strongest globally, reflecting the country's emphasis on quality training and technical competency.

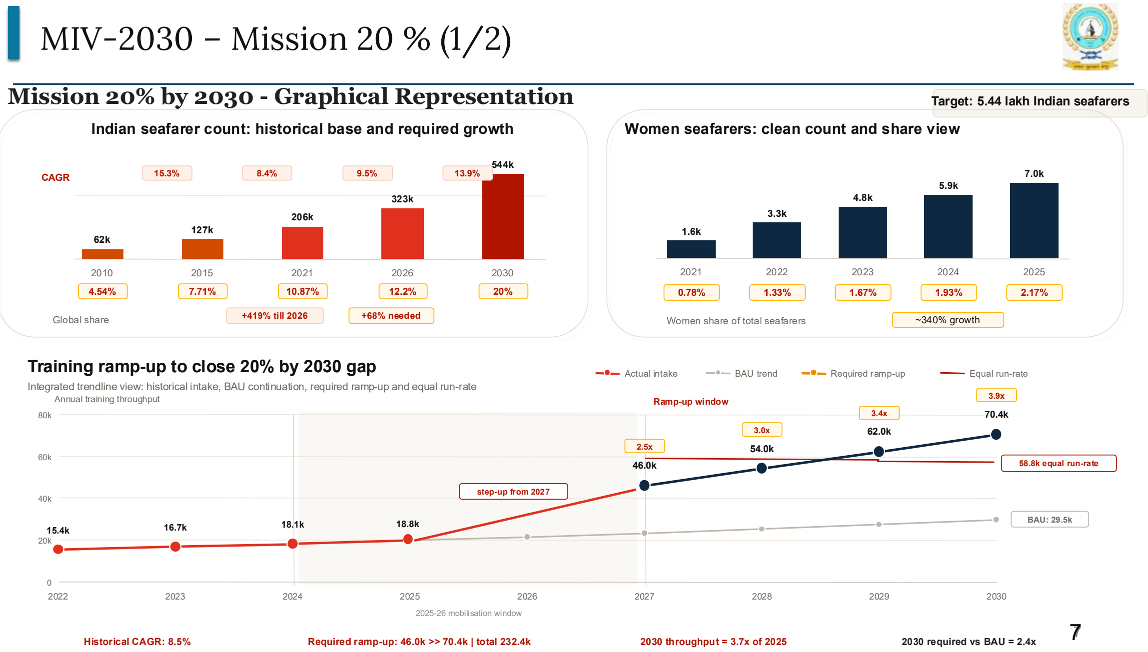
India has emerged as a preferred source of maritime talent due to:

- Compliance with international STCW standards.
- High-quality maritime education and training.
- Strong English language proficiency.
- Reputation for technical and managerial competence.

- Availability of young workforce entering the maritime sector.

However, the current global landscape presents a significant growth opportunity. By expanding training capacity, increasing training berths, improving placement outcomes and leveraging digital initiatives, India can realistically target **Mission 20%**, requiring the addition of approximately **200,000 seafarers** to the national maritime workforce and firmly establishing India as the world's leading provider of maritime talent.

1.2 Mission 20% by 2030: Growth Roadmap



A) Growth of the Indian Seafaring Workforce

India's seafaring workforce has recorded sustained growth over the last two decades:

- The number of Indian seafarers increased from approximately **62,000 in 2010** to **1.27 lakh in 2015**.
- The workforce further increased to **2.06 lakh in 2021** and approximately **3.23 lakh in 2026**.
- India's estimated share of the global seafaring workforce increased from **4.54% in 2010** to **12.2% in 2026**.
- The Indian seafarer base has expanded by approximately **419% between 2010 and 2026**, demonstrating the effectiveness of maritime training, certification and employment initiatives.
- To achieve a **20% global share by 2030**, India must increase the number of seafarers to approximately **5.44 lakh**.

- This requires an additional increase of nearly **2.21 lakh seafarers**, equivalent to approximately **68% growth over the 2026 level**.
- The required growth rate for 2026–2030 is approximately **13.9% per annum**, which is substantially higher than the growth achieved during 2021–2026.

B) Increasing Participation of Women Seafarers

The participation of women in the Indian maritime workforce has shown strong and consistent growth:

- The number of women seafarers increased from approximately **1,600 in 2021** to **3,300 in 2022**.
- The number further increased to **4,800 in 2023**, **5,900 in 2024**, and approximately **7,000 in 2025**.
- Accordingly, the share of women in India's total seafaring workforce increased from **0.78% in 2021** to **2.17% in 2025**.
- This represents growth of approximately **340% in the number of women seafarers within four years**.
- Despite this progress, women continue to constitute a relatively small share of the overall seafaring workforce.
- Mission 20% therefore provides an opportunity to accelerate women's participation through focused outreach, training support, onboard placement opportunities, safe working conditions and structured career progression.

C) Training Ramp-Up Required

India's annual maritime training intake increased gradually from:

- **15,400 trainees in 2022**
- **16,700 trainees in 2023**
- **18,100 trainees in 2024**
- **18,800 trainees in 2025**

The historical annual growth rate in training intake has been approximately **8.5%**. Continuation of the present business-as-usual trend would result in annual training throughput of only about **29,500 by 2030**, which would be insufficient to achieve Mission 20%.

A major expansion of training capacity is therefore required from 2027 onwards:

Year	Required Annual Training Throughput	Multiple of 2025 Intake
2027	46,000	2.5 times
2028	54,000	3.0 times
2029	62,000	3.4 times
2030	70,400	3.9 times

The cumulative required training throughput during **2027–2030** is approximately **2.324 lakh trainees**.

D) Scale of the Required Intervention

The annual training throughput will need to increase from approximately **18,800 in 2025** to **70,400 by 2030**. This means that:

- The 2030 training throughput must be approximately **3.7 times the 2025 level**.
- An immediate step-up will be required from 2027, rather than relying only on incremental growth.
- The expansion must be supported by corresponding growth in onboard training berths, certification capacity and employment opportunities.
- Expansion of numbers must be accompanied by strong quality assurance to ensure that Indian seafarers remain globally competitive and fully compliant with applicable standards.

1.3 What Global Leaders Optimise For

1. Export and Welfare Engine (Philippines Model)

The Philippines remains the world's largest supplier of seafarers through a coordinated national strategy centred on manpower export.

Key Features

- Strong government support for maritime manpower exports.
- Licensed and regulated manning agencies.
- Structured training-to-employment pipeline.
- Extensive welfare and protection mechanisms for seafarers abroad.
- Continuous engagement with global shipowners and crewing companies.

Key Lesson for India A robust deployment ecosystem and welfare framework significantly improve employability, retention and global demand for national seafarers.

2. National Assets and Self-Reliance (China, USA, Russia Model)

These countries treat maritime manpower development as a strategic national capability linked to economic and security objectives.

Key Features

- Dedicated training ships and cadet berths.
- Investment in maritime universities and advanced simulators.
- Development of specialist competencies aligned with national priorities.
- Strong integration between training institutions and domestic shipping sectors.
- Long-term workforce planning linked to maritime industrial growth.

Key Lesson for India Strategic investments in maritime infrastructure and training capacity can create sustainable and self-reliant workforce growth.

3. Career and Services Market (Singapore, UK, Romania Model)

These countries focus on creating a complete maritime career ecosystem extending beyond shipboard employment.

Key Features

- Industry-sponsored cadet programmes.
- Strong employer-academia partnerships.
- Advanced simulation and specialist training centres.
- Multiple career pathways across shipping, offshore and maritime services sectors.
- Continuous professional development opportunities.

Key Lesson for India A strong maritime services ecosystem improves attractiveness of maritime careers and supports long-term talent retention.

4. Standards and Berth Incentives (EU and Multi-Country Model)

Several maritime administrations have successfully expanded workforce supply by combining high-quality standards with financial support mechanisms.

Key Features

- Strict STCW-compliant training framework.
- Mutual recognition of certificates.
- Government-supported cadet berth programmes.

- Digital documentation and evidence systems.
- Strong quality assurance and oversight.

Key Lesson for India Availability of training berths and internationally trusted certification systems are essential for scaling seafarer numbers without compromising quality.

1.4 What India Should Adapt

1. Fund Verified Sea-Time

The biggest bottleneck in producing certified officers remains access to onboard training and sea-time.

Recommended Actions

- Introduce berth-credit or berth-support schemes for shipping companies.
- Support cadets through sea-time stipends and financial assistance.
- Leverage Government-to-Government arrangements for training opportunities.
- Utilize major Indian ports as facilitators for cadet training initiatives.
- Encourage participation of Indian-flag and foreign-going vessels.

Expected Outcome Significant increase in cadet completion rates and faster conversion of trainees into certified officers.

2. Build Practical Capacity

India's training ecosystem must expand rapidly to support Mission 20%.

Recommended Actions

- Strengthen existing Maritime Training Institutes (MTIs).
- Develop additional simulator centres and practical training infrastructure.
- Enhance faculty availability and instructional quality.
- Promote industry-linked maritime clusters.
- Establish training ships and shared training facilities.

Expected Outcome Substantial increase in annual training throughput while maintaining international quality standards.

3. Digitise the Trust Chain

Global employers increasingly require transparent and verifiable training and certification records.

Recommended Actions

- Digitalise Certificates of Competency (CoC).
- Maintain electronic TAR/TRB records.
- Integrate RPSTL, placement and certification databases.
- Enable verification of credentials through secure digital platforms.
- Establish end-to-end digital tracking of trainee progression.

Expected Outcome Enhanced trust among international employers, reduced fraud and improved transparency.

4. Create Specialist Corridors

Future demand growth is expected in specialised maritime sectors beyond conventional shipping.

Recommended Actions

- Develop competency frameworks for LNG and LPG operations.
- Expand offshore and renewable energy maritime training.
- Build pathways for cruise shipping employment.
- Prepare workforce for autonomous and digital shipping technologies.
- Promote green shipping and alternative fuel competencies.

Expected Outcome Higher-value employment opportunities and improved global competitiveness of Indian seafarers.

5. Protect and Retain Talent

Sustained growth requires strong welfare, safety and career progression measures.

Recommended Actions

- Strengthen anti-fraud measures across training and recruitment ecosystems.
- Promote women seafarer participation through targeted initiatives.
- Expand wellness and mental health programmes.
- Create structured sea-to-shore transition pathways.
- Improve grievance redressal and welfare support systems.

Expected Outcome Higher retention rates, increased workforce participation and a stronger global reputation for Indian maritime talent.

4.2 Sagar Mein Samman

Sagar Mein Samman

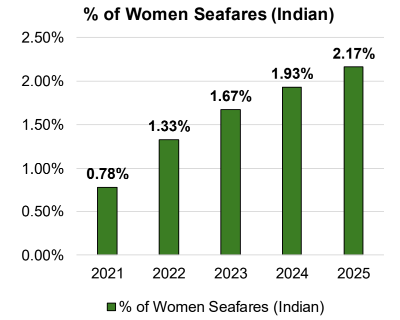
"Honour at Sea"

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.

4 Strategic Pillers

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



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

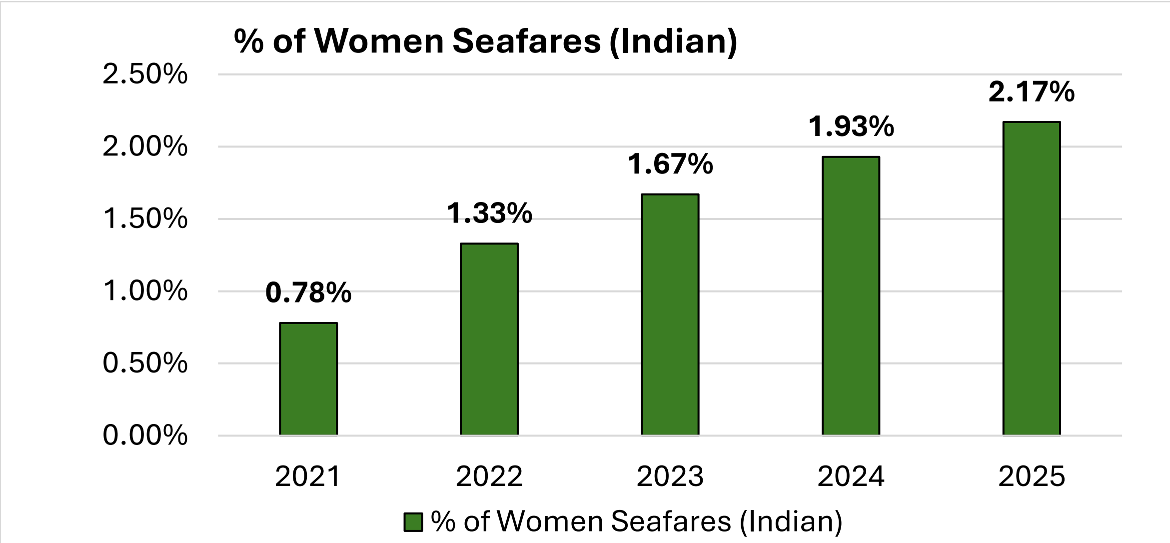
Sagar Mein Samman (SMS), meaning "Honour at Sea", is a flagship initiative of DGMA aimed at promoting gender inclusion, equality, and welfare within the maritime sector. The initiative recognizes the need to create a more inclusive maritime ecosystem by encouraging greater participation of women in seafaring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

Logo of Sagar Mein Samman

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.

4.3. Sagar Mein Yog

Sagar Mein Yog

"Sagar Mein Yog" is an initiative by the DGMA, Govt. of India, aimed at promoting physical and mental well-being among seafarers through yoga and mindfulness practices.

SAGAR MEIN YOG

Sagar Mein Yog

- Introduced under DGS Order 19 of 2024, focusing on mental, physical, and emotional well-being of seafarers.
- Standardizes wellness practices across training institutes via MoU with NUSI.
- Helps reduce stress, fatigue, and medical emergencies enhancing safety compliance.
- Integrates structured wellness modules into Pre-Sea, At-Sea, and Post-Sea stages

LMS Link

Sagar Mein Yog enhance India's maritime regulatory framework by setting structured standards for wellness across the crewing ecosystem.

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.

SAGAR MEIN YOG

Logo of Sagar Mein Yog

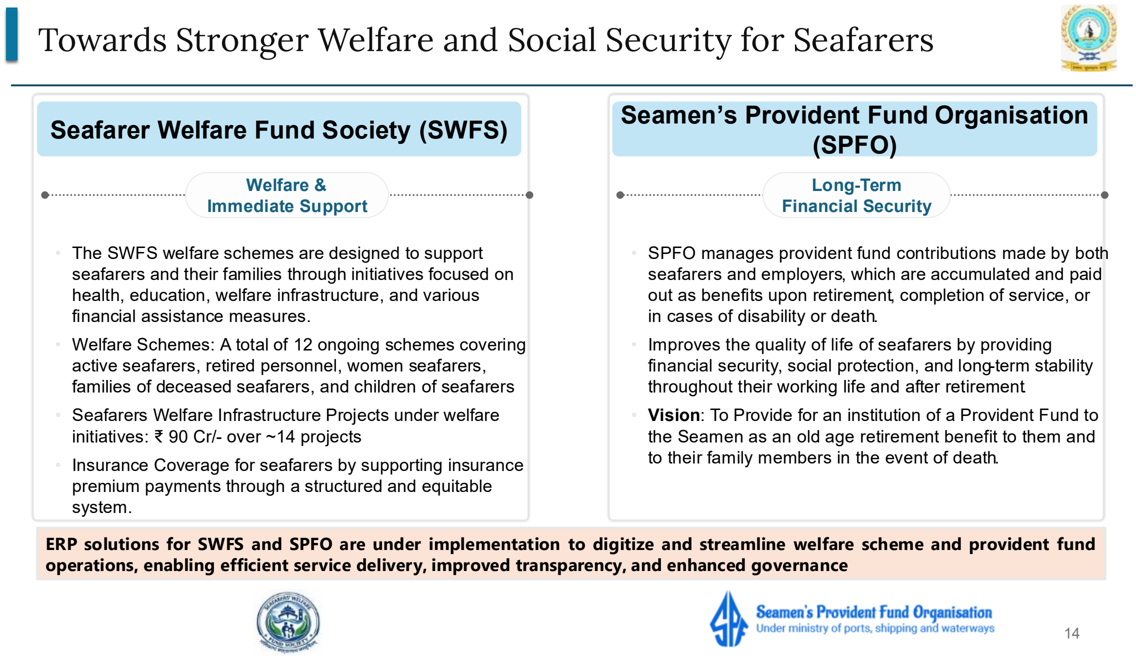
The initiative is intended to address challenges such as stress, fatigue, and health-related concerns commonly associated with seafaring life. By promoting wellness and mindfulness practices, the programme aims to contribute to improved well-being while supporting safety compliance and operational readiness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

4.4. Towards Stronger Welfare and Social Security for Seafarers



The Government of India has established a comprehensive framework for seafarer welfare and social security through two dedicated institutions, namely the Seafarer Welfare Fund Society (SWFS) and the Seamen's Provident Fund Organisation (SPFO). Together, these organizations provide both immediate welfare assistance and long-term financial security to Indian seafarers and their families, supporting them throughout their professional careers and beyond. The slide highlights the complementary roles performed by SWFS and SPFO in strengthening the welfare ecosystem for Indian maritime personnel.

The Seafarer Welfare Fund Society (SWFS) serves as the welfare arm of the maritime administration and implements a wide range of welfare schemes in accordance with the principles of the ILO Maritime Labour Convention (MLC), 2006. SWFS currently administers multiple welfare and assistance schemes aimed at addressing the diverse needs of active seafarers, retired personnel, women seafarers, families of deceased seafarers, and children of seafarers. These include financial assistance in cases of death, permanent disability, maternity, old age, educational achievements, medical emergencies, abandonment, and career progression. The welfare framework is designed to provide direct support to seafarers and their dependents during periods of vulnerability and need.

Notable schemes administered by SWFS include the Survivors' Benefit Scheme, which provides financial assistance up to ₹6 lakh to the nominee of a deceased seafarer; the Invalidity Benefit Scheme, offering support up to ₹6 lakh in cases of permanent disability; the Maternity Benefit Scheme for women seafarers; the Old Age Benefit Scheme providing support at 65 and 75 years of age; and the Family Benefit Scheme, which encourages education and professional development of seafarers' children. In addition, schemes such as the Death on Board Benefit Scheme, Ex-Gratia Support Benefit Scheme for abandoned seafarers, Medical and Term Insurance Premium Assistance Scheme, and Medical Support Scheme for Critical or Terminal Illnesses further strengthen the social protection available to Indian seafarers.

To encourage professional growth and career advancement, SWFS has also introduced the Indian Certificate of Competency (CoC) Recognition and Career Progression Scheme, which provides one-time financial assistance to rating seafarers who obtain an Indian Certificate of Competency and advance to officer positions. These initiatives demonstrate SWFS's commitment not only to welfare assistance but also to enhancing employability and career development opportunities within the maritime sector.

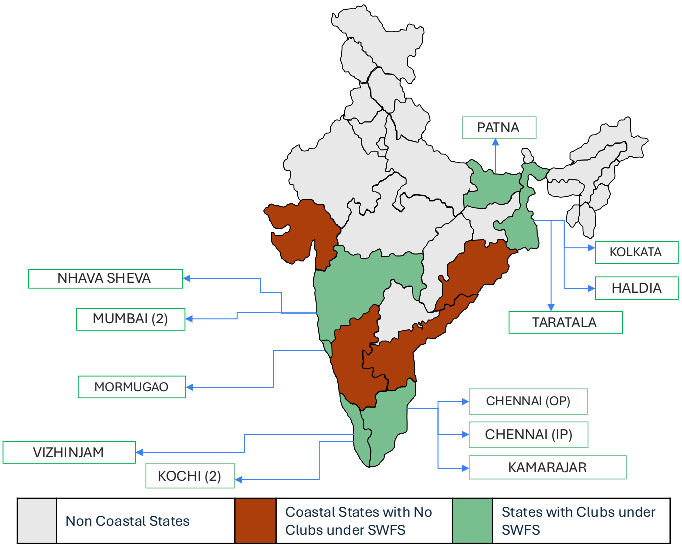
A significant recent initiative under SWFS is the Financial Assistance Scheme for Death or Permanent Disability suffered by Seafarers in Warlike / High-Risk Areas, introduced in March 2026. Under this scheme, one-time assistance of ₹10 lakh is provided in cases of death or permanent disability suffered in designated high-risk maritime regions, including the Persian/Arabian Gulf, Gulf of Oman, Gulf of Aden, Southern Red Sea, and adjoining Indian Ocean areas. The scheme recognizes the increasing challenges faced by seafarers operating in conflict-prone regions and provides an additional layer of protection and support to affected families.

Complementing these welfare initiatives, the Seamen's Provident Fund Organisation (SPFO) functions as the principal social security institution for seafarers by administering provident fund contributions made by both seafarers and employers. Through systematic accumulation and management of provident fund contributions, SPFO provides retirement benefits and financial assistance in cases of disability or death. The organization plays a critical role in ensuring long-term financial stability, income security, and social protection for seafarers and their dependents. By promoting savings and financial resilience, SPFO contributes significantly to the overall well-being and dignity of seafarers during their active service period as well as after retirement.

To further enhance service delivery and modernize operations, ERP solutions for both SWFS and SPFO are presently under implementation. These digital transformation initiatives are aimed at creating integrated, technology-enabled platforms for welfare scheme administration, provident fund management, stakeholder services, accounting, fund management, grievance handling, approvals, and reporting. The ERP systems will provide role-based access, workflow automation, document management, real-time dashboards, MIS reporting, and seamless integration with digital platforms and payment systems. The implementation of ERP solutions is expected to improve operational efficiency, transparency, accountability, governance, and stakeholder experience while enabling data-driven decision-making and providing a unified digital ecosystem for seafarers, shipping companies, RPSLs, and administrators.

4.5 Seafarer Welfare Infrastructure Initiative

Seafarer Welfare Infrastructure Initiative



SR NO	NAME OF PROJECT	LOCATION	GRANT AMOUNT
1	MERCHANT NAVY OFFICERS AND SEAMENS SOCIETY	KOCHI, KERELAM	₹50,00,000.00
2	ROYAL SEAMENS CLUB	MUMBAI, MAHARASHTRA	₹7,50,00,000.00
3	OUTREACH CENTER	PATNA, BIHAR	₹42,36,226.00
4	SEAFARERS CLUB (OUTSIDE PORT)	CHENNAI, TAMIL NADU	₹10,80,24,094.00
5	MAI & NABIK GRIHA SAMITY	TARATALA, WEST BENGAL	₹13,76,00,000.00
6	SEAFARERS CLUB	MORMUGAO, GOA	₹13,00,00,000.00
7	MARINE CLUB	KOLKATA, WEST BENGAL	₹7,75,00,000.00
8	SEAFARERS CLUB CUM HOSTEL	HALDIA, WEST BENGAL	₹1,00,00,000.00
9	SEAFARERS CLUB	VIZHINJAM, KERELAM	₹3,05,00,000.00
10	SEAFARERS CLUB (INSIDE PORT)	CHENNAI, TAMIL NADU	₹14,62,00,000.00
11	SEAFARERS CLUB	NHAVA SHEVA, MAHARASHTRA	₹2,66,00,000.00
12	SEAFARERS WELFARE CENTER	KAMARAJAR, TAMIL NADU	₹13,00,00,000.00
13	MOBILE SEAFARERS WELFARE UNIT	KOCH, KERELAM	₹1,00,00,000.00
14	SEAFARERS' WELFARE CENTRE	MUMBAI, MAHARASHTRA	₹5,75,00,000.00

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In addition to administering welfare schemes and financial assistance programmes, the Seafarer Welfare Fund Society (SWFS) has undertaken a nationwide Seafarer Welfare Infrastructure Initiative aimed at creating physical welfare infrastructure for seafarers across major maritime hubs in India. The objective of this initiative is to provide accessible welfare, recreational, accommodation, counselling, and support facilities for seafarers and their families at important port locations. The initiative reflects the commitment of SWFS towards improving the quality of life and well-being of seafarers both during and between sea service engagements.

As part of this initiative, SWFS has provided financial grants to establish and strengthen a network of 14 Seafarer Welfare Infrastructure Projects across the country with a cumulative investment of approximately ₹90 crore. These projects are strategically distributed across major maritime centres to ensure wider geographical coverage and accessible welfare support for Indian seafarers.

The infrastructure developed under this initiative includes Seafarers' Clubs, Welfare Centres, Hostels, Outreach Centres, Marine Clubs, Mobile Welfare Units, and Welfare Facilities within port premises. These facilities serve as dedicated spaces where seafarers can access welfare services, obtain information, communicate with family members, receive counselling and assistance, participate in recreational activities, and avail temporary accommodation and other support services when ashore.

The map illustrates the nationwide presence of SWFS-supported welfare facilities covering key maritime locations such as Mumbai, Nhava Sheva, Kochi, Vizhinjam, Mormugao, Chennai, Kamarajar, Kolkata, Haldia, Taratala, and Patna. States highlighted in green indicate locations where welfare clubs and facilities have already been established under SWFS support, while other coastal regions continue to be assessed for future expansion.

Among the major projects supported under the initiative are the Royal Seamen's Club, Mumbai, one of the largest welfare infrastructure projects supported by SWFS; the Seafarers' Clubs at Chennai, Kochi, Vizhinjam, Mormugao, Haldia, and Nhava Sheva; the Seafarers' Welfare Centre at Kamarajar Port; the Marine Club at Kolkata; the Mai & Nabik Griha Samity facility at Taratala; and a dedicated Outreach Centre at Patna to support seafarers and inland stakeholders. In addition, a Mobile Seafarers Welfare Unit has been established in Kochi to extend welfare services beyond fixed locations and improve outreach to seafarers.

These welfare infrastructure facilities complement the financial welfare schemes administered by SWFS by providing a physical support ecosystem for seafarers. Together, they create a comprehensive welfare framework that addresses not only emergency financial assistance but also social, recreational, educational, and community welfare needs. The initiative is particularly important in supporting seafarers during periods of leave, transition between contracts, training, documentation processes, and personal emergencies.

The Seafarer Welfare Infrastructure Initiative therefore represents a significant long-term investment in maritime welfare and demonstrates SWFS's vision of creating a sustainable, inclusive, and seafarer-centric welfare ecosystem across India's maritime sector. By strengthening welfare infrastructure at key ports and maritime locations, SWFS is ensuring that Indian seafarers receive accessible support services throughout their professional journey and beyond.

4.6. Suraksha Sarvapratham

Suraksha Sarvapratham

DGMA is focused on promoting safety on vessels and is set to launch a campaign called the Suraksha Sarvpratham, ensuring that the seafarers are able to discharge their duties in a risk-free manner.

To reduce accidents and minimize risks aboard ships.	Detailed documentation of incidents that occur at sea and during port operations.	Systematic recording and analysis of incidents will help identify patterns, understand root causes, and implement preventative strategies.	Instill a culture of safety among seafarers.
Web-based learning management systems for training.	Free online courses will be developed.	To create a safer working environment for seafarers by reducing the frequency and severity of accidents at sea and in ports.	Comprehensive incident documentation, strict adherence to safety protocols, and innovative AI-based safety videos---to establish Safety Culture

Recognizing that seafarers are the backbone of the maritime industry and that safety remains the foundation of efficient shipping operations, the Directorate General of Maritime Administration (DGMA) is launching the **"Suraksha Sarvapratham"** initiative. The campaign is aimed at strengthening safety culture across the maritime sector and ensuring that seafarers are able to perform their duties in a safe, secure, and risk-free environment. The initiative adopts a preventive and proactive approach towards maritime safety by emphasizing awareness, reporting, analysis, training, and continuous improvement.

A key objective of the campaign is to **reduce accidents and minimize operational risks aboard ships and during port operations**. Maritime incidents often result in loss of life, injuries, damage to property, environmental pollution, and significant economic consequences. Through Suraksha Sarvapratham, DGMA seeks to encourage greater vigilance and adherence to established safety procedures across the maritime ecosystem.

The campaign places significant emphasis on the **systematic documentation and reporting of incidents occurring at sea and in ports**. Comprehensive recording of accidents, near misses, unsafe acts, and hazardous conditions will facilitate the creation of a robust database for safety management. Such records will enable stakeholders to identify recurring patterns, assess operational vulnerabilities, and gain deeper insights into the causes behind maritime incidents.

An important component of the initiative is the **analysis of incident data to identify trends and root causes**. By understanding why accidents occur, preventive measures can be implemented more effectively. Root cause analysis will help move beyond immediate corrective actions and focus on long-term solutions that address underlying deficiencies in systems, procedures, equipment, or human factors. This evidence-based approach will support the development of targeted safety interventions and risk mitigation strategies.

The campaign also seeks to **instill a strong safety culture among seafarers and maritime organizations**. Safety culture goes beyond compliance with regulations and requires every individual onboard and ashore to consider safety as a shared responsibility. Through regular awareness programmes, safety communications, and best-practice dissemination, the initiative aims to promote a mindset in which safety becomes an integral part of everyday maritime operations.

To support continuous learning and skill development, DGMA proposes the establishment of **web-based learning management systems and digital training platforms**. These platforms will provide seafarers with easy access to safety-related educational content, guidelines, learning modules, and assessment tools. Digital learning solutions will facilitate wider outreach and ensure that safety training remains accessible irrespective of geographical location.

As part of this effort, **free online safety courses** will be developed and made available to seafarers and maritime stakeholders. These courses will cover critical areas such as accident prevention, emergency preparedness, personal safety, risk assessment, safe operational practices, and lessons learned from previous incidents. The objective is to continuously enhance safety competencies across the industry and create a well-informed maritime workforce.

The ultimate goal of Suraksha Sarvapratham is to **create a safer working environment by reducing both the frequency and severity of accidents at sea and within port areas**. Improved safety performance not only protects lives but also enhances operational reliability, reduces financial losses, improves environmental protection, and strengthens the reputation of India's maritime sector.

To further reinforce safety awareness, the initiative proposes the use of **innovative AI-enabled safety awareness videos, digital campaigns, and modern communication tools**. Combined with comprehensive incident documentation and strict adherence to established safety protocols, these tools will help promote behavioural change and strengthen safety consciousness among seafarers. The integration of technology with traditional safety management practices is expected to improve engagement, learning effectiveness, and long-term retention of safety lessons.

Sagar Prashikshan 2026

About the Conclave

- The proposed **Maritime Training & Skilling Conclave** seeks to provide a common platform for regulators, training institutions, industry stakeholders, and subject matter experts to deliberate on these issues and chart a way forward.
- The conclave is aligned with the objectives of the STCW Convention and Digital India, aiming to build a transparent, technology-enabled, and industry-responsive maritime training ecosystem that meets evolving global standards.

Rationale

- To identify and bridge gaps between maritime training outcomes and industry skill requirements
- To enable structured stakeholder consultation on regulatory, academic, and digital reforms
- To strengthen faculty development and continuous upskilling mechanisms
- To promote adoption of technology-driven training, including LMS and simulation-based learning
- To develop actionable recommendations for a standardized, transparent, and industry-aligned maritime training ecosystem

Status Update

In view of the austerity measures and expenditure rationalization directives, the proposed **Sagar Prashikshan - National Maritime and Skilling Conclave** has been temporarily deferred. DGMA remains committed to the initiative, and planning will be resumed at the earliest suitable opportunity.

5. Maritime Human Capital | Protection, Welfare and Empowerment of Seafarers

5.1 Seafarer Assistance and Facilitation Counter

Seafarers Assistance & Facilitation Counter

Aim: On-ground assistance at the Pranaam helpdesk to support seafarers with documentation and immigration, reducing fraud, legal issues, and emergency cases while ensuring smooth airport entry.

Problem Statement

- UK visa-free entry for Indian seafarers is reportedly being misused by asylum seekers posing as crew.

Potential Solution

- It was agreed that DGMA-trained teams at Pranam helpdesk would vet seafarers and alert airlines to prevent misuse.

Other Benefits

- The process prevents undocumented seafarers from UK entry, avoiding arrests and distress to families.

The inauguration of the PRANAAM Seafarers Assistance Counter successfully conducted on 21st January 2026 at Chhatrapati Shivaji Maharaj International Airport, Terminal 2, Mumbai.

PRANAAM Seafarers Assistance Counter at Mumbai Airport to Strengthen Welfare and Facilitation Support

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Seafarers Assistance & Facilitation Counter

The **Seafarers Assistance & Facilitation Counter** has been established as a dedicated on-ground support mechanism to assist Indian seafarers during their international travel and documentation processes. The initiative is aimed at providing handholding support at critical transit points, particularly airports, to facilitate smooth movement of seafarers, address documentation-related challenges, coordinate with relevant authorities, and provide immediate assistance during emergencies. The facility forms part of DGMA's broader vision of strengthening welfare and support services for Indian seafarers through both digital and physical intervention mechanisms.

The concept emerged in response to growing concerns regarding the misuse of immigration and crew travel provisions by individuals falsely posing as seafarers. In particular, instances were reported where non-seafarers attempted to exploit visa exemptions and crew transit facilities intended for genuine maritime personnel. Such practices not only undermine immigration systems but also create operational challenges for airlines, shipping companies, and immigration authorities while adversely impacting the reputation of bona fide Indian seafarers.

To address these concerns, it was proposed that specially trained DGMA personnel stationed at the airport facilitation counter would assist in verifying seafarer credentials, validating supporting documentation, and coordinating with airlines and concerned authorities where required. This proactive verification mechanism helps ensure that travel privileges intended for genuine seafarers are utilized appropriately while reducing the possibility of fraudulent travel attempts.

Beyond preventing misuse, the facilitation counter serves several important welfare functions. Seafarers frequently face documentation issues, visa and immigration-related queries, last-minute travel complications, contractual concerns, emergency situations, and coordination challenges while joining or leaving vessels. The counter acts as a dedicated support point where seafarers can obtain guidance, clarification, and assistance in resolving such issues. This is particularly beneficial for young seafarers, first-time travellers, and crew members required to undertake urgent international travel for vessel joining.

The initiative also contributes significantly towards safeguarding the interests of Indian seafarers overseas. By ensuring that only properly documented and verified seafarers undertake international travel, the mechanism helps prevent situations in which individuals may face detention, deportation, immigration violations, or legal proceedings abroad. This in turn protects seafarers and their families from avoidable hardship, financial distress, and reputational consequences arising from documentation or travel irregularities.

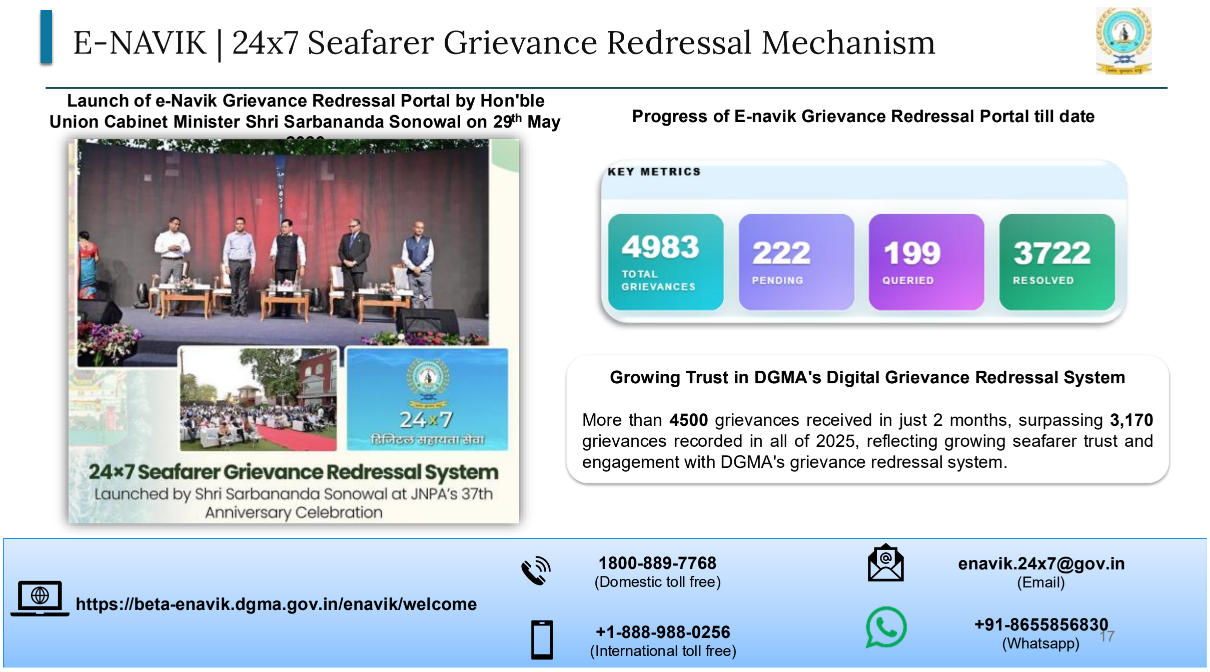
In addition to immigration and documentation support, the counter is envisioned as an important welfare touchpoint for seafarers. The facility can assist in coordinating support during emergencies, connecting seafarers with relevant government agencies and stakeholders, facilitating communication during distress situations, and providing guidance regarding welfare schemes, grievance redressal mechanisms, and other available support services. The initiative therefore strengthens the overall support ecosystem available to Indian seafarers during critical stages of their travel and employment cycle.

A major milestone under this initiative was the inauguration of the ***PRANAAM Seafarers Assistance Counter at Chhatrapati Shivaji Maharaj International Airport (CSMIA), Terminal 2, Mumbai, on 21 January 2026.*** The facility was established through collaborative efforts of maritime stakeholders with the objective of providing a dedicated assistance desk for Indian seafarers passing through one of the country's busiest international gateways. The inauguration marked an important step towards institutionalizing airport-based support services for seafarers and creating a more responsive facilitation framework.

The establishment of the PRANAAM Seafarers Assistance Counter demonstrates DGMA's commitment to a **"Seafarer First"** approach by creating practical, ground-level mechanisms that complement digital initiatives such as E-NAVIK. While digital platforms provide grievance redressal and monitoring capabilities, the facilitation counter ensures direct human assistance at critical transit points. Together, these initiatives contribute towards safer travel, improved welfare delivery, enhanced compliance, and a more seamless experience for Indian seafarers serving across the global maritime industry

6. Digital Interventions

6.1. E-NAVIK | 24x7 Seafarer Grievance Redressal Mechanism



The Directorate General of Maritime Administration (DGMA) has taken a significant step towards strengthening seafarer welfare and governance through the launch of E-NAVIK, a dedicated 24x7 Digital Grievance Redressal Mechanism for Indian seafarers. The platform has been designed to provide a centralized, technology-enabled system through which seafarers can register complaints, track progress, seek assistance, and obtain timely resolution of issues related to employment, welfare, certification, training, documentation, abandonment, repatriation, and other maritime matters.

The E-NAVIK Grievance Redressal Portal was formally launched by the Hon'ble Union Minister for Ports, Shipping and Waterways during a public event held in May 2026. The launch marked a significant milestone in DGMA's ongoing digital transformation initiatives aimed at improving accessibility, responsiveness, transparency, and accountability in services delivered to Indian seafarers. The platform serves as a single-window mechanism enabling seafarers from India and abroad to access grievance redressal services at any time and from any location.

The system has been developed with the objective of ensuring that every grievance raised by a seafarer receives structured attention, proper tracking, and timely resolution. Through a digital workflow-based approach, complaints can be routed to the appropriate department or authority, monitored through dashboards, escalated where necessary, and resolved with full visibility to stakeholders. The portal also improves institutional accountability by maintaining an auditable record of complaint registration, action taken, timelines, and closure status.

The progress achieved since the launch of the portal demonstrates strong adoption and engagement by the seafaring community. As reflected in the dashboard, the platform has received 4,983 grievances, of which 3,722 grievances have been resolved, while 222 cases are pending and 199 are under query or clarification stage. These figures indicate an active grievance management system and a significant volume of interactions being handled through the digital portal.

A key indicator of the platform's success is the growing confidence of Indian seafarers in DGMA's grievance redressal framework. The slide highlights that more than 4,500 grievances were received within a short period after launch, surpassing the number of grievances recorded during the entire preceding year. This reflects increased awareness, improved accessibility, and stronger trust in the administration's ability to respond to seafarer concerns through a transparent and responsive digital mechanism.

To ensure round-the-clock accessibility, multiple communication channels have been integrated into the E-NAVIK framework. Seafarers can access the portal through the web-based interface, submit requests online, and seek assistance through dedicated domestic and international toll-free helplines, email, and WhatsApp-based communication channels. This multi-channel approach ensures that support remains available to seafarers regardless of their location, time zone, or connectivity constraints while serving onboard vessels or overseas.

The E-NAVIK platform represents an important component of DGMA's broader vision of digital governance and seafarer-centric service delivery. By leveraging technology to simplify grievance registration, improve monitoring, and reduce response times, the initiative contributes to better welfare outcomes, enhanced stakeholder confidence, and stronger regulatory oversight. The platform also complements other welfare and social security initiatives undertaken through SWFS and SPFO by providing an accessible avenue for seafarers to seek support and resolution of issues affecting their professional and personal well-being.

Overall, E-NAVIK serves as a flagship example of citizen-centric digital governance in the maritime sector, ensuring that Indian seafarers have access to a transparent, accountable, and responsive grievance redressal mechanism operating 24 hours a day, 7 days a week.

6.2. E-NAVIK Seafarer Tracking Dashboard

E-NAVIK | Seafarer Tracking Dashboard

Hon'ble Union Minister for Ports, Shipping and Waterways, Shri Sarbananda Sonowal, envisages a technology-enabled "Seafarer-First" ecosystem that ensures the safety, welfare, and continuous monitoring of every Indian seafarer, irrespective of the vessel's flag.

"Track Every Indian Seafarer, Protect Every Indian Seafarer"

A centralized operational dashboard for real-time monitoring, welfare assessment, escalation management, and crisis response for Indian seafarers worldwide.

Union government launches tracker for seafarer safety

Saurabh Trivedi
NEW DELHI

Union Minister for Ports, Shipping and Waterways Sarbananda Sonowal ordered a comprehensive 'Seafarer-First' response on Tuesday to safeguard Indian crew operating in the conflict-hit Strait of Hormuz.

Mr. Sonowal ordered real-time vessel-by-vessel monitoring of Indian seafarers and directed the appointment of dedicated liaison officers for every affected Indian sailor.

Union Minister for Ports, Shipping and Waterways Sarbananda Sonowal

Operational dashboard

The Ministry of Ports, Shipping and Waterways (MoPSW) will coordinate the response round the clock in association with the Ministry of External Affairs, the Indian Navy, the Directorate General of Shipping, Indian missions in Iran, Oman and the UAE, as well as other maritime stakeholders.

The Minister directed the Secretary, MoPSW, and the Director General of Shipping to establish a comprehensive operational dashboard to track every Indian seafarer aboard vessels in the Persian Gulf, Strait of Hormuz, and Gulf of Oman, irrespective of the ship's flag.

The dashboard will provide real-time information on vessel location, ownership, cargo, crew welfare, threat levels, intended voyage, next port of call, and the availability of supplies. Mr. Sonowal also instructed officials to ensure every vessel transiting the affected waters undertakes a fresh threat assessment before sailing.

Tracking every Indian seafarer, irrespective of vessel's flag: Sonowal

Indian crew member killed in strike

DHRUVAKSH SAHA
New Delhi, 14 July

Amidst the escalating maritime security crisis in West Asia, following attacks on two merchant vessels in the Strait of Hormuz, shipping minister Sarbananda Sonowal has directed officials to track every Indian seafarer, irrespective of the vessel's flag. The minister also strongly condemned the attacks on the vessels, calling them "irresponsible, irresponsible, and uncalled for," a shipping ministry statement said.

Sonowal also said that any voyages through the strait will only happen after fresh threat assessments. He was holding a review meeting with the officials of shipping and external affairs ministries, Indian Navy, Directorate General of Maritime Administration, and other key maritime agencies, reviewing the evolving security environment across the Persian Gulf.

The minister ordered real-time and vessel-by-vessel monitoring, the appointment of dedicated liaison officers for every affected Indian seafarer, and round-the-clock coordination. The review meeting took place following the attacks on MT Al Bahiyah and MT Mombasa in the Strait of Hormuz. The two vessels together carried 30 Indian seafarers among a combined crew of 46.

According to government statements, one Indian seafarer lost his life, while another sustained injuries aboard MT Al Bahiyah. On MT Mombasa, nine Indian nationals were injured, including two who remain seriously injured.

"India has expressed its strong resentment and objection to the manner of attacks on defenceless civilian merchant vessels. These have resulted in the death and serious injury of Indian seafarers who, as key workers ensuring the proper functioning of global supply chains, due to these irresponsible, unwarranted and uncalled-for attacks," he said. He asked officials to establish a comprehensive vessel-by-vessel operational dashboard to account for every Indian on every vessel, irrespective of their flags, operating in the Persian Gulf, Strait of Hormuz, and Gulf of Oman.

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The E-NAVIK Seafarer Tracking Dashboard represents a major step towards establishing a technology-enabled, seafarer-centric maritime governance framework in India. The initiative reflects the vision of creating a comprehensive "Seafarer-First" ecosystem that prioritizes the safety, welfare, security, and continuous monitoring of Indian seafarers, irrespective of the vessel's flag, ownership, or operating region. The dashboard has been conceptualized as a centralized operational platform that enables maritime authorities to maintain real-time visibility of Indian seafarers deployed across global shipping routes and high-risk maritime regions.

The concept for the dashboard emerged in response to evolving global maritime security challenges and the increasing need for proactive monitoring of Indian seafarers serving onboard vessels operating in conflict-prone and high-risk waters. Recent geopolitical developments and attacks on merchant vessels highlighted the importance of having a real-time system capable of identifying the location, status, and welfare of Indian crew members worldwide. The initiative strengthens India's ability to respond swiftly during emergencies and enhances institutional preparedness for crisis situations affecting Indian seafarers.

The E-NAVIK Tracking Dashboard is envisioned as a centralized operational command and monitoring platform that consolidates information relating to Indian seafarers and vessels on which they serve. The dashboard seeks to provide real-time information on vessel position, crew composition, ownership details, vessel routes, ports of call, voyage details, and operational status. By integrating data from multiple maritime sources, the platform enables authorities to obtain a consolidated view of Indian seafarers working across the global maritime ecosystem.

A key objective of the dashboard is to ensure that every Indian seafarer can be tracked and monitored irrespective of the vessel's flag state. Traditionally, information regarding Indian seafarers serving on foreign-flagged vessels may be dispersed across different databases and stakeholders. The proposed system aims to bridge this gap by creating a unified monitoring framework that ensures visibility over Indian nationals serving across international fleets. This approach enhances both safety oversight and emergency response capabilities while reinforcing India's commitment towards the protection of its maritime workforce.

The dashboard is also intended to function as a critical tool for real-time welfare assessment, escalation management, and crisis response. During maritime emergencies, security incidents, abandonment cases, geopolitical conflicts, piracy threats, or natural disasters, the system would enable authorities to identify affected Indian seafarers quickly, establish communication channels, coordinate with employers and diplomatic missions, and ensure necessary support measures are initiated. Such capabilities are expected to significantly improve response coordination and reduce the time taken to reach affected seafarers and their families.

The operational framework envisages close coordination among DGMA, shipping companies, RPSLs, maritime administrations, overseas missions, port authorities, and other relevant stakeholders. By maintaining a comprehensive digital repository and operational dashboard, authorities will be able to monitor emerging risks, identify vulnerable seafarers, assess potential impacts of security incidents, and make informed decisions in a timely manner. The availability of real-time data will support proactive intervention rather than reactive crisis management. (Image: Overall dashboard and media coverage)

Beyond emergency response, the dashboard is expected to contribute to broader maritime governance objectives by generating valuable operational insights and analytics relating to Indian seafarer deployment patterns, geographical distribution, vessel exposure, and welfare indicators. Such information can support evidence-based policymaking, resource allocation, welfare planning, risk assessment, and future initiatives aimed at strengthening seafarer protection measures. The dashboard therefore serves not only as a monitoring tool but also as a strategic decision-support platform for maritime administration.

Overall, the E-NAVIK Seafarer Tracking Dashboard embodies the principle of “Track Every Indian Seafarer, Protect Every Indian Seafarer.” By leveraging digital technologies, real-time monitoring, integrated data systems, and coordinated stakeholder engagement, the initiative seeks to enhance safety, strengthen welfare support, improve crisis preparedness, and ensure that every Indian seafarer remains connected to a responsive support system regardless of where they are deployed across the world.

6.3. Landmark Launch of E-Samudra

Landmark Launch of E-Samudra

08 AUGUST 2026

E-Samudra: A new digital gateway for maritime governance

LAUNCHED BY

Hon’ble Union Minister
Shri Sarbananda Sonowal

Ministry of Ports, Shipping & Waterways

E-Samudra is DGMA’s flagship digital platform—a comprehensive, paperless and citizen-centric ecosystem designed to advance ease of doing business.

Image courtesy: Directorate General of Maritime Administration

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e-Samudra is a flagship digital transformation initiative of the Ministry of Ports, Shipping and Waterways aimed at creating a unified, transparent, and technology-driven maritime governance ecosystem for India. Developed under the Directorate General of Maritime Administration (DGMA), the platform consolidates more than 15 major regulatory domains, including seafarer services, ship registration and mortgages, charter permissions, vessel surveys and certifications, ports, recognised organizations, multimodal transport operators, maritime service providers, tonnage taxation, medical practitioners, ISM/DSM audits, and financial management into a single digital interface.

Launched in its beta version on 08th August 2026, e-Samudra replaces fragmented legacy systems and manual processes with end-to-end digital workflows, automated validations, online approvals, real-time tracking, dashboards, and integrated data repositories. The platform significantly reduces service delivery timelines from weeks and months to days and, in several cases, to near real-time processing, thereby enhancing ease of doing business for seafarers, ship owners, ports, logistics operators, and maritime service providers.

The initiative strengthens regulatory oversight through audit trails, analytics, and data-driven decision-making while promoting transparency, accountability, and compliance with national and international maritime standards. Upon full stabilization, e-Samudra will serve as the digital backbone of India's maritime administration, supporting Maritime Amrit Kaal Vision 2047, fostering global competitiveness of the Indian maritime sector, and contributing significantly towards the vision of a technologically empowered and globally leading maritime nation.

Objective

The primary objective of the e-Samudra project is to implement a comprehensive IT transformation that enables the digitization of all organizational processes. The project aims to achieve several key goals:

i. Transitioning to a paperless system to enhance transparency and expedite service delivery through web-based communication and cutting-edge technological advancements.

ii. Automating all functions related to shipping and seafarer operations, as well as internal administration and maintenance. This will facilitate integration with the IT systems of the Ministry of Ports, Shipping, and Waterways for efficient data exchange, resulting in unified dashboards for various stakeholders.

iii. Enhancing existing e-Governance operations and processes, improving user interactions, integration channels, and overall ease of doing business, while supporting the initiatives and objectives of the Ministry of Ports, Shipping, and Waterways.

iv. Assisting the Ministry of Ports, Shipping, and Waterways, along with DGS, in improving the Data Governance Quality Index (DGQI).

The successful implementation of the DGS e-Samudra is anticipated to create a streamlined flow of information, thereby enhancing decision-making capabilities within the organization. This transformation is expected to lead to increased customer satisfaction, improved financial performance, greater transparency, and enhanced consistency in business operations and processes.

7. Overview

The DGS e-Samudra system is designed to transform the Directorate General of Shipping's (DGS) e-Governance services into a fully paperless environment, significantly enhancing the digital services available to DGS and its associated offices. This initiative will cater to various stakeholders, including shipping entities, seafarers, multimodal transport operators, DGS-approved medical practitioners, and shipyards. The project will involve the development of 15 distinct modules, implemented in accordance with the latest cybersecurity standards established by the Ministry of Electronics and Information Technology (MeitY).

The e-Samudra initiative represents a holistic e-Governance solution aimed at digitizing and integrating all aspects of maritime administration in India.

The modules included in this note along with their brief description are as follows,

1. **Seafarer Profile and Available Services**: The module serves as the backbone of the e-Samudra initiative, providing a centralized digital repository for all seafarer-related data. Integrated with legacy and new systems, it ensures seamless synchronization of personal, educational, training, and certification details. It enables creation and updating of seafarer profiles for Indian and foreign nationals through automated data retrieval from connected systems like the DGS e-Governance, Examination, and Training databases. The module also digitizes end-to-end management of Continuous Discharge Certificates (CDC) and Certificates of Proficiency (CoP), Competency (CoC), and other certifications, enabling online applications, automated verification, and digital issuance. By integrating with RPS companies, Maritime Training Institutes, and the Mercantile Marine Department, it enhances transparency, efficiency, and compliance while reducing manual intervention and processing time.

2. **Shipping Entity and Available Services:** This module provides a unified digital platform for registration, verification, and management of shipping companies, cooperatives, and foreign flag entities. It supports both data migration for existing users and online registration for new entities, ensuring seamless onboarding and structured access to DGS services. Integrated with the Vessel Registry, it enables automated creation and activation of ship and entity profiles, promoting transparency, data consistency, and efficient regulatory compliance. The module encompasses key sub-modules, including Plan Approval, Tonnage Measurement, Ship Registration, NOC from SMO/SWFS/SPFO, Charter Permissions & Licenses, Exemptions, Dispensations & Extensions, and Tonnage Taxation—together streamlining plan submissions, certification, chartering, and compliance processes. By digitizing these workflows, the system enhances efficiency, accountability, and service delivery across the maritime ecosystem under e-Samudra.

3. **Survey and Certification**: The Module enables comprehensive digital management of vessel surveys and certifications under the e-Samudra platform. Covering all vessel categories—cargo, passenger, fishing, high-speed craft, and others—the module digitizes end-to-end workflows from application submission, inspection scheduling, and survey reporting to

certificate issuance and MIS generation. Integrated with MMDs and Recognized Organizations, it ensures compliance with national and IMO regulations, improves transparency, and enhances operational efficiency. Automated notifications, structured approval workflows, and centralized data storage minimize manual processing and strengthen oversight of maritime safety and certification activities.

4. **ISM/ DSM Audits**: The system shall have end-to-end management of International Safety Management (ISM) and Document of Compliance (DOC) audits for shipping companies, ensuring adherence to safety, operational, and pollution-prevention standards. The module enables empanelment of auditors, scheduling and tracking of interim, initial, intermediate, and renewal audits, and generation of Safety Management Certificates (SMC) for passenger, cargo, high-speed, and other vessel types. Integrated workflows streamline document verification, audit reporting, and approvals by ISM Cell In-Charge and Chief Surveyor, while maintaining audit trails, notifications, and regulatory compliance. By centralizing all audit-related processes, the module enhances efficiency, traceability, and transparency for both shipping companies and the Directorate.

5. **Ports**: The module will digitize and streamline port regulatory and operational processes, enhancing compliance, safety, and efficiency. It shall support creation and management of comprehensive port profiles, ensuring up-to-date infrastructure and compliance records. Sub-modules cover NSPC Clearance for navigational safety, ISPS Audits for port security, Port Reception Facility (PRF) Audits for environmental compliance, and Shore Electricity Supply management for sustainable operations. By centralizing workflows, automating approvals, and maintaining digital records, the module ensures transparency, accountability, and operational efficiency for all ports under DGS.

6. **Service Providers**: This Module of e-Samudra will digitize and automate the lifecycle of maritime service provider approvals, audits, and certifications, enhancing transparency, efficiency, and regulatory compliance. Key sub-modules include IMSBC Laboratory Approvals for cargo testing, FFA/LSA Service Station Registration and Survey, Verified Gross Mass (VGM) Provider Management, Bunker Supplier Accreditation and Audits, Insurance Provider Approvals, and L/B Davit Service Station (DSS) Management. Each sub-module supports end-to-end digital workflows—from profile creation and

application submission to approval, renewal, and compliance tracking. By integrating these processes, the module shall minimize manual intervention, maintain traceable audit trails, and strengthen the DGS's oversight and operational efficiency across maritime service providers.

7. **Sailing Vessel Seaman**: This Module shall provide a streamlined digital framework for managing the registration and identity processes of sailing vessel seamen. It will allow creation and maintenance of individual seaman profiles, along with issuance, renewal, duplication, and cancellation of ID cards through a secure online interface. The Tindal Certification and Sign On/Off sub-module is expected to facilitate the management of crew certifications and Sign On/Off records, ensuring accurate tracking of seafarer movements and compliance with regulatory standards. These functionalities would improve transparency, enhance operational efficiency, and provide a reliable mechanism for both seamen and the Directorate General of Shipping to manage seafarer records effectively.

8. **Recognized Organization**: The Module shall provide a unified interface between the Directorate General of Shipping (DGS) and ROs for carrying out delegated statutory functions. It would allow DGS to onboard new or existing ROs through a structured profile creation process, enabling future operations such as authorization, vessel data mapping, and issuance of statutory certificates, with all actions linked to the RO's profile for traceability and regulatory oversight. The module is expected to support certificate generation by ROs, audits conducted by the Competent Authority including document review, on-site evaluation, and tracking of non-conformances and automated workflows for corrective action verification. Additionally, it shall facilitate periodic renewal of RO agreements, typically valid for five years, with six-month prior alerts, visual guidance through renewal stages, and provisions for amendments during the contract period, thereby ensuring transparency, compliance, and continuity of operations.

9. **Medical Practitioner**: Here, there shall be management of registration, approval, renewal, and monitoring of DG-approved medical practitioners through a secure online platform. It would allow practitioners to submit applications, issue medical certificates, and maintain digital records, while enabling DGS to track renewals, schedule surprise audits, and ensure compliance, quality, and transparency in all medical certification processes.

10. **Multimodal Transport Operators**: The module shall provide a fully digital framework for managing MTO registration, renewal, modifications, compliance, appeals, and grievance redressal under the MMTG Act, 1993. It would enable applicants to submit and track registration and renewal forms, update license details, respond to Show Cause Notices, file appeals, and raise grievances, while DGS officials can review, approve, monitor, and maintain complete audit trails—ensuring efficiency, transparency, and regulatory compliance throughout the MTO licensing lifecycle.

11. **Finance, Accounts, Audit and Public Procurement**: The F.A.A.P.P. Module shall provide an integrated digital platform for managing DGS financial, audit, and procurement activities. Upon commissioning, it will support budget preparation, allocation, and monitoring; track and resolve audit observations; manage accounts with PFMS integration; and handle end-to-end public procurement processes, including bidding, contract issuance, and performance tracking. The module shall enhance transparency, efficiency, and accountability, providing a secure and auditable environment for all related operations.

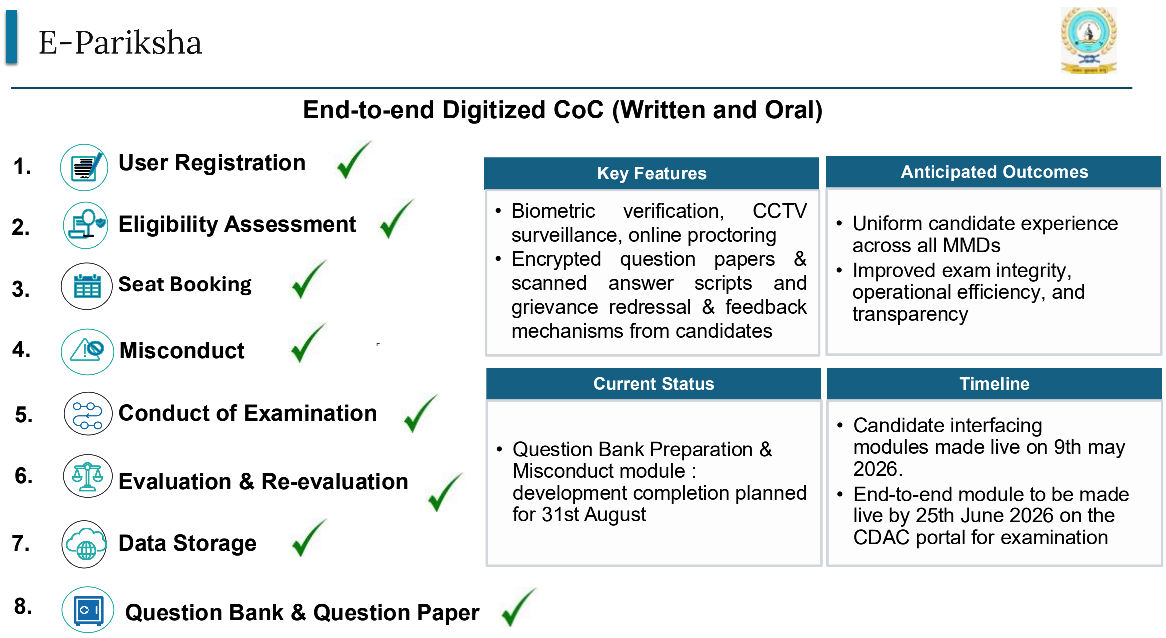
12. **Common Processes for Availing Services on e-Samudra**: The common processes such as Creation of Profile for Existing Users, Creation of Profile for New Users, Correction of Profile and Feedback/Complaint for external stakeholders of the portal, i.e. The seafarer, shipping entities, service providers etc.

13. **Common Processes for Departments using e-Samudra**: The common processes such as Profile Creation, Application Approvals, Delegation of Access, Sending a Query to the Applicant, Suspension/Debarment of Seafarer, Suspension/ Debarment of Officer only for the internal stakeholders of the portal, i.e. DGS and its allied offices authorized officials.

14. **Shipbuilding Financial Assistance Portal** (SBFAP): The SBFAP provides a comprehensive digital framework to manage shipyard registration, financial assistance applications, and fund disbursement in a transparent, accountable, and structured manner. shipyards are able to register, apply for In-Principle Approval, submit Novation Requests, and track budget allocations. The portal shall also support phased financial assistance requests, including pre- and post-audit disbursements, with pending integration to PFMS for smooth fund transfer. Through evaluator management, audit trails, automated notifications, and real-time dashboards, the system

shall ensure timely, trackable, and compliant processing, strengthening oversight, financial discipline, and operational efficiency within India's shipbuilding sector.

7.1 E-Pariksha



The Directorate General of Maritime Affairs (DGMA) is implementing a comprehensive **end-to-end digitized examination system** for Certificate of Competency (CoC) examinations, covering both written and oral assessments. The initiative aims to standardize examination processes across all Mercantile Marine Departments (MMDs), enhance transparency, strengthen examination integrity, and provide a seamless experience for candidates.

The existing examination process involves multiple independent stages including candidate registration, eligibility verification, seat allocation, examination conduct, evaluation, result processing, and record management. Examination reforms seek to integrate these processes into a single digital platform that provides end-to-end tracking, secure data handling, automated workflows, and real-time monitoring.

Components of the End-to-End Examination System

1. User Registration

Candidates will be able to register through a centralized digital platform. The system will maintain a single candidate profile, facilitating application submission, document verification, examination registration, and future examination-related transactions.

2. Eligibility Assessment

The platform will automatically evaluate a candidate's eligibility based on sea-service records, academic qualifications, mandatory training certificates, and other prescribed requirements. Automated validation will reduce processing time and improve consistency.

3. Seat Booking

Eligible candidates will be able to select examination dates and centres online. The seat booking process will provide real-time visibility of available examination slots, ensuring efficient allocation and reducing manual intervention.

4. Misconduct Management

A dedicated misconduct module will digitally record and manage examination irregularities. The module will facilitate reporting, investigation, adjudication, and maintenance of records, ensuring fairness and consistent handling of misconduct cases.

5. Conduct of Examination

The examination process will be conducted through a secure digital framework incorporating candidate authentication, monitoring systems, and standardized procedures across examination centres.

6. Evaluation and Re-evaluation

Digital evaluation workflows will streamline answer-script assessment and facilitate re-evaluation requests where applicable. The system will maintain complete traceability of marks awarded and decisions taken during the evaluation process.

7. Data Storage

All examination-related records, including applications, answer scripts, evaluations, results, and audit logs, will be securely stored in centralized repositories. This will ensure consistency, accessibility, and long-term record preservation.

8. Question Bank and Question Paper Management

The system will maintain a secure digital question bank and support automated question paper generation. Encryption and controlled access mechanisms will protect question paper confidentiality and reduce the risk of unauthorized disclosure.

Key Features

1. **Biometric Verification and Enhanced Security:** The examination system will incorporate biometric verification of candidates to ensure identity authentication. CCTV surveillance and online proctoring mechanisms will provide additional safeguards during examination conduct and strengthen examination credibility.
2. **Secure Examination Management:** Question papers will be encrypted and securely transmitted through the system. Answer scripts will be digitally scanned and stored, creating a complete electronic record and reducing the risk of document loss or tampering.
3. **Candidate-Centric Services:** The platform will include grievance redressal and feedback mechanisms, allowing candidates to raise concerns, seek clarifications, and submit suggestions through a structured and transparent process.

Anticipated Outcomes

1. **Uniform Candidate Experience:** The digital platform will standardize examination processes across all MMDs, ensuring a consistent and predictable experience for candidates irrespective of examination location.
2. **Improved Examination Integrity:** The use of biometric authentication, surveillance systems, encrypted question papers, and digital records will significantly enhance examination integrity and credibility.
3. **Enhanced Operational Efficiency:** Automation of eligibility verification, seat allocation, evaluation workflows, and record management will reduce manual effort, improve processing times, and optimize resource utilization.
4. **Increased Transparency and Accountability:** Digital audit trails, centralized records, and workflow-based approvals will improve transparency and support informed decision-making at every stage of the examination process.

Current Status

Development of the Question Bank Management System and Misconduct Management Module is underway. Completion of these components is planned as part of the ongoing examination reform initiative to support full end-to-end digital examination management.

7.2 Digitalisation of MTI & Ratings Exit Exam

Digitalisation of MTI & Ratings Exit Exam

Improvements in MTI Exit Examination

SLA Contract Framework

Guaranteed uptime, transparency, and accountability with defined performance parameters including availability metrics and responsiveness standards.

Secure Question Bank

Protected examination content repository with vetted question rotation algorithms ensuring exam integrity and preventing content compromise.

Integrated Support System

24/7 helpdesk with real-time technical assistance ensuring seamless examination experiences for all candidates.

Live Surveillance Monitoring

CCTV integration with centralized **Video Management System (VMS)** providing real-time oversight and enhanced examination integrity, strengthened by Virtual Guru's internal monitoring protocols.

Improvements in BES Ratings Exit Examination

Current Drawbacks	Advancements in the Upgraded Examination System
Outdated examination platform, leading to limited automation, slower processing, and inconsistent user experience. Insufficient monitoring and security features, affecting integrity and real-time oversight of the exam process.	Modern, secure, and scalable digital examination platform with enhanced proctoring, analytics, and automated evaluation. Improved candidate services, including better usability, faster results, stronger authentication, and transparent grievance handling.

The DGMA is undertaking the digital transformation of the Maritime Training Institute (MTI) Exit Examination and the GP Rating Exit Examination with the objective of strengthening examination integrity, improving candidate experience, enhancing transparency, and aligning assessment processes with contemporary digital governance practices. This initiative forms part of the broader modernization of India's maritime training and certification ecosystem and seeks to establish a standardized, secure, and scalable examination framework.

For the MTI Exit Examination, the upgraded framework introduces a structured Service Level Agreement (SLA)-based model that establishes guaranteed system uptime, defined responsiveness standards, and clear accountability mechanisms for service delivery. The examination ecosystem is being strengthened through the implementation of a secure question bank with controlled question rotation algorithms designed to prevent compromise of examination content and ensure fairness in assessment. A dedicated 24×7 technical support system will provide real-time assistance to candidates and examination centres, minimizing disruptions and ensuring seamless conduct of examinations. In addition, CCTV integration with a centralized Video Management System (VMS) will enable live surveillance and real-time oversight of examination activities, significantly enhancing transparency and reducing the risk of malpractice.

The enhanced MTI Exit Examination platform is also envisioned to incorporate stronger cybersecurity controls, secure identity verification mechanisms, and compliance-oriented safeguards to protect examination data and candidate information. Together, these measures create a more resilient digital examination environment capable of supporting large-scale assessments while maintaining the credibility and reliability of certification processes.

Parallel reforms are being implemented for the GP Rating Exit Examination (BES). The existing examination arrangement is characterized by an outdated platform with limited automation, slower processing timelines, inconsistent user experiences, and inadequate monitoring capabilities. These limitations affect examination efficiency and restrict real-time visibility into examination operations. The upgraded system addresses these shortcomings through the deployment of a modern, secure, and scalable digital examination platform featuring enhanced proctoring capabilities, automated evaluation mechanisms, advanced analytics, and improved operational reliability.

The proposed system will deliver a significantly improved candidate experience through stronger authentication protocols, faster result processing, transparent grievance redressal mechanisms, and more user-friendly interfaces. Enhanced monitoring and analytics capabilities will generate actionable insights to support continuous improvement of assessment methodologies, question banks, pass criteria, and overall examination quality. The reforms are expected to improve examination integrity, reduce operational risks, strengthen stakeholder confidence, and support the long-term objective of creating a digitally enabled maritime training and certification framework.

Overall, the digitalisation of MTI and Rating Exit Examinations represents a transition from largely transactional examination administration to a technology-enabled assessment ecosystem focused on transparency, accountability, security, operational efficiency, and quality assurance. The initiative is expected to strengthen the credibility of maritime certification processes and contribute to the development of a modern, data-driven training ecosystem for Indian seafarers.

7.3 Training Ecosystem

Training Ecosystem

The Training Ecosystem Vision aims to establish a unified, cloud-based digital platform with it's components supporting the objectives outlined in MIV-2030 and AKAM-2027, thereby strengthening maritime education and training.

Key Features

- Integration of 7 critical modules (e.g., Faculty Development, LMS, Web-Based Simulators) into one cohesive system.
- Real-time oversight and advanced technology for secure, transparent processes.

Current Status

- The RFP was published on 13th April. Multiple queries have been received from seven vendors in response to the RFP. Response for the queries received is being prepared.

Outcome of the Training Ecosystem RFP

- Selection of a Master System Integrator to deliver an integrated training ecosystem, improving maritime training, skilling, certification, and overall efficiency.

The proposed **Training Ecosystem** is a cloud-based, integrated digital platform designed to bring maritime training delivery, faculty development, attendance monitoring, simulator-based learning, training records, and certificate validation into one secure system. The ecosystem seeks to modernize maritime education by replacing fragmented and paper-based processes with standardized, transparent, and technology-enabled mechanisms.

Objectives

The primary objective of the Training Ecosystem is to strengthen the integrity of maritime training delivery and assessment. The platform will provide standardized mechanisms for conducting learning activities, monitoring attendance, assessing candidates, maintaining training records, and validating course completion.

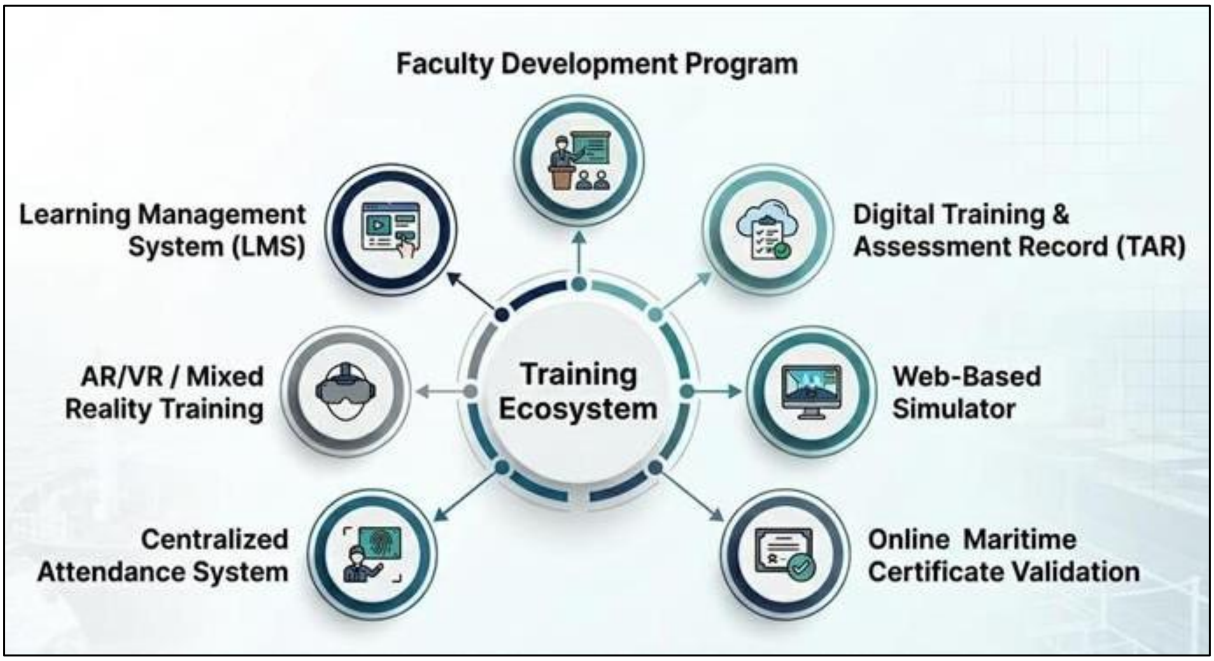
The ecosystem will also enhance transparency in certification services by creating secure and verifiable digital records. This will help improve the reliability of training and certification processes while strengthening confidence among seafarers, Maritime Training Institutes, regulators, and employers.

Expected Impact

The Training Ecosystem will support the transition from paper-based records and disconnected processes to secure digital platforms. Centralized records and standardized workflows will improve traceability, reduce manual intervention, and provide better visibility into training delivery and assessment.

The platform is intended to help eliminate fraud, bridge gaps between academic training and industry requirements, and align maritime education with modern shipboard technologies. Through digital learning, advanced simulation, faculty development, and verifiable certification, the ecosystem will help Indian seafarers remain globally competitive.

Core Components of the Ecosystem



1. Learning Management System

The **Learning Management System** will provide standardized e-learning with integrated tracking, assessment controls, and completion-linked access. It will enable structured delivery of digital course content and maintain records of candidate participation and progress. Assessment controls will help ensure that the prescribed learning and evaluation requirements are completed before course progression or completion is recorded.

2. Faculty Development Programme

The **Faculty Development Programme** will support the continuous upskilling and professional development of maritime faculty. Structured learning and assessment will help faculty members update their subject knowledge, teaching practices, and familiarity with modern maritime technologies. This component will contribute to improved instructional quality and greater consistency in training delivery across MTIs.

3. Digital TAR Book

The **Digital TAR Book** will serve as a structured digital training record for onboard training and practical competency verification. It will enable systematic recording of assigned tasks, completed activities, and competency-related progress. Digital maintenance of training records will improve traceability and make the verification process more structured and transparent.

4. Centralized Attendance System

The **Centralized Attendance System** will use facial biometric attendance for candidates, faculty members, and administrators across Maritime Training Institutes. Centralized attendance records will strengthen the authenticity of participation data and support monitoring of actual attendance against prescribed training requirements.

5. Web-Based Simulator

The **Web-Based Simulator** will provide online simulation of real maritime scenarios for interactive learning and assessment. It will allow candidates to engage with operational situations in a controlled digital environment and support applied learning through scenario-based exercises.

6. Online Marine Certificate Validation

The **Online Marine Certificate Validation** component will facilitate the secure uploading, verification, and digital stamping of maritime certificates. It will strengthen the reliability of certificate verification and support the creation of secure and verifiable digital certification records.

7. AR, VR and Mixed-Reality Training

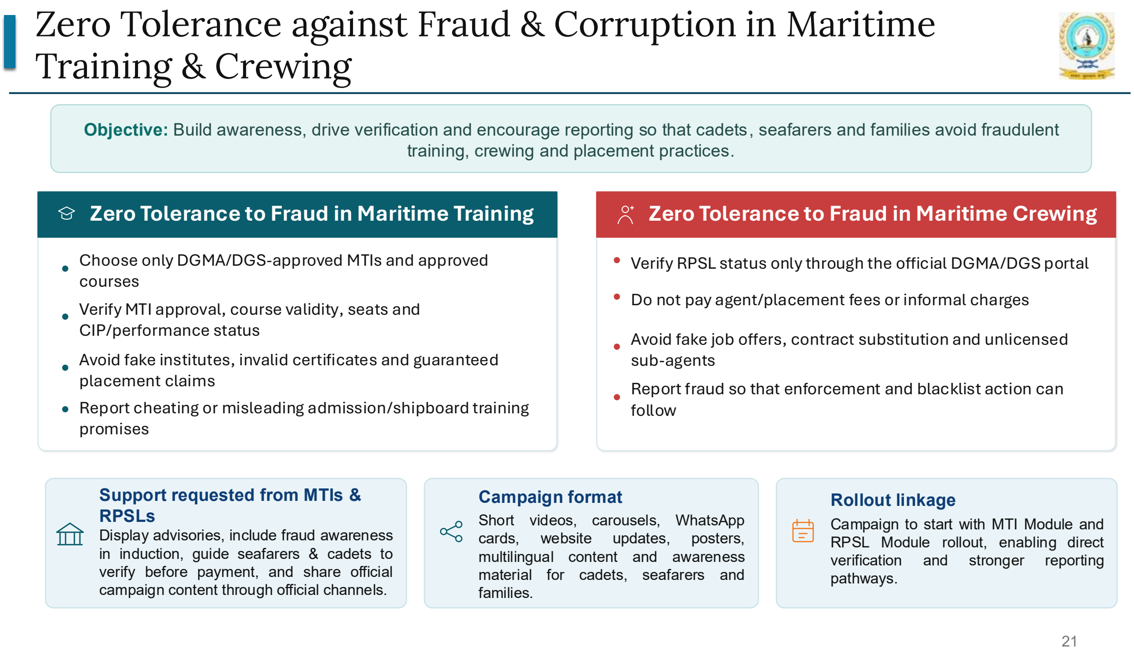
The **Augmented Reality, Virtual Reality and Mixed-Reality Training** component will provide immersive practical training for complex shipboard and port-operation scenarios. This technology-enabled approach will expose candidates to operational situations in a simulated environment and complement classroom and conventional practical training.

RFP Status

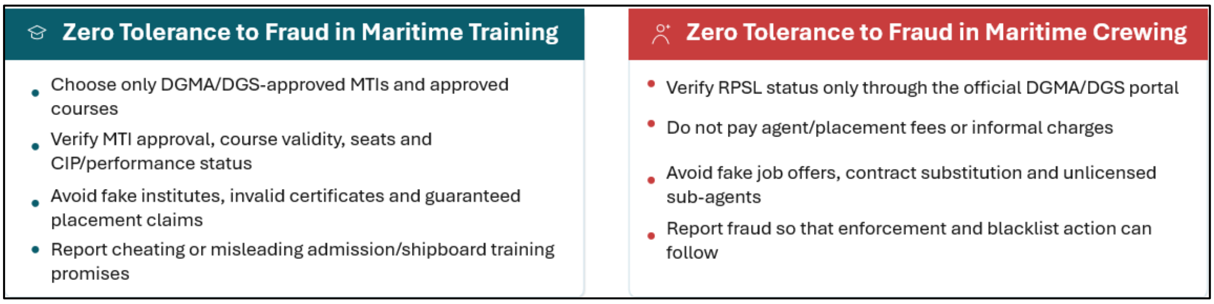
- **RFP published:** 13 April 2026
- **Bid submission opening:** 22 June 2026
- **Current status:** Technical evaluation is ongoing

The Training Ecosystem will create an integrated digital framework covering the complete maritime learning cycle, from training delivery and faculty development to attendance, simulation, competency records, assessment, and certificate validation. The initiative is expected to strengthen training integrity, improve transparency, reduce the scope for fraud, and better align Indian maritime training with modern shipboard technologies and global industry requirements.

8. Zero Tolerance against Fraud & Corruption in Maritime Training & Crewing



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.

9. Join Merchant Navy Campaign- (From Middle of October, 2026)

Join Merchant Navy Campaign- (From Middle of October, 2026)

"Inspiring India's Next Generation of Global Seafarers"

The Join Merchant Navy campaign is a nationwide digital outreach initiative by the DGMA to position the Merchant Navy as an aspirational, globally respected, and inclusive career for Indian youth.

Key Focus

- Introduce India's maritime heritage and inspire youth to consider a career at sea.
- Highlight career pathways, global opportunities, technical excellence, and financial benefits.
- Promote inclusivity by highlighting opportunities for women, students from non-coastal states, and first-generation aspirants.
- Drive enrolment

Target Audience

- Students (Class IX–XII),
- diploma and undergraduate aspirants
- Parents and guardians
- Young women considering maritime careers
- School and college career counsellors.

Platforms

- X(Twitter)
- Instagram
- Facebook
- LinkedIn
- YouTube
- WhatsApp
- DGMA Website & Digital Channels

Key Performance Indicators

- Total campaign reach and impressions
- Engagement rate across platforms
- Website traffic to DGMA career pages
- Downloads/views of career guidance resources
- Click-throughs to DGMA-approved institute directory
- Growth in followers and campaign participation

Objective of Campaign: To inspire and guide India's youth towards a globally recognised career in the Merchant Navy by increasing awareness, dispelling misconceptions, and promoting DGMA-approved maritime career pathways.

The Directorate General of Maritime Affairs (DGMA) is launching the"Join Merchant Navy" Campaign, a nationwide digital outreach initiative aimed at positioning the Merchant Navy as an aspirational, globally respected, and inclusive career pathway for Indian youth. The campaign seeks to address the persistent awareness gap surrounding maritime careers by introducing students, parents, educators, and career counsellors to the opportunities available within India's maritime sector and the global shipping industry. The campaign is designed to support the sector's long-term workforce requirements by attracting a larger and more diverse talent pool into maritime education and training institutions.

The campaign will be rolled out extensively from the middle of October 2026 across multiple digital platforms, leveraging social media, video content, career guidance resources, and institutional outreach to maximize national reach. The initiative aims to communicate the strategic importance of seafaring careers, India's maritime heritage, and the growing opportunities available to Indian seafarers in an increasingly globalized maritime workforce. By showcasing real career journeys, training pathways, and success stories, the campaign seeks to create positive awareness and improve perceptions of the Merchant Navy among young aspirants.

A key objective of the campaign is to highlight the diverse career pathways available within the maritime sector, including deck, engine, electro-technical, and shore-based maritime professions. The outreach will emphasize the global employability of Indian seafarers, the technical skills developed through maritime education, opportunities for international exposure, and the long-term career progression available in the industry. In addition, the campaign will communicate the financial and professional benefits associated with maritime careers while providing accurate guidance regarding eligibility, training requirements, and approved pathways for entry into the sector.

The campaign also seeks to promote greater inclusivity within the maritime workforce. Special emphasis will be placed on encouraging participation from women, students from non-coastal states, and first-generation aspirants who may have limited exposure to maritime careers. Through targeted communication and awareness initiatives, the campaign aims to broaden the geographical and demographic representation of candidates entering maritime education and training programmes across the country. This approach aligns with the broader objective of expanding India's seafarer talent pool and ensuring equitable access to maritime career opportunities.

The primary target audience includes school students in Classes IX to XII, diploma and undergraduate students exploring professional career options, parents and guardians who influence educational decisions, young women considering careers in technical professions, and school and college career counsellors. By engaging all key stakeholders in the career decision-making ecosystem, the initiative seeks to build informed understanding and long-term interest in maritime professions.

To ensure wide visibility and engagement, the campaign will be disseminated through multiple digital channels including X (Twitter), Instagram, Facebook, LinkedIn, YouTube, WhatsApp, and official DGMA digital platforms. The multi-platform approach will allow the campaign to engage different audience segments through tailored content formats such as short videos, infographics, testimonials, virtual interactions, informational guides, and awareness campaigns. The use of both social media and official digital channels will help create sustained engagement while directing prospective candidates toward authentic information and approved maritime training pathways.

The success of the campaign will be monitored through a set of measurable Key Performance Indicators (KPIs). These include overall campaign reach and impressions across platforms, engagement rates on digital content, traffic generated to DGMA career information pages, downloads and views of career guidance materials, click-throughs to directories of DGMA-approved maritime institutes, growth in followers across official digital channels, and participation in campaign-related activities and outreach initiatives. These indicators will help assess campaign effectiveness and inform future outreach strategies.

Overall, the Join Merchant Navy Campaign is envisaged as a strategic national awareness initiative aimed at inspiring and guiding India's youth towards a globally recognized maritime career. By increasing awareness, dispelling misconceptions, promoting inclusivity, and providing access to accurate career information, the campaign is expected to strengthen the maritime talent pipeline and support India's ambition of increasing its participation in the global seafaring workforce.

10. National Maritime Games 2027

National Maritime Games

Vision: India's premier sporting platform for the maritime fraternity - promoting fitness, discipline, teamwork, sportsmanship, national pride and industry collaboration.

Mission: Bring maritime professionals, cadets, seafarers, ports, shipping companies, MTIs and allied stakeholders together through a professionally managed Zonal-to-National sporting ecosystem.

Item	Proposed position
Event window	5–12 January 2027
Proposed venue	Ganpat University, Gujarat
Target Participant	5,000 (Approx)
Proposed official opening	9 January 2027, proposed to be graced by the Hon'ble Prime Minister of India, subject to PMO/security confirmation
Closing and medal ceremony	12 January 2027
National Outreach	265 organization

- 28 Disciplines games across team, Racquet, aquatic, Indoor and endurance sports.
- Participation Ecosystem – Seafarers | Ports | PSUs | Shipping Companies | Shipyards | RPSLs | MTIs | Veterans | Para Athletes. |

The Maritime National Games is proposed as a national sporting platform dedicated to the maritime fraternity, with the objective of promoting fitness, discipline, teamwork, sportsmanship, national pride, and industry collaboration. The initiative seeks to bring together maritime professionals, cadets, seafarers, ports, shipping companies, Maritime Training Institutes (MTIs), and allied stakeholders through a professionally managed sporting ecosystem extending from zonal competitions to a national-level event.

The proposed event is scheduled to be conducted from 5 to 12 January 2027, with Ganpat University, Gujarat identified as the proposed venue. Participation is expected to involve approximately 5,000 participants drawn from across the maritime sector. The official opening is proposed for 9 January 2027, with the event proposed to be graced by the Hon'ble Prime Minister of India, subject to PMO and security clearances. The closing and medal ceremony is proposed to be held on 12 January 2027.

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Event window	5–12 January 2027
Proposed venue	Ganpat University, Gujarat
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Closing and medal ceremony	12 January 2027
National Outreach	265 organization

The initiative is designed as a national outreach programme involving approximately 265 organizations from across the maritime ecosystem. Participation is envisaged from seafarers, ports, public sector undertakings, shipping companies, shipyards, Recruitment and Placement Service Licence (RPSL) holders, Maritime Training Institutes, veterans, and para-athletes, thereby creating a common platform for engagement and collaboration across different segments of the maritime community.

The proposed sporting programme encompasses 28 sporting disciplines covering team sports, racquet sports, aquatic events, indoor competitions, and endurance-based events. Through this broad range of disciplines, the initiative seeks to encourage participation across age groups, professions, and levels of sporting experience within the maritime sector.

Beyond competition, the Maritime National Games is envisaged as a platform for fostering interaction and engagement among maritime stakeholders from across the country. By bringing together maritime professionals, trainees, institutions, and industry organizations within a common sporting framework, the initiative aims to strengthen camaraderie, promote healthy lifestyles, encourage teamwork, and support greater collaboration within the maritime ecosystem.

Overall, the Maritime National Games is proposed as a flagship national initiative for the maritime sector that combines sports, professional engagement, and industry outreach. Through large-scale participation, national-level competition, and broad stakeholder involvement, the initiative seeks to create a sustainable sporting ecosystem that reinforces the values of fitness, discipline, teamwork, and national pride while strengthening connections across India's maritime community.

9. Sagar Prashikshan 2026

Sagar Prashikshan -2026 is a proposed Annual National Maritime Training and Skilling Conclave intended to provide a common platform for regulators, Maritime Training

Institutes (MTIs), industry stakeholders, and subject matter experts to deliberate on key issues affecting maritime education, training, and workforce development. The initiative seeks to facilitate structured dialogue on the future direction of maritime training in India and support development of a modern, industry-responsive training ecosystem.

The conclave is aligned with the objectives of the STCW Convention and the Digital India programme, with a focus on building a transparent, technology-enabled, and industry-responsive maritime training framework capable of meeting evolving global requirements.

A key objective of the initiative is to identify and bridge gaps between maritime training outcomes and industry skill requirements. The conclave is intended to facilitate structured stakeholder consultation on regulatory, academic, and digital reforms while supporting stronger engagement between training institutions and industry. The discussions are also expected to focus on faculty development, continuous upskilling mechanisms, and adoption of technology-driven learning approaches, including Learning Management Systems (LMS) and simulation-based training methodologies.

The initiative further seeks to develop actionable recommendations for creating a standardized, transparent, and industry-aligned maritime training ecosystem. By bringing together key stakeholders in a common forum, the conclave is expected to support policy development, encourage knowledge sharing, and strengthen collaboration across the maritime training sector.

As a status update, the proposed Sagar Prashikshan – National Maritime and Skilling Conclave has been temporarily deferred in view of austerity measures and expenditure rationalization directives. However, DGMA remains committed to the initiative and plans to resume further planning and implementation activities at an appropriate stage in the future.

10. Ship Building and Repairs

10.1. 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.

10.2. 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.

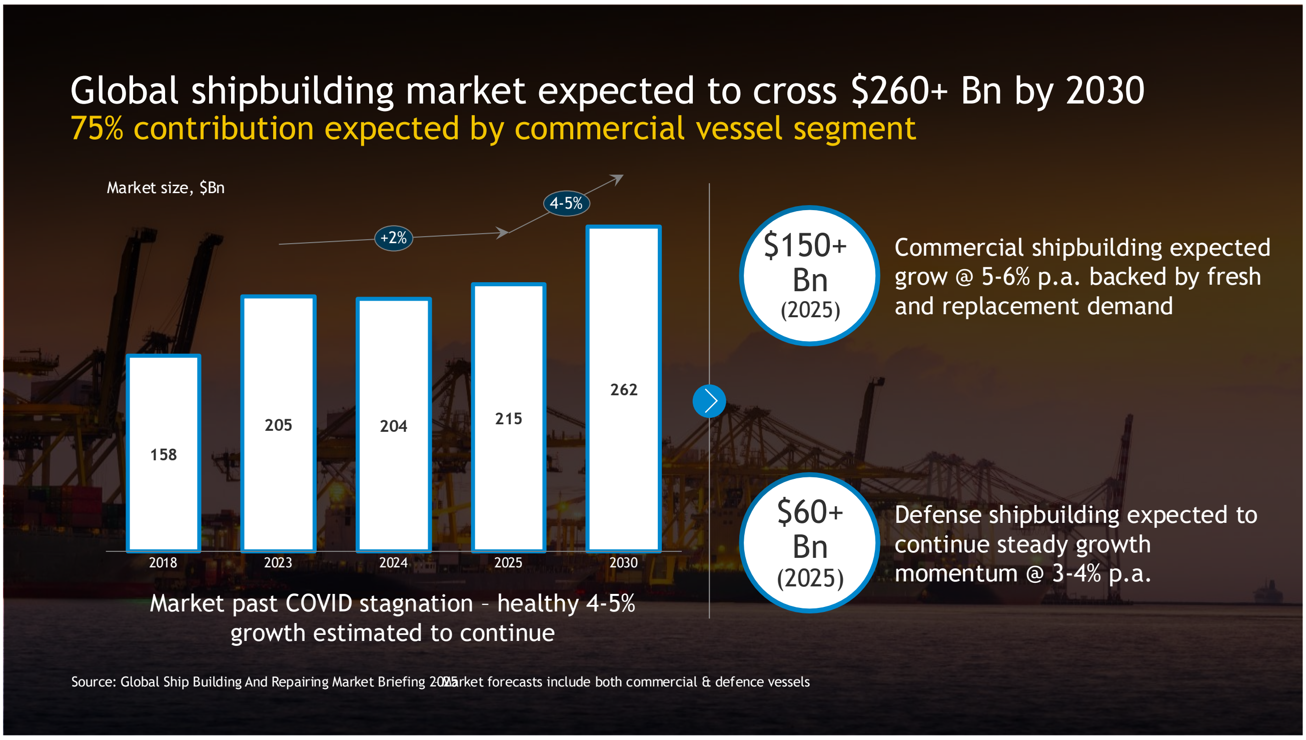


Exhibit 2.1: Global shipbuilding and repair market size, 2018 to 2030

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.

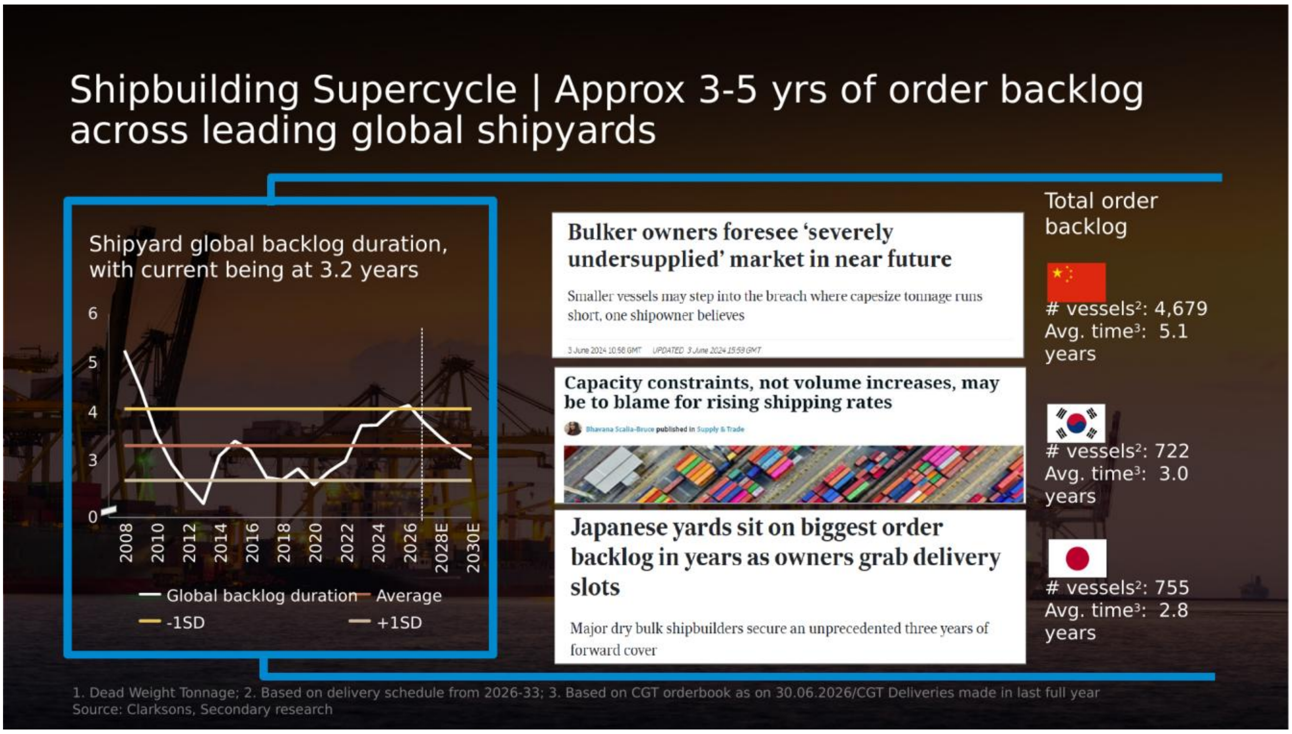


Exhibit 2.2: Global shipyard backlog duration and country order books

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.

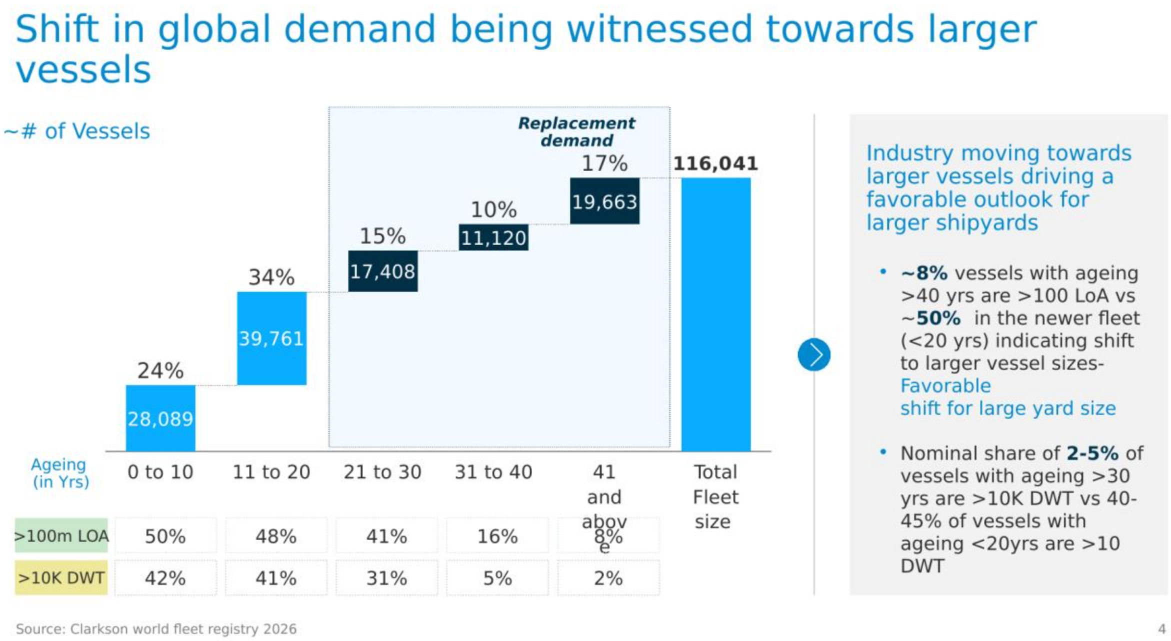


Exhibit 2.3: Global fleet by age band, with vessel size characteristics

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.

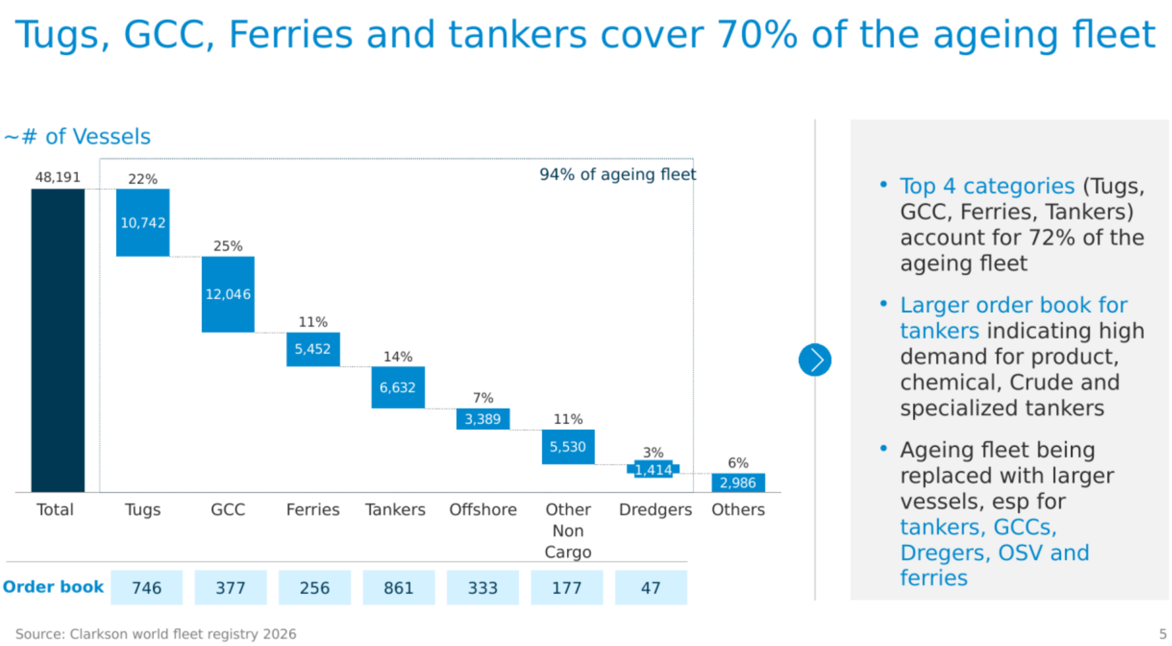


Exhibit 2.4: Ageing fleet and order book by vessel category

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.

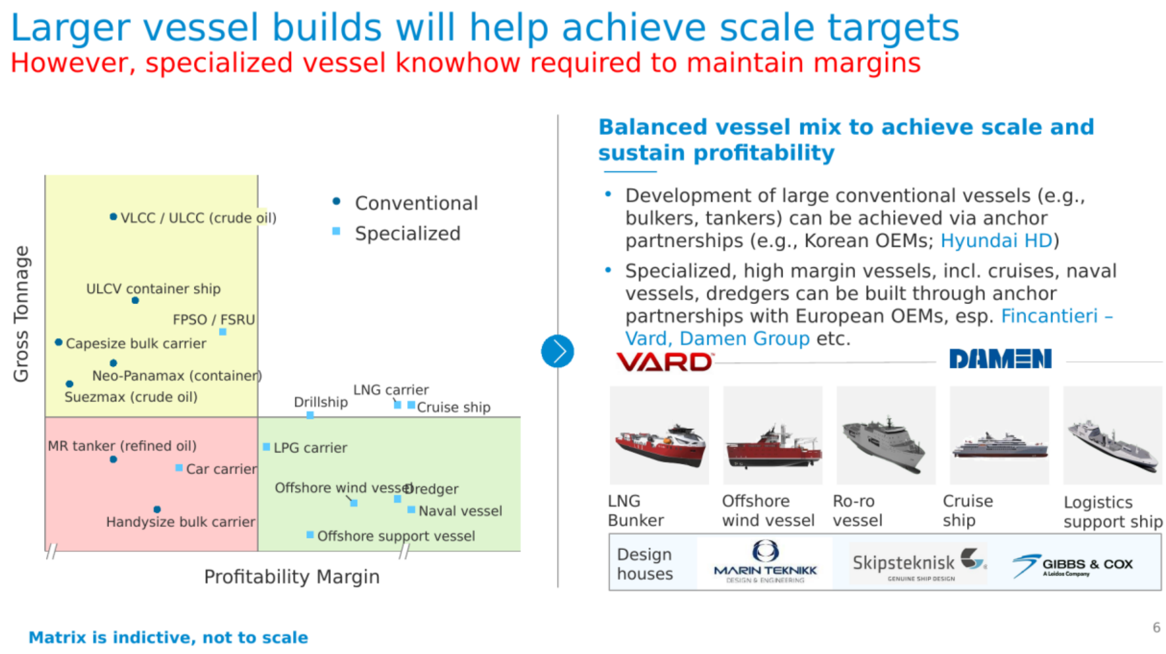


Exhibit 2.5: Indicative positioning of vessel types by gross tonnage and profitability margin

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.

10.3. 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.

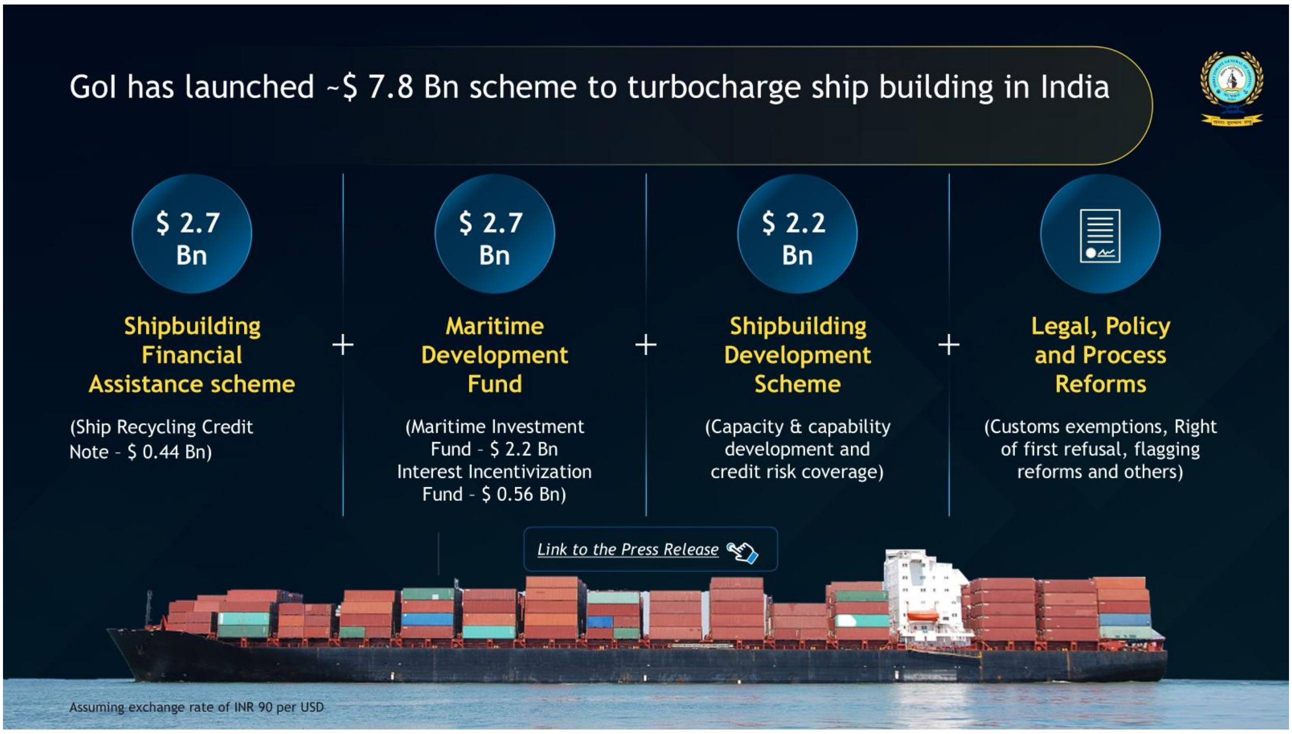


Exhibit 3.1: The four pillars of the shipbuilding programme and their outlays

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.

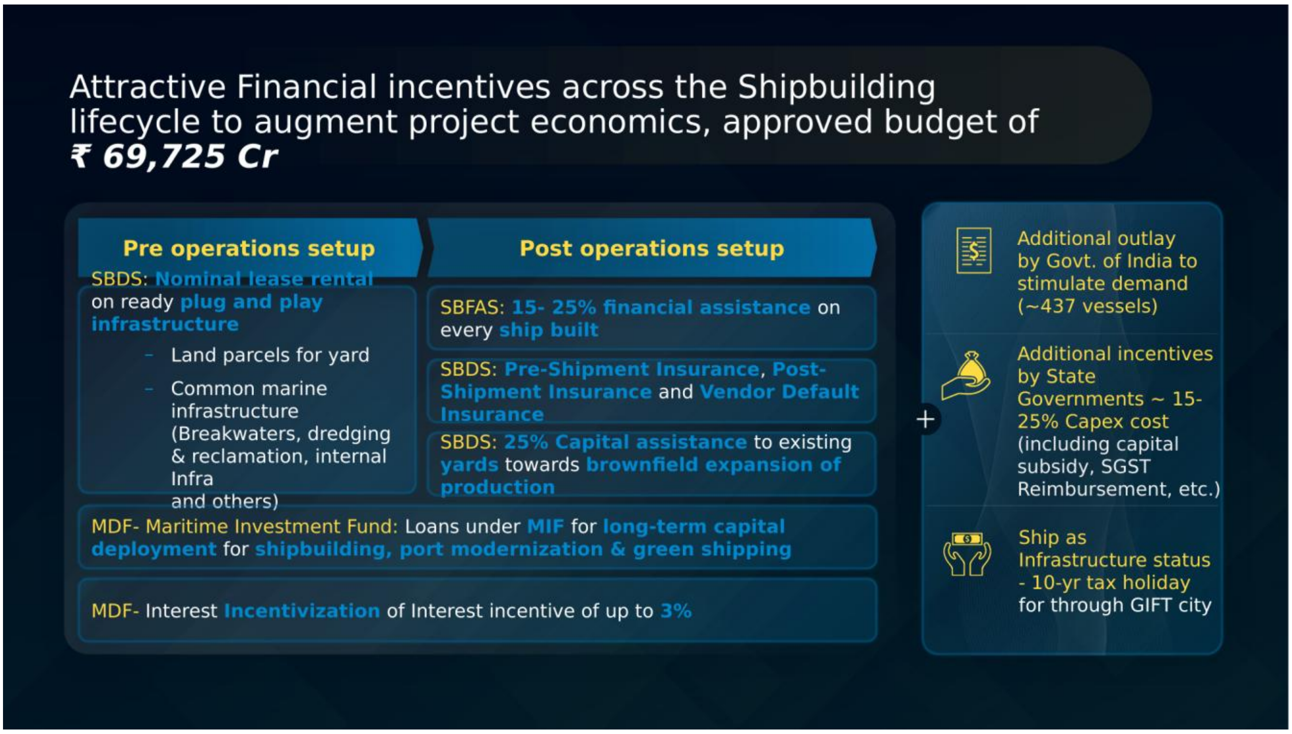


Exhibit 3.2: Financial incentives mapped across the shipbuilding lifecycle

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.

10.4. 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.

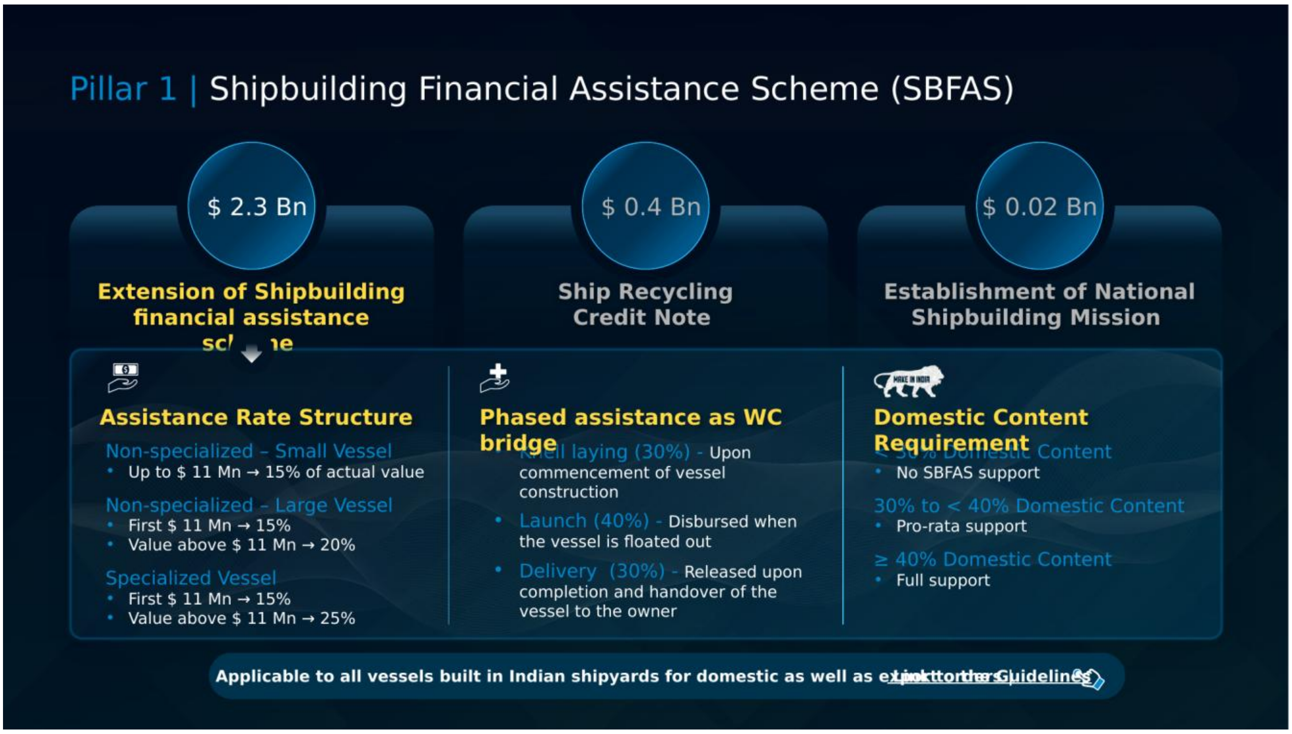


Exhibit 4.1: Shipbuilding Financial Assistance Scheme: composition and assistance structure

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.

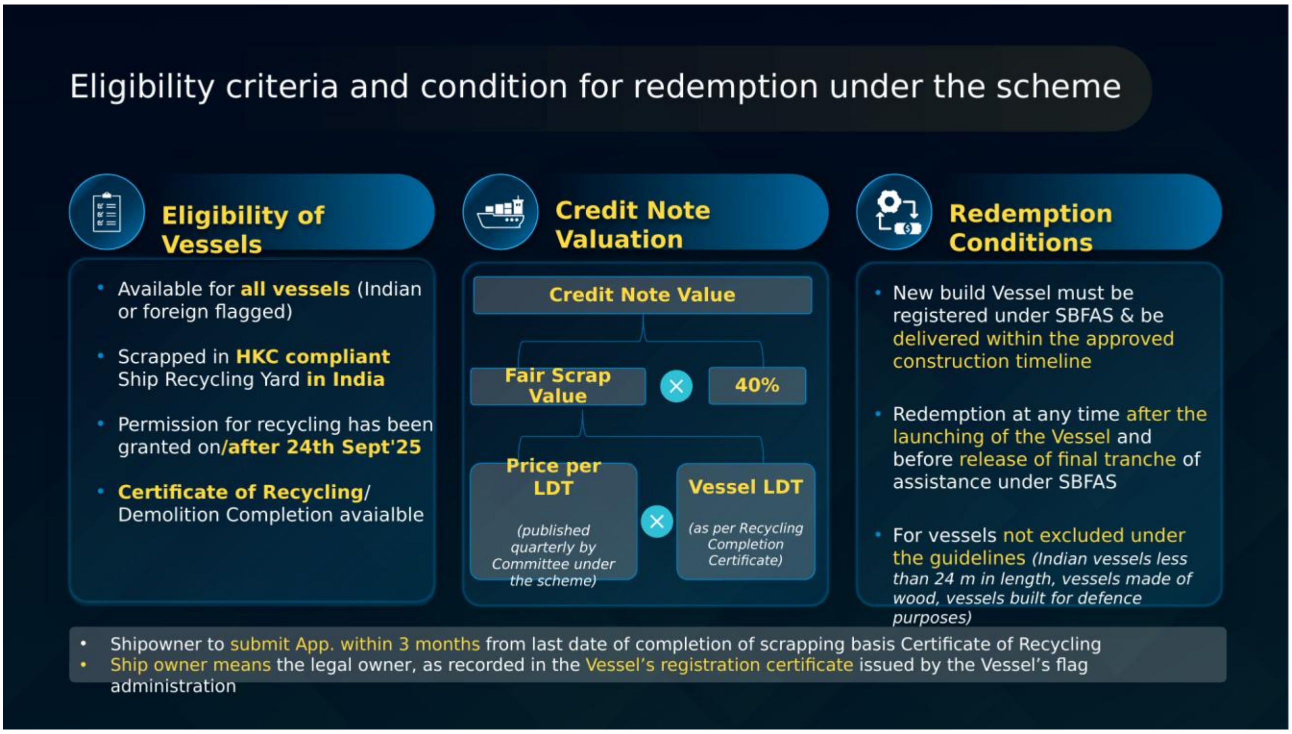


Exhibit 4.4: Eligibility, valuation and redemption conditions under the SRCN

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.

10.5. 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.

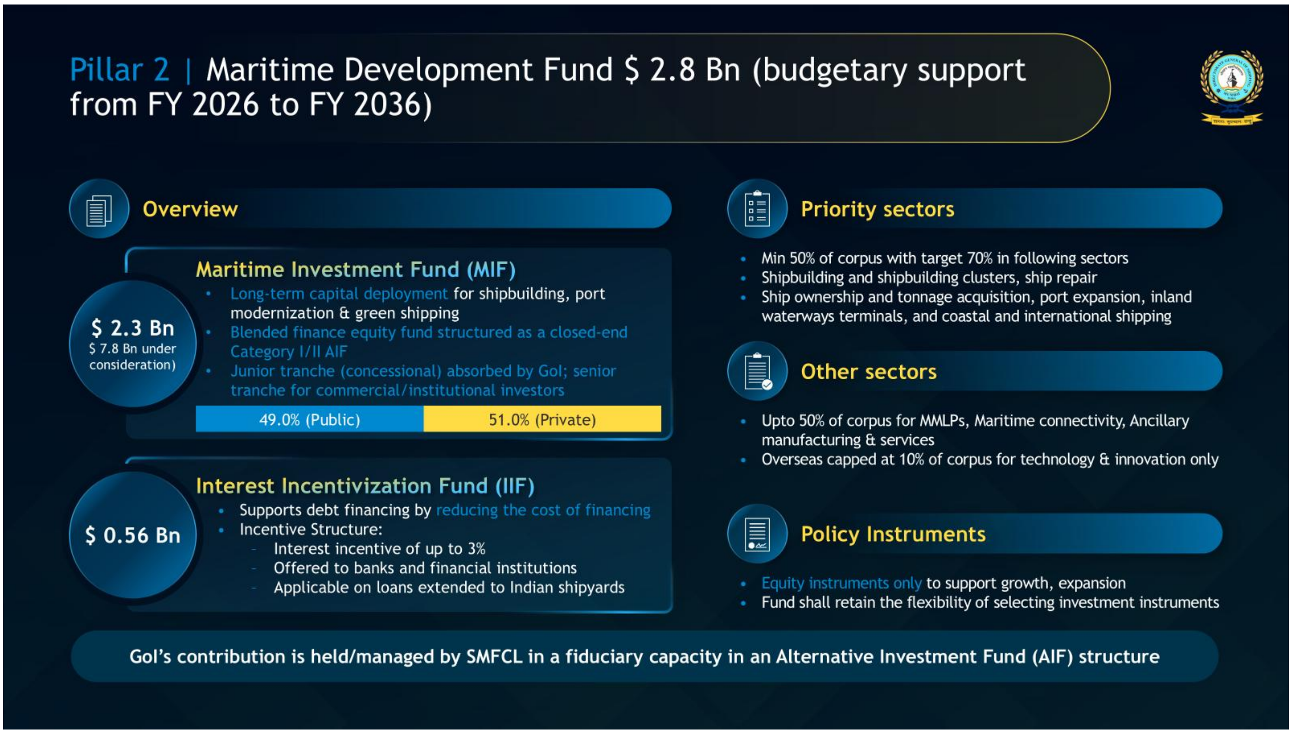


Exhibit 5.1: Maritime Development Fund: structure, sectors and instruments

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.

10.6. 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.

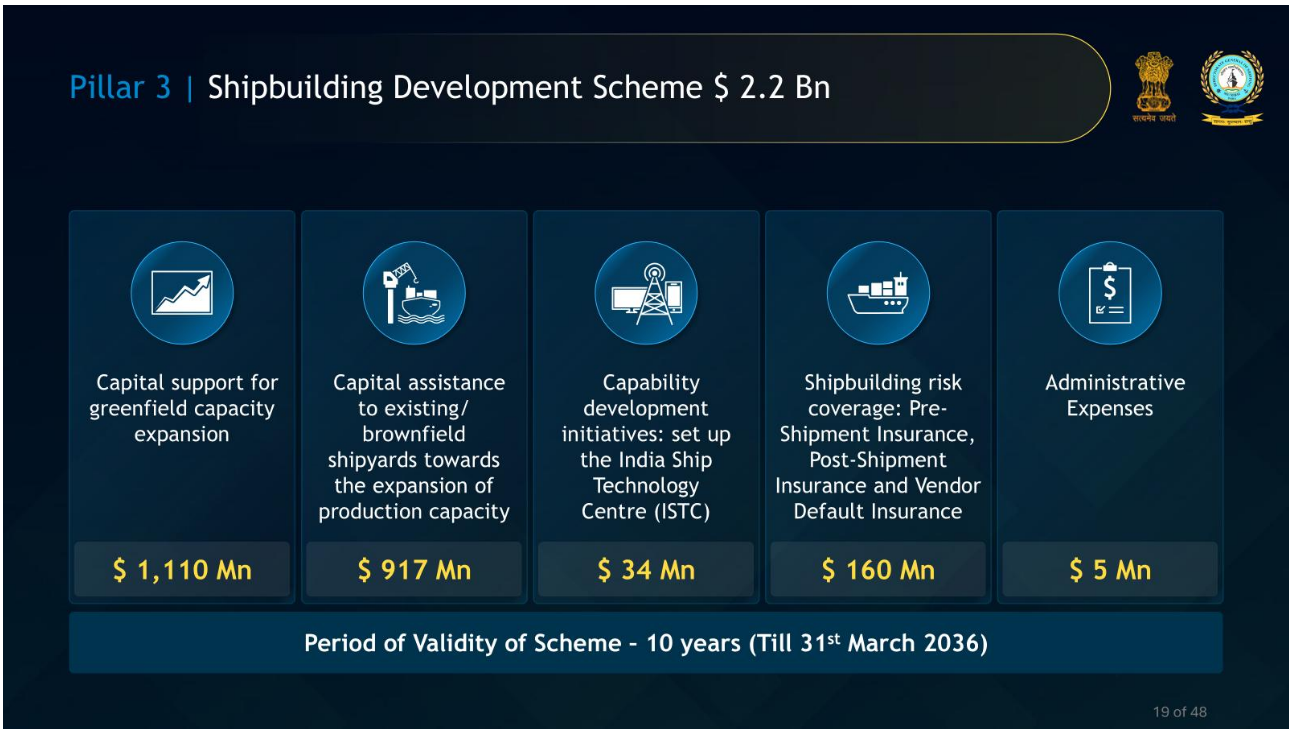


Exhibit 6.1: Shipbuilding Development Scheme: allocation by component

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.

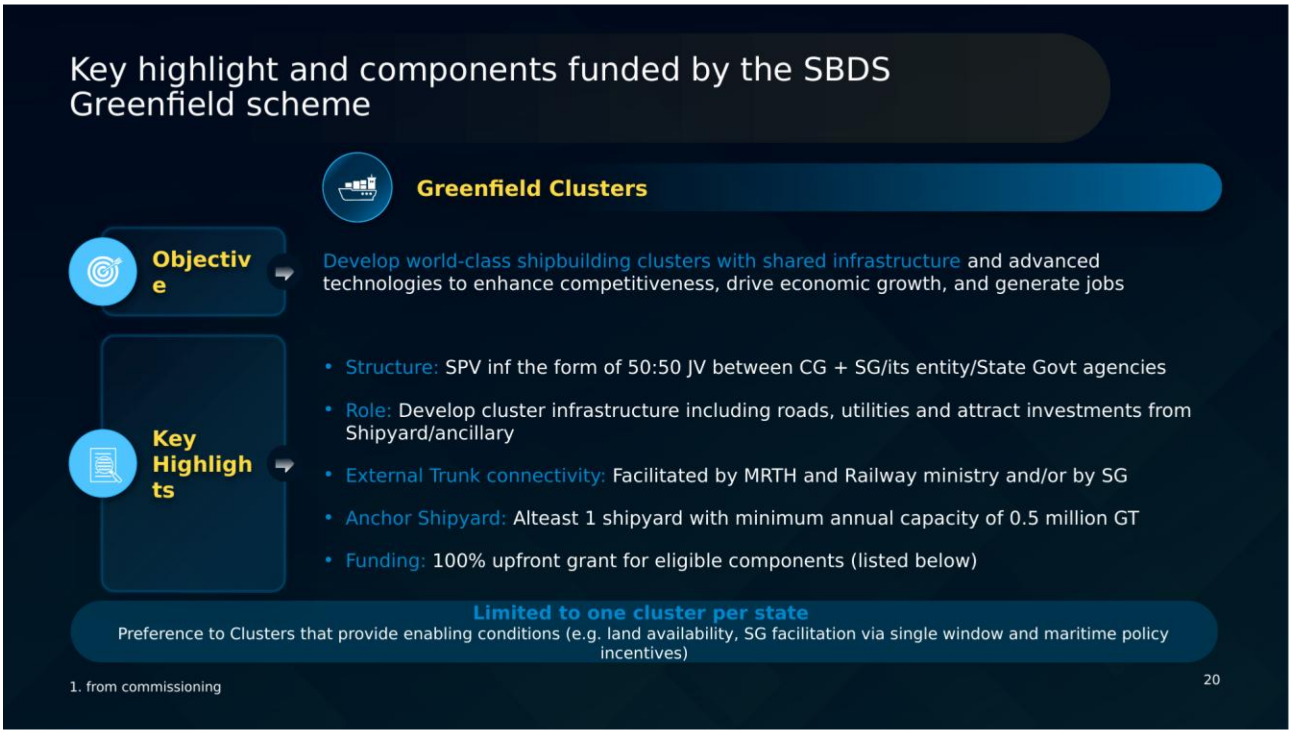


Exhibit 6.2: Greenfield cluster scheme: objective and key highlights

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.

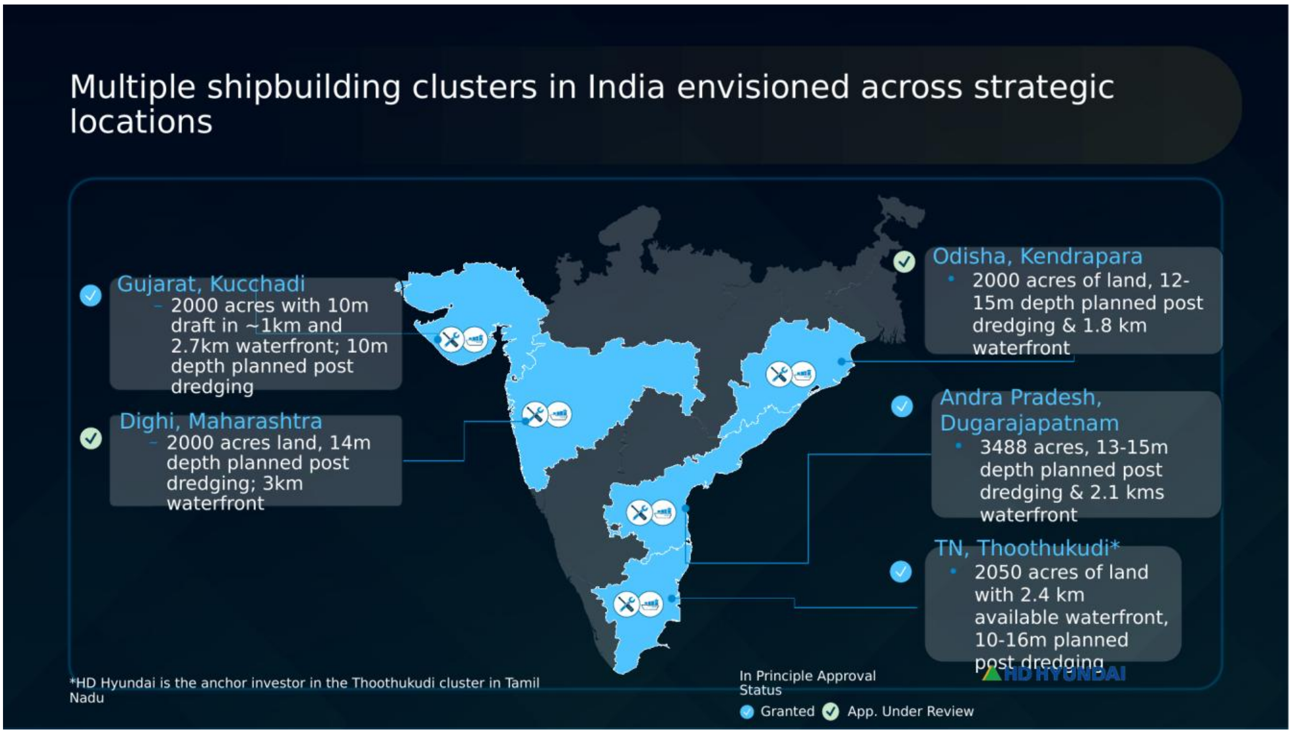


Exhibit 6.4: Envisaged shipbuilding cluster locations across coastal states

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.

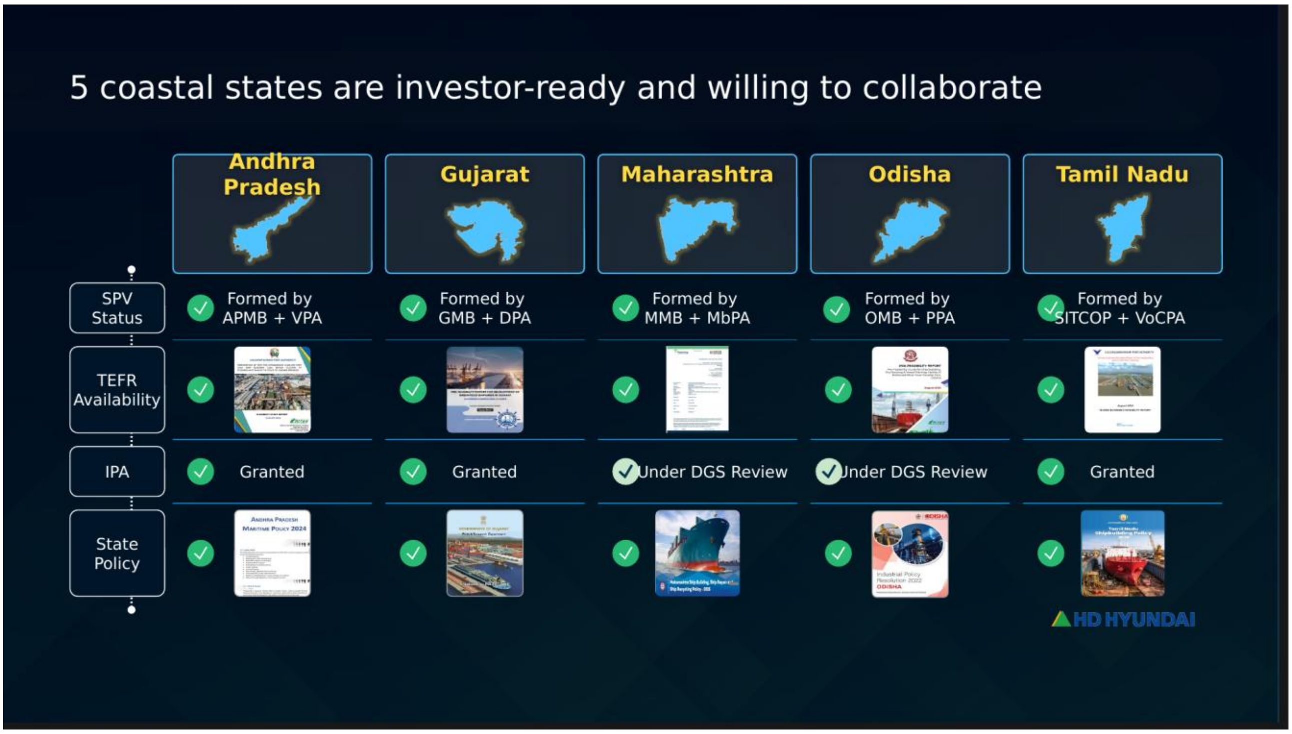


Exhibit 6.5: Readiness of the five participating coastal states

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.

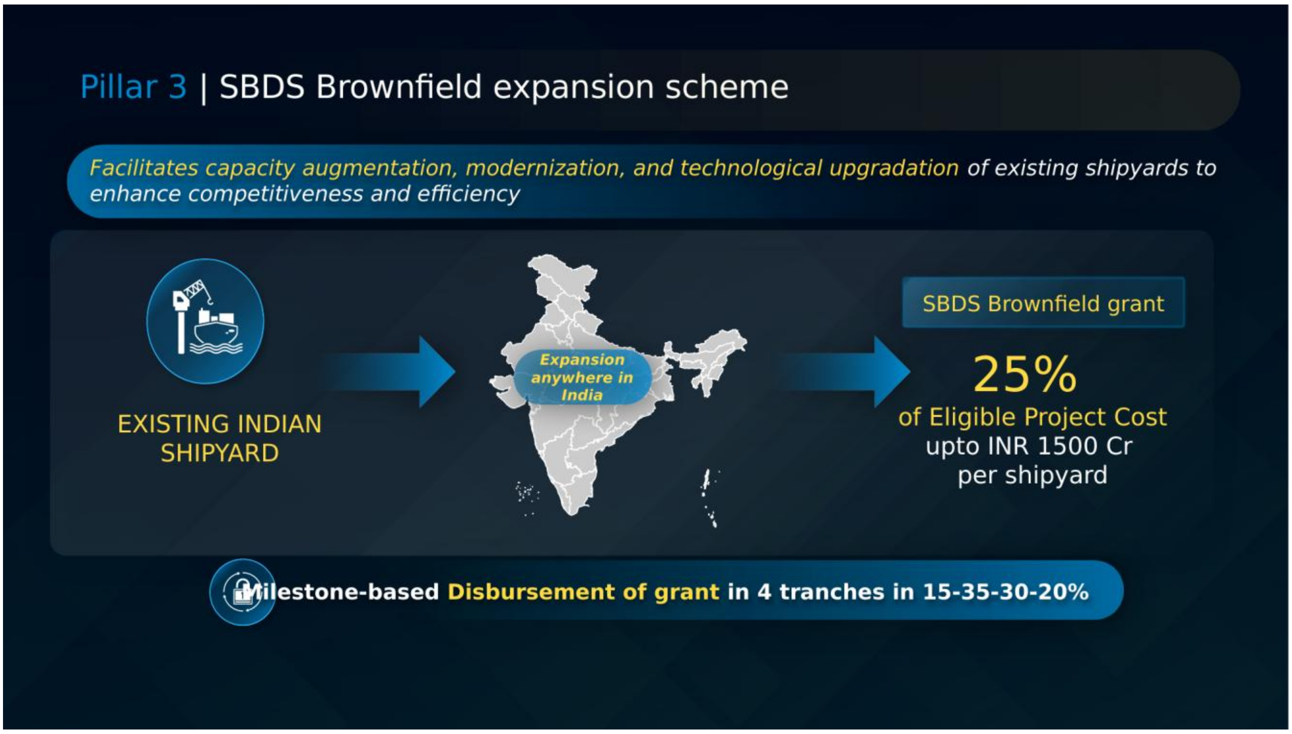


Exhibit 6.6: The brownfield expansion scheme: support structure

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.

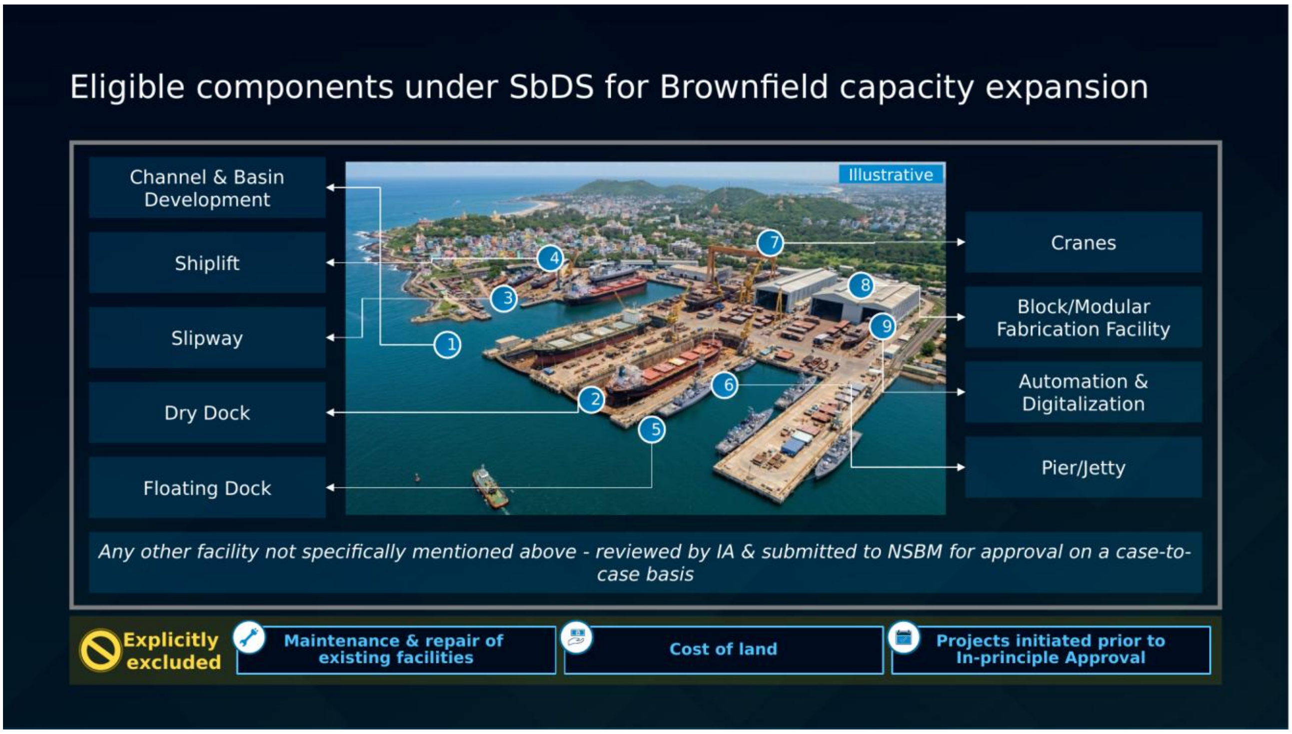


Exhibit 6.7: Eligible and excluded components under the brownfield scheme

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

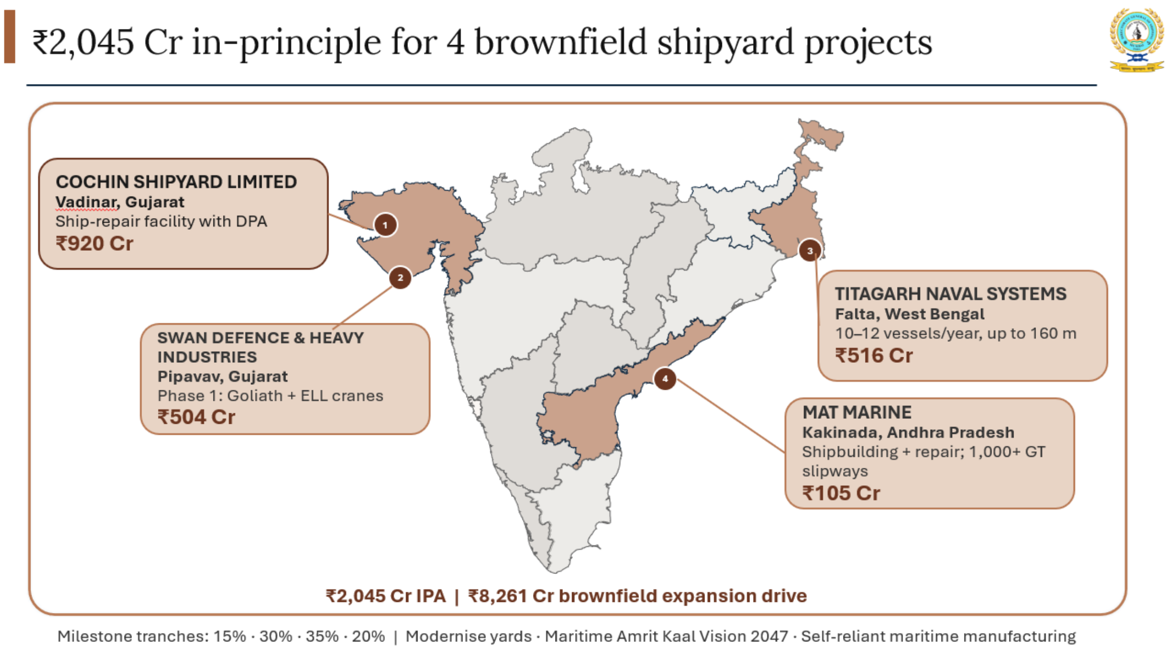
Table 6.4: Brownfield pipeline: shipyards, investment and status

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.

Brownfield



Brownfield Shipyard Capacity Expansion Programme

The Brownfield Shipyard Capacity Expansion Programme constitutes the second major pillar of the Shipbuilding Development Scheme and is designed to strengthen India's existing shipbuilding and ship repair ecosystem through targeted investments in capacity augmentation, infrastructure modernisation and technological upgradation. While the greenfield component seeks to create new shipbuilding clusters and develop common infrastructure at new locations, the brownfield component focuses on unlocking latent capacity within existing shipyards by supporting the expansion of critical maritime infrastructure, adoption of advanced manufacturing technologies and development of modern production facilities.

The component has been allocated USD 917 million (approximately ₹8,000 crore) and is intended to accelerate the transformation of Indian shipyards into globally competitive facilities capable of undertaking larger vessel construction programmes, improving production efficiency, expanding repair capabilities and reducing infrastructure bottlenecks. The initiative is aligned with the objectives of Maritime Amrit Kaal Vision 2047, which identifies shipbuilding and ship repair as strategic sectors for achieving maritime self-reliance and increasing India's participation in global maritime value chains.

Unlike the greenfield component, which primarily addresses common infrastructure deficits and seeks to establish entirely new industrial ecosystems, the brownfield programme supports investments within commercially operating shipyards. Accordingly, the scheme is structured as a co-investment mechanism wherein the Government provides catalytic capital assistance while shipyard operators undertake the majority of the project investment and execution responsibility.

Financial Assistance Framework

Under the scheme, eligible shipyards are entitled to receive financial assistance equivalent to 25 per cent of the approved project cost, subject to an upper ceiling of USD 167 million (approximately ₹1,500 crore) per shipyard. The grant is available for capacity expansion projects located anywhere in India and is intended to facilitate investments that may otherwise be deferred due to capital constraints or long payback periods.

The assistance is released on a milestone-based basis through four tranches:

Milestone	Percentage of Approved Grant
First Tranche	15%
Second Tranche	35%
Third Tranche	30%
Fourth Tranche	20%

The structure of the disbursement mechanism reflects a carefully calibrated risk-sharing framework. The relatively modest initial release ensures that public resources are protected from projects that fail to progress beyond the commencement stage. Subsequent releases are linked to demonstrated physical and financial progress, thereby incentivising timely execution and ensuring that government support remains closely aligned with project implementation milestones.

The grant design also preserves commercial discipline. Since shipyards are required to contribute approximately seventy-five per cent of project costs, investment decisions remain market-driven and are grounded in long-term commercial viability rather than subsidy dependence.

Eligible Infrastructure Components

The scheme recognises that capacity constraints within shipyards arise from a combination of waterfront infrastructure limitations, production bottlenecks and inadequate modern manufacturing facilities. Accordingly, assistance is available for a broad range of infrastructure assets including:

- Dry docks;
- Floating docks;
- Slipways;
- Shiplifts;
- Piers and jetties;
- Channel and basin development works;
- Block and modular fabrication facilities;
- Heavy lifting cranes and related equipment;
- Automation systems;
- Digitalisation and smart manufacturing infrastructure; and
- Other infrastructure approved by the National Shipbuilding Mission on a case-by-case basis.

The inclusion of these components reflects the critical role they play in determining yard productivity and competitiveness. Dry docks, floating docks, slipways and shiplifts dictate the size and number of vessels that can be handled simultaneously. Basin and channel development determine the maximum draft and dimensions of vessels that can access the yard. Modular fabrication facilities and heavy-lift crane systems enable advanced block construction methods that significantly reduce overall vessel construction cycles. Similarly, automation and digitalisation investments improve labour productivity, quality control and process efficiency, thereby enabling Indian shipyards to benchmark themselves against leading international facilities.

The scheme specifically excludes:

- Maintenance and repair of existing facilities;
- Projects initiated prior to obtaining in-principle approval; and
- Land acquisition costs.

These exclusions ensure that public support is directed towards the creation of new productive assets rather than routine maintenance expenditure or real estate acquisition.

Brownfield Project Pipeline

The brownfield expansion programme has witnessed significant industry response and has generated a geographically diverse pipeline of shipyard modernisation and capacity augmentation projects. As of the latest review, eleven projects have either received approval, submitted applications or are at various stages of project preparation.

The total identified project pipeline amounts to approximately USD 944 million (around ₹8,500 crore) of proposed investment, indicating strong industry interest in expanding domestic shipbuilding and ship repair capabilities.

The project pipeline is distributed across both the eastern and western coasts, thereby supporting balanced regional maritime development and improving national capacity resilience.

In-Principle Approved Brownfield Projects

A major milestone under the programme has been the granting of in-principle approval (IPA) to four brownfield shipyard projects, representing a combined approved investment of approximately ₹2,045 crore and forming part of a larger brownfield investment pipeline of ₹8,261 crore.

(i) Cochin Shipyard Limited, Vadinar, Gujarat

The largest approved project under the programme is being undertaken by Cochin Shipyard Limited (CSL) in partnership with Deendayal Port Authority at Vadinar, Gujarat.

The project, with an approved investment of approximately ₹920 crore, involves the development of a dedicated ship repair facility on India's western coast. The proposed facility is expected to strengthen the country's maritime repair ecosystem and reduce dependence on overseas repair locations for commercial and offshore vessels.

The project also supports the broader national objective of positioning India as a regional hub for ship repair and maintenance services.

(ii) Swan Defence and Heavy Industries, Pipavav, Gujarat

The second approved project pertains to Swan Defence and Heavy Industries at Pipavav, Gujarat, with an approved investment of approximately ₹504 crore.

The first phase focuses on installation of critical heavy-manufacturing assets including:

- Goliath Cranes; and
- Extra Large Lift (ELL) Cranes.

These investments are expected to substantially enhance modular construction capability, facilitate handling of larger ship blocks and improve overall production productivity.

Future phases are expected to include advanced outfitting facilities, fabrication infrastructure and automation technologies.

(iii) Titagarh Naval Systems, Falta, West Bengal

Titagarh Naval Systems has secured in-principle approval for development of a new shipyard facility at Falta, West Bengal, with an approved investment of approximately ₹516 crore.

The project is expected to establish a modern shipbuilding facility capable of constructing 10 to 12 vessels annually, with vessel lengths of up to 160 metres.

This represents a significant addition to India's medium-sized shipbuilding capacity and is expected to strengthen maritime manufacturing capabilities on the eastern coast.

(iv) MAT Marine, Kakinada, Andhra Pradesh

The fourth approved project pertains to MAT Marine at Kakinada, Andhra Pradesh, with an approved investment of approximately ₹105 crore.

The project focuses on developing shipbuilding and ship repair infrastructure, including slipway facilities capable of handling vessels exceeding 1,000 GT. While relatively smaller in scale, the project addresses important infrastructure gaps and contributes to regional capacity development along the eastern coast.

Strategic Significance

The portfolio of approved projects demonstrates the flexibility and broad applicability of the brownfield programme. Together, the projects address multiple segments of the maritime ecosystem, including:

- Shipbuilding;
- Ship repair;
- Heavy fabrication;
- Modular construction;
- Yard modernisation; and
- Capacity expansion.

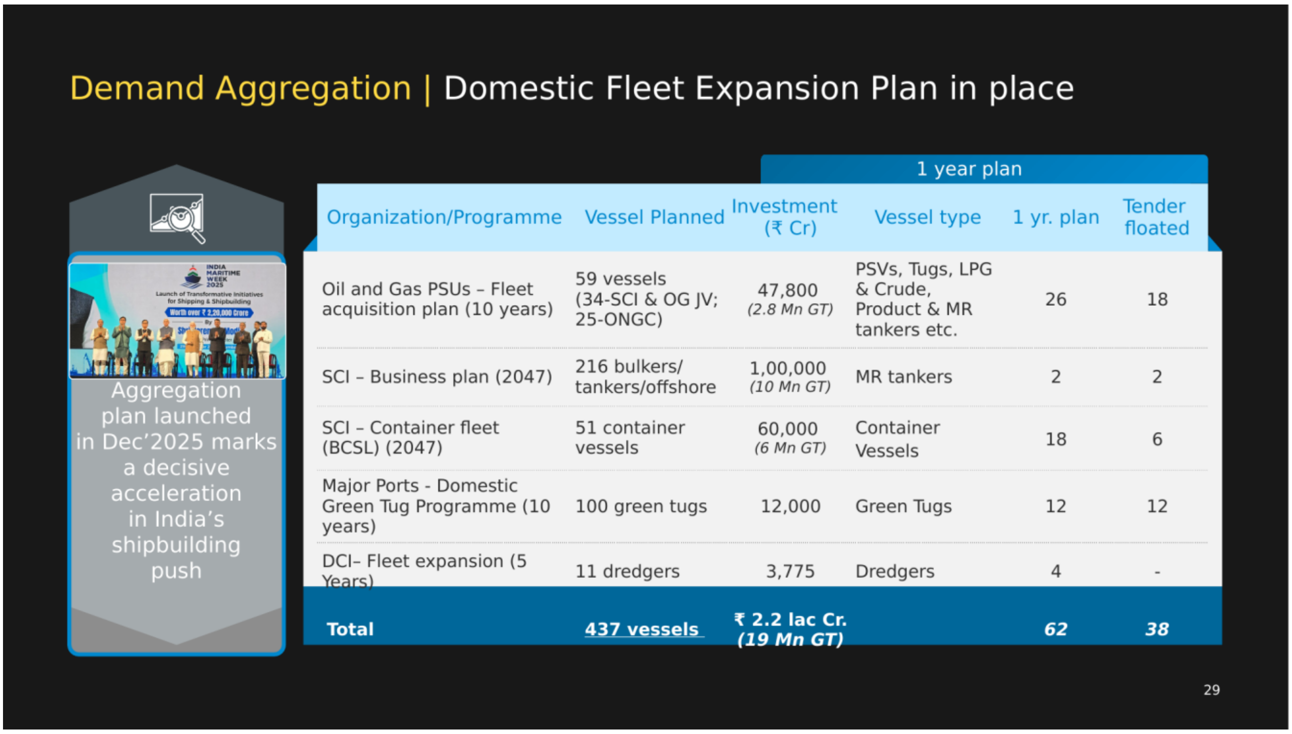
Importantly, the approved projects are geographically distributed across Gujarat, West Bengal and Andhra Pradesh, reducing concentration of maritime infrastructure and supporting balanced national shipbuilding growth.

The programme also encourages private sector participation while leveraging the strengths of leading public sector entities such as Cochin Shipyard Limited and major port authorities. The resulting investments are expected to generate long-term benefits through enhanced production capability, increased repair capacity, technological advancement, employment generation and stronger domestic value chains.

10.7. 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.



Organization/Programme	Vessel Planned	Investment (₹ Cr)	Vessel type	1 yr. plan	Tender floated
Oil and Gas PSUs – Fleet acquisition plan (10 years)	59 vessels (34-SCI & OG JV; 25-ONGC)	47,800 *(2.8 Mn GT)*	PSVs, Tugs, LPG & Crude, Product & MR tankers etc.	26	18
SCI – Business plan (2047)	216 bulkers/ tankers/offshore	1,00,000 *(10 Mn GT)*	MR tankers	2	2
SCI – Container fleet (BCSL) (2047)	51 container vessels	60,000 *(6 Mn GT)*	Container Vessels	18	6
Major Ports - Domestic Green Tug Programme (10 years)	100 green tugs	12,000	Green Tugs	12	12
DCI– Fleet expansion (5 Years)	11 dredgers	3,775	Dredgers	4	-
Total	**437 vessels**	**₹ 2.2 lac Cr. *(19 Mn GT)***		**62**	**38**

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.

10.8. 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.

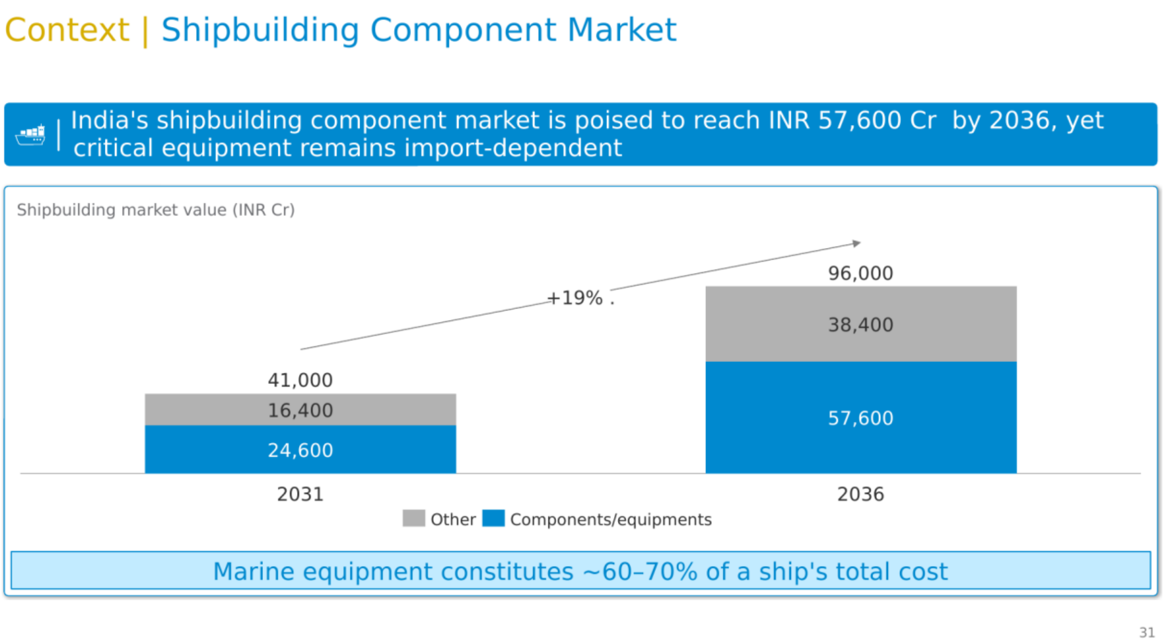


Exhibit 8.1: The Indian shipbuilding component market to 2036

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.

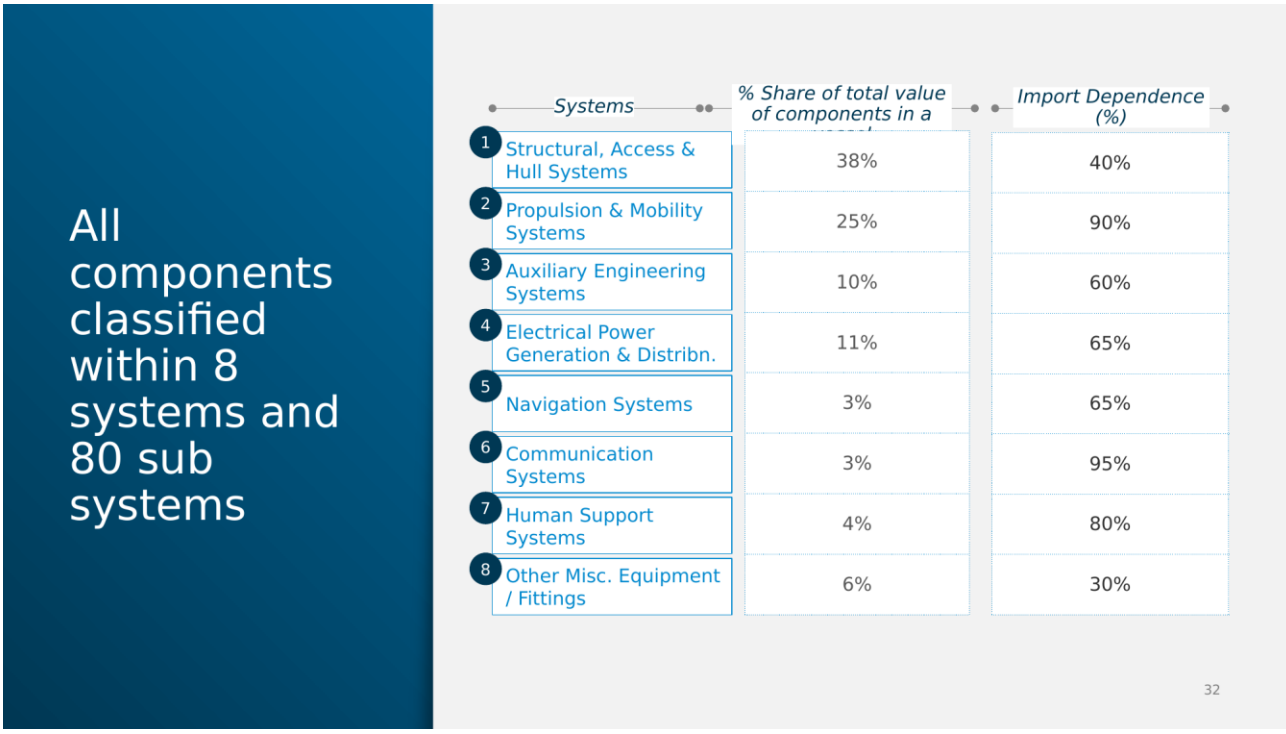


Exhibit 8.2: The eight systems by share of vessel value and import dependence

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.

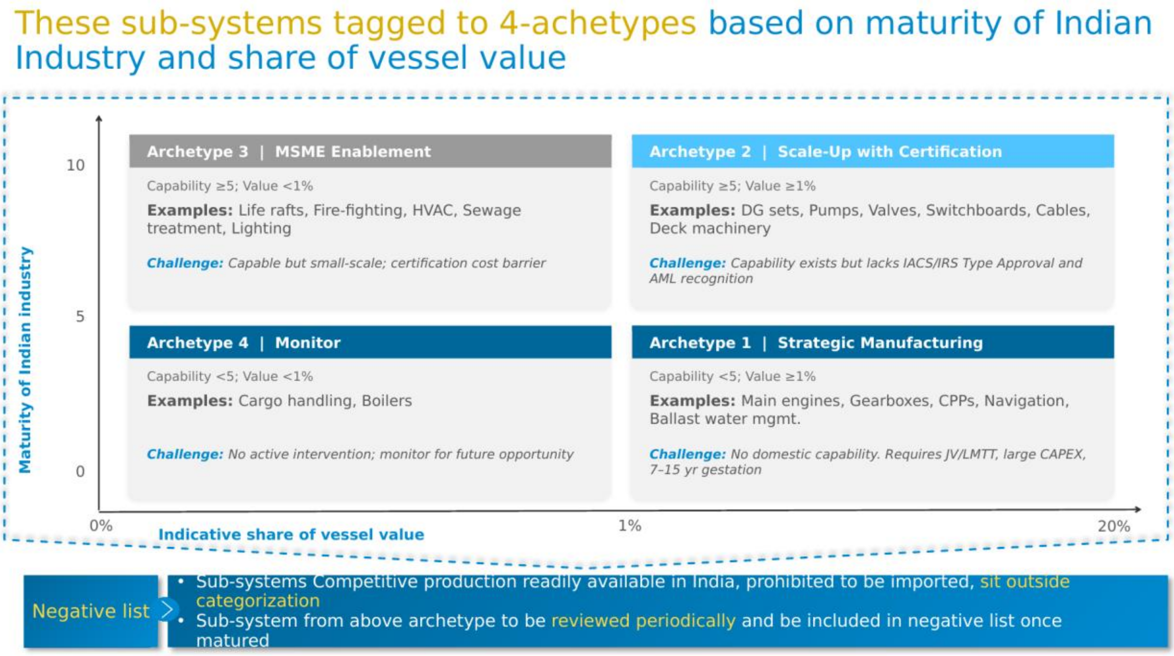


Exhibit 8.3: The four intervention archetypes for component sub-systems

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.

10.9. 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.

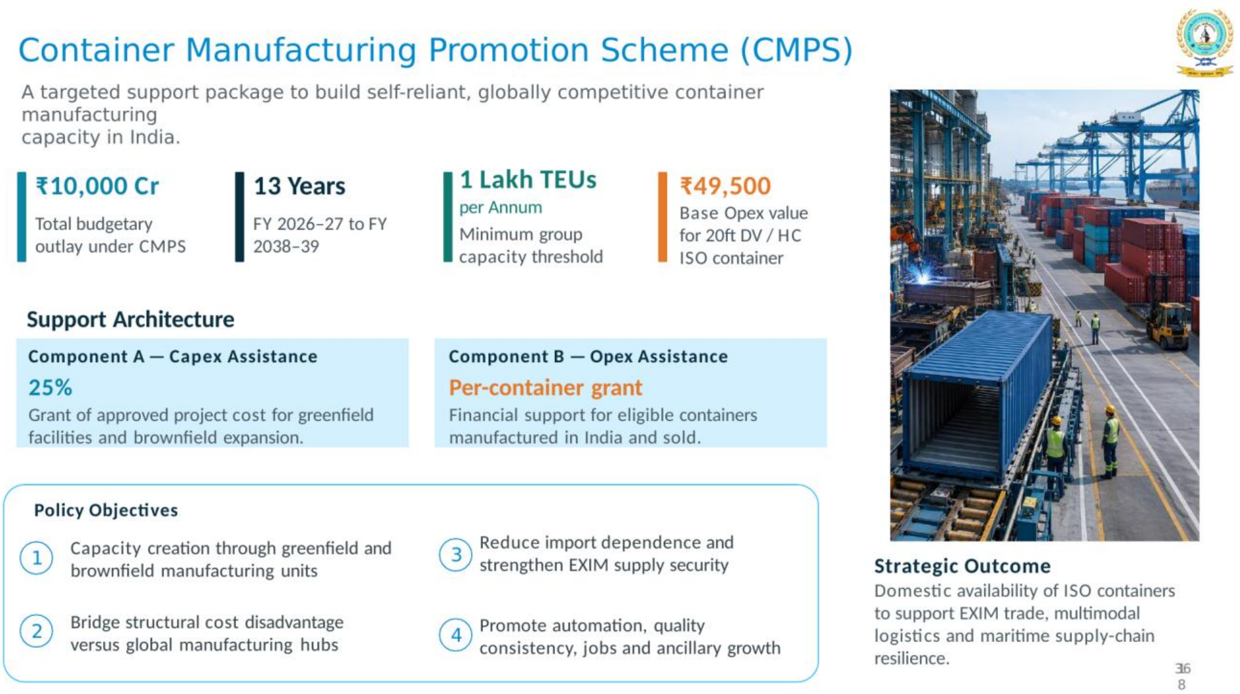


Exhibit 9.1: Container Manufacturing Promotion Scheme: architecture and parameters

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.

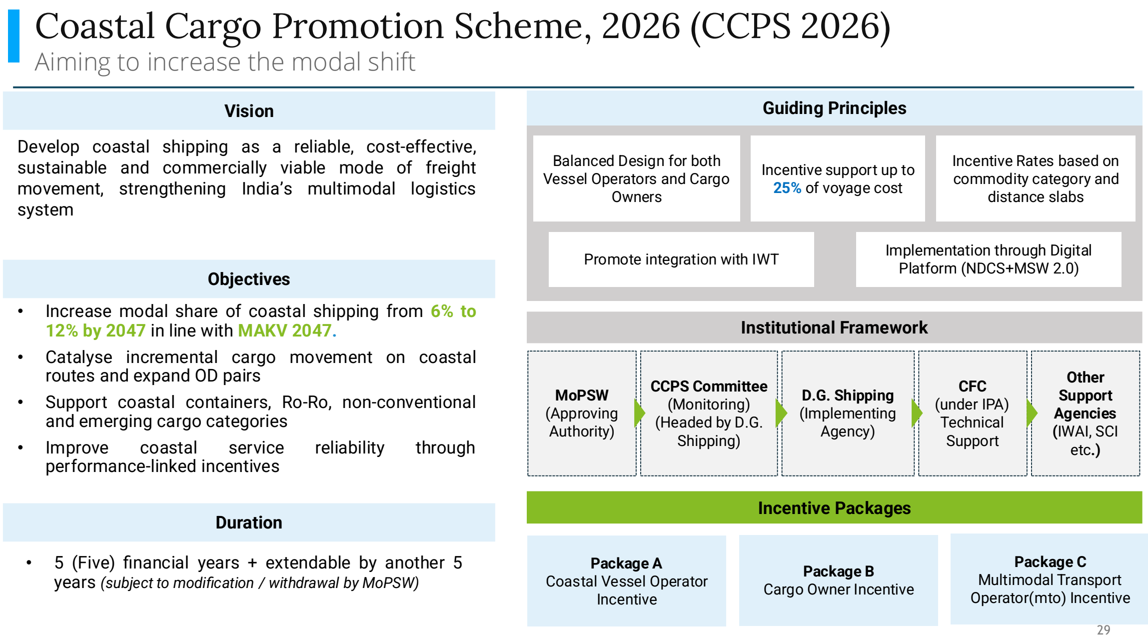
Component B provides operating expenditure assistance as a per-container grant for eligible containers manufactured in India and sold. This is the more distinctive element. Capital assistance alone would create capacity that then failed to operate competitively, because the disadvantage Indian manufacturers 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.

10.10. Coastal Cargo Promotion Scheme



Vision and Strategic Objectives

The Coastal Cargo Promotion Scheme, 2026 (CCPS 2026) seeks to develop coastal shipping as a reliable, cost-effective, sustainable and commercially viable mode of freight transportation. The Scheme is intended to strengthen India's multimodal logistics system by facilitating a progressive shift of cargo from road and rail to coastal shipping. Its central objective is to increase the modal share of coastal shipping from the existing level of 6% to 12% by 2047, in alignment with the targets envisaged under Maritime Amrit Kaal Vision 2047 (MAKV 2047).

CCPS 2026 will focus on generating incremental cargo movement along coastal routes and expanding the number of viable origin-destination pairs. The Scheme seeks to support cargo segments with significant potential for transportation by sea, including coastal containers, Roll-on/Roll-off cargo, non-conventional cargo and emerging commodity categories. By promoting additional cargo volumes rather than merely supporting existing traffic, the Scheme is expected to encourage the development of new coastal services and strengthen demand across coastal shipping corridors.

A major emphasis is also placed on improving the reliability and commercial sustainability of coastal services. Performance-linked incentives are proposed to encourage regular operations, dependable services and improved cargo availability. The overall approach recognises that coastal shipping can become a preferred freight option only when vessel operators have adequate cargo assurance and cargo owners receive competitive, predictable and efficient transportation services.

Guiding Principles and Institutional Framework

The Scheme adopts a balanced design that addresses the commercial requirements of both coastal vessel operators and cargo owners. Incentive support may extend up to 25% of the voyage cost, with the applicable rate determined according to the commodity category and distance slab. This differentiated incentive structure is intended to reflect variations in cargo characteristics, voyage distance and associated transportation costs, rather than applying a uniform rate across all coastal movements.

CCPS 2026 also promotes integration between coastal shipping and Inland Water Transport (IWT). Such integration can support a more interconnected water-based logistics network and facilitate cargo movement across coastal and inland waterways. Implementation is proposed through a digital platform integrating the National Data Centre Services Plus (NDCS+) and Maritime Single Window 2.0 (MSW 2.0). Digital implementation is expected to provide a common mechanism for administering the Scheme and coordinating the participation of vessel operators, cargo owners, multimodal transport operators and government agencies.

The Ministry of Ports, Shipping and Waterways (MoPSW) will function as the approving authority. A dedicated CCPS Committee, headed by the Director General of Shipping, will be responsible for monitoring the Scheme. The Directorate General of Shipping will act as the implementing agency, while a Central Facilitation Cell under the Indian Ports Association will provide technical support. Other agencies, including the Inland Waterways Authority of India, Shipping Corporation of India and relevant supporting institutions, may assist in implementation depending on the operational requirements of the Scheme. This institutional arrangement establishes a clear chain for approval, monitoring, implementation, technical facilitation and inter-agency support.

Incentive Packages and Scheme Duration

The incentive framework is structured into three packages to support the principal stakeholders involved in coastal cargo movement. Package A provides incentives to coastal vessel operators, recognising the operational costs and commercial risks associated with maintaining coastal services. Package B provides incentives to cargo owners to encourage the diversion of eligible cargo from conventional land-based modes to coastal shipping. Package C supports multimodal transport operators, acknowledging their role in integrating coastal shipping with first-mile and last-mile transport and facilitating end-to-end cargo movement.

The three-package structure is intended to address both the supply and demand sides of the coastal shipping ecosystem. Support to vessel operators can facilitate the availability and continuity of coastal services, while incentives to cargo owners can stimulate cargo demand. Incentivising multimodal transport operators can strengthen coordination between coastal shipping, inland waterways and surface transport, thereby supporting a more integrated logistics chain.

The Scheme is proposed for an initial duration of five financial years, with the possibility of extension for a further five years. Any continuation will remain subject to the modification or withdrawal of the Scheme by the Ministry of Ports, Shipping and Waterways. The duration provides a defined period for supporting additional coastal cargo movement, expanding viable routes and assessing the effectiveness of the incentive packages in achieving the targeted modal shift.

10.11. Transition from SBFAP to SBFAS and Integration with the Ship Recycling Credit Note (SRCN) Mechanism

India's shipbuilding support framework is undergoing a significant transition from the legacy Shipbuilding Financial Assistance Policy (SBFAP) to the newly approved Shipbuilding Financial Assistance Scheme (SBFAS). The transition represents a shift from a production-linked support mechanism towards a more comprehensive and long-term industrial development framework that seeks not only to support vessel construction but also to create stronger linkages between shipbuilding, domestic value addition and ship recycling.

The introduction of the Ship Recycling Credit Note (SRCN) mechanism alongside SBFAS further strengthens this ecosystem approach by creating incentives for vessel owners to recycle ships at compliant Indian ship recycling facilities and reinvest the resulting benefits into new vessel construction. Taken together, the three initiatives establish an integrated policy architecture wherein ship recycling generates incentives for new vessel acquisition, while the shipbuilding assistance scheme improves the commercial viability of domestic vessel orders.

This integrated framework is intended to stimulate demand for Indian-built vessels, increase order visibility for domestic shipyards, encourage investment in ship recycling infrastructure and contribute to the broader objective of maritime self-reliance under Maritime Amrit Kaal Vision 2047.

Shipbuilding Financial Assistance Policy (SBFAP): Performance and Outcomes

The Shipbuilding Financial Assistance Policy served as the principal support mechanism for domestic shipbuilding over the last several years and provided direct financial assistance for vessels constructed in Indian shipyards.

As of August 2026, the policy has supported the construction of approximately 204 vessels, with cumulative financial assistance of approximately ₹651 crore disbursed to Indian shipyards. The implementation experience demonstrates the importance of targeted government support in sustaining competitiveness against established international shipbuilding centres, particularly in segments where Indian yards face cost disadvantages arising from lower economies of scale, financing constraints and infrastructure limitations.

Fund disbursement under the policy has shown steady growth over successive years, reflecting increasing utilisation by the domestic industry. The trend also indicates growing confidence among vessel owners and shipyards regarding the availability of policy support and the predictability of implementation mechanisms.

The experience gained during implementation of SBFAP has informed the design of the new Shipbuilding Financial Assistance Scheme, enabling policymakers to retain effective features while introducing reforms aimed at increasing domestic value addition and improving long-term sectoral competitiveness.

Shipbuilding Financial Assistance Scheme (SBFAS)

The Shipbuilding Financial Assistance Scheme (SBFAS) is scheduled to become operational from 24 September 2025 and represents the next-generation incentive framework for Indian shipbuilding.

The scheme has been designed with a significantly larger financial corpus of approximately ₹24,736 crore, signalling a substantial increase in governmental commitment towards the development of the sector. Within this allocation, approximately ₹4,001 crore has been specifically earmarked for integration with the Ship Recycling Credit Note mechanism, thereby establishing an institutional linkage between the shipbuilding and recycling industries.

A key design feature of SBFAS is the introduction of differentiated levels of financial assistance based on vessel category and domestic content.

The scheme provides:

- 15% financial assistance for eligible vessels up to a defined threshold;
- 20% assistance for larger non-specialised vessels; and
- 25% assistance for specialised vessel categories.

This differentiated structure reflects the policy objective of encouraging construction of technologically advanced and strategically significant vessels while continuing support for conventional commercial shipbuilding activities.

Domestic Content Incentivisation

One of the most important reforms introduced under SBFAS is the incorporation of a domestic value addition framework.

The assistance structure links benefit levels to domestic content utilisation within the vessel construction process. Broadly, the framework provides:

- No additional domestic-content benefit where domestic content remains below 30%;
- Pro-rata support where domestic content ranges between 30% and 40%; and
- Full benefits once domestic content exceeds 40%.

This approach aligns financial assistance with the objective of creating stronger domestic manufacturing linkages across the maritime value chain. By incentivising procurement of domestically manufactured components, equipment and systems, the scheme is expected to generate multiplier effects extending beyond shipyards into ancillary industries such as steel fabrication, marine engineering, electrical systems, machinery manufacturing and specialised maritime equipment production.

The domestic content requirement also supports long-term industrial capability development and reduces dependence on imported shipbuilding inputs.

Initial Implementation Pipeline under SBFAS

The transition from SBFAP to SBFAS has already generated a significant project pipeline. Current implementation data indicates that approximately 118 vessels with a combined contract value of around ₹12,352 crore have been identified under the emerging framework.

These projects are expected to attract financial assistance of approximately ₹2,684 crore, demonstrating substantial industry interest even during the initial stages of implementation.

The early response suggests that the revised incentive architecture has been positively received by shipowners and shipyards. The sizeable contract value associated with the initial pipeline also indicates increasing confidence in India's capability to undertake a larger share of domestic vessel construction demand.

As implementation progresses, the pipeline is expected to expand further, particularly in specialised vessel categories that receive enhanced levels of assistance under the scheme.

Ship Recycling Credit Note Mechanism (SRCN)

The Ship Recycling Credit Note mechanism represents a major policy innovation intended to create a circular maritime industrial ecosystem.

The mechanism incentivises shipowners to recycle vessels at compliant Indian recycling facilities and subsequently utilise the resulting credit entitlement towards acquisition of new vessels.

Under the framework, a shipowner recycling a vessel at an eligible Indian yard becomes entitled to a credit note equivalent to 40% of the fair scrap value generated from recycling.

The issued credit note can subsequently be redeemed against the acquisition of eligible new vessels, subject to prescribed conditions.

Importantly, the benefit is capped at 5% of the value of the new vessel, thereby ensuring that the incentive remains supplementary rather than becoming the primary determinant of procurement decisions.

The credit note remains valid for a period of three years, providing flexibility to vessel owners in planning replacement investments.

Key Features of the SRCN Architecture

The SRCN design incorporates several features aimed at improving usability and encouraging wider industry participation.

The mechanism is:

- Transferable, enabling credit notes to be traded or transferred between eligible entities;
- Stackable, allowing SRCN benefits to be combined with benefits available under shipbuilding support schemes;
- Capable of partial utilisation, thereby supporting flexibility in redemption; and
- Available for vessels recycled at Hong Kong Convention-compliant Indian recycling facilities.

The transferability feature is particularly significant because it ensures that shipowners who may not immediately require a replacement vessel can still realise economic value from the credit note through transfer to another market participant.

Similarly, the ability to combine SRCN benefits with shipbuilding assistance substantially improves the economics of ordering new vessels from Indian shipyards.

Collectively, these provisions strengthen the policy objective of creating a continuous cycle of recycling, reinvestment and fleet renewal within the domestic maritime ecosystem.

Implementation Status of SRCN

Implementation of the SRCN framework has commenced with encouraging initial results.

As of the latest implementation review:

- 51 vessel owners have registered under the framework;
- 63 vessels have been beached for recycling;
- 28 recycling processes have been completed;
- 14 applications have been received; and

Three credit notes have been issued.

The issuance of the first credit notes represents an important milestone, demonstrating operationalisation of the framework and establishing proof of concept for future transactions.

The gradual increase in registrations, vessel beaching activity and completed recycling cases indicates growing awareness of the mechanism among industry participants and suggests potential for scaling over the coming years.

Strategic Significance of the Integrated Framework

The combination of SBFAS and SRCN creates a policy framework that addresses both supply-side and demand-side constraints affecting the shipbuilding industry.

On the supply side, the financial assistance scheme improves shipyard competitiveness and supports domestic manufacturing capability. On the demand side, SRCN creates a direct incentive for vessel owners to place new orders following recycling of older tonnage.

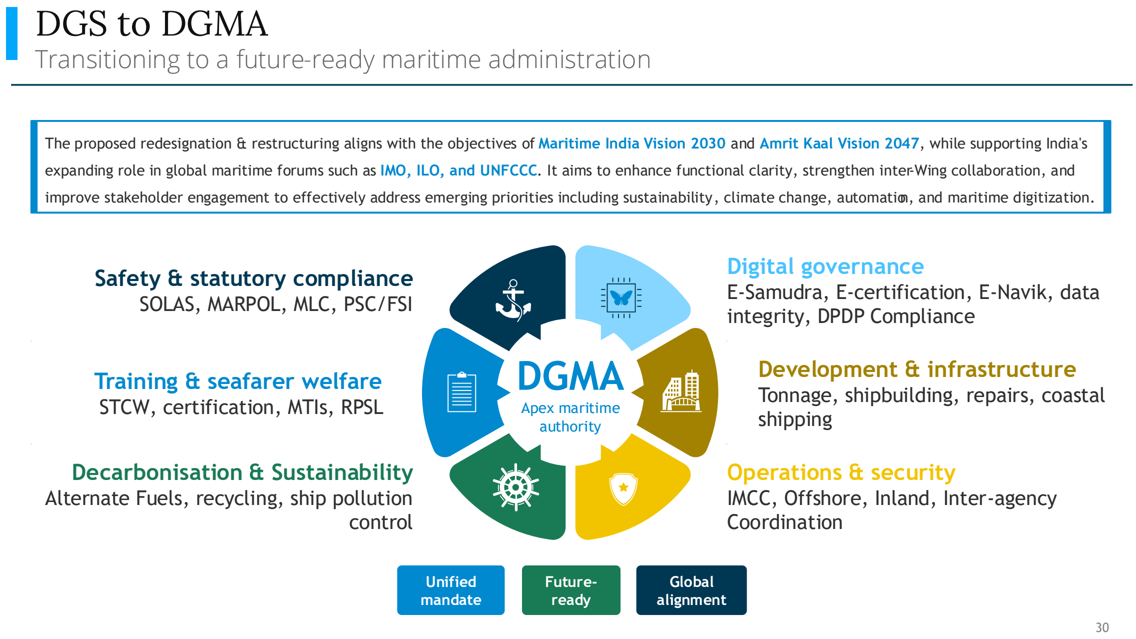
This linkage effectively creates a circular value chain in which obsolete vessels are recycled domestically, generating financial incentives for acquisition of new vessels that are, in turn, supported through shipbuilding assistance.

The framework therefore promotes:

- Fleet modernisation;
- Increased shipbuilding orders;
- Higher domestic value addition;
- Growth of compliant ship recycling facilities;
- Employment generation across maritime sectors; and
- Strengthening of India's maritime industrial base.

By linking shipbuilding assistance, domestic manufacturing incentives and ship recycling benefits into a single ecosystem, the Government has laid the foundation for a more sustainable and self-reinforcing maritime industrial strategy capable of supporting the long-term objectives of Maritime Amrit Kaal Vision 2047.

11. DGMA EoDB Transformation Framework



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.

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

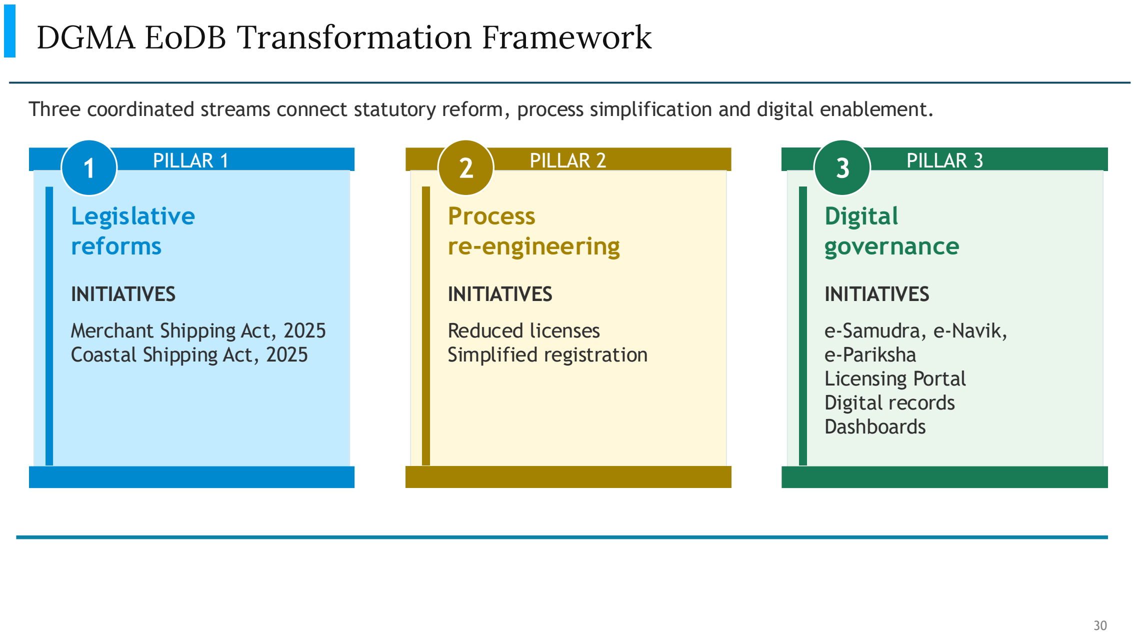
The future maritime administration will operate through digital-first systems such as e-Samudra, e-Certification, e-Navik, digital licensing systems, maritime databases, dashboards, and electronic compliance mechanisms. These reforms are intended to improve transparency, reduce processing timelines, 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.



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.

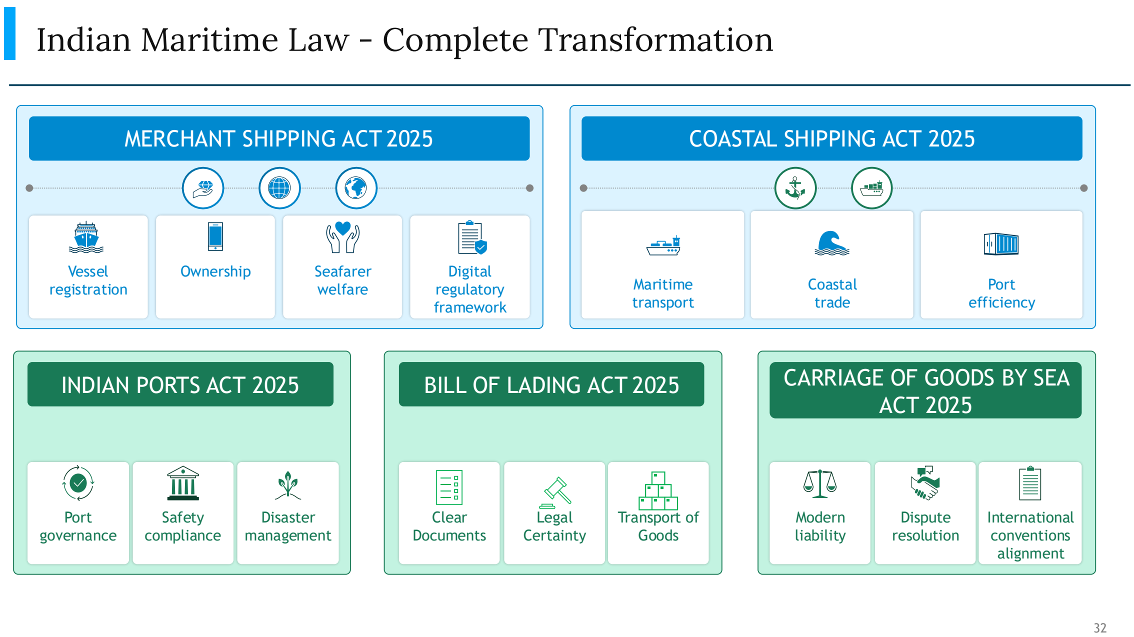
e-Navik

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.

12. Indian Maritime Law - Complete Transformation



India's maritime legal framework is undergoing a comprehensive transformation through the introduction of four cornerstone legislations, namely the Merchant Shipping Act, 2025, the Carriage of Goods by Sea Act, 2025, the Indian Ports Act, 2025 and the Coastal Shipping Act, 2025. Together, these legislations seek to replace legacy provisions with a modern regulatory architecture capable of supporting India's growing maritime ambitions while addressing contemporary requirements relating to safety, trade facilitation, environmental protection, technological advancement and ease of doing business. The reform package has been designed to establish a harmonised legal ecosystem that aligns domestic maritime governance with international best practices and supports the objectives of Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047.

The Merchant Shipping Act, 2025 constitutes the primary legislative framework governing shipping administration in India. The Act provides a modern legal basis for vessel registration, ownership, flag administration, seafarer welfare, safety oversight and regulatory governance. The legislation incorporates contemporary maritime practices and supports the transition towards a digital-first regulatory environment by enabling electronic certification, online service delivery, digital record management and technology-enabled compliance mechanisms. The Act further strengthens India's ability as a flag State by modernising registration procedures, improving oversight mechanisms and providing a regulatory framework capable of supporting emerging maritime technologies and future shipping requirements. Simultaneously, greater emphasis has been placed on seafarer welfare and labour protections, recognising the critical role played by maritime manpower in sustaining India's position as a leading seafaring nation.

The Carriage of Goods by Sea Act, 2025 introduces a modern cargo liability and maritime commerce regime aligned with evolving international trade practices. The legislation seeks to provide greater certainty in contractual relationships between carriers, cargo owners, shippers, consignees and other stakeholders engaged in maritime trade. By establishing clearer liability provisions and strengthening dispute resolution mechanisms, the Act enhances legal predictability and reduces transactional uncertainty associated with maritime cargo movements. The alignment of domestic provisions with internationally accepted conventions further strengthens confidence among global trading partners and contributes towards creating a stable and predictable legal environment for India's growing EXIM trade.

The Indian Ports Act, 2025 modernises the legislative framework governing port administration and port-related activities. Recognising the evolving role of ports as integrated logistics and economic hubs, the Act focuses on strengthening port governance, regulatory oversight, safety management and emergency preparedness. The legislation introduces a more comprehensive framework for ensuring compliance with safety and operational standards while supporting coordinated responses to maritime incidents, environmental emergencies and disaster situations. Enhanced governance provisions are expected to improve transparency, accountability and operational efficiency across port ecosystems while ensuring that Indian ports remain resilient, secure and globally competitive.

The Coastal Shipping Act, 2025 provides a dedicated legal framework for promoting coastal cargo movement and strengthening maritime transport within the domestic economy. Coastal shipping has emerged as a critical component of India's multimodal logistics strategy owing to its potential to reduce transportation costs, improve logistics efficiency, lower carbon emissions and decongest road and rail networks. The legislation seeks to facilitate greater participation in coastal trade by providing regulatory clarity, simplifying operational requirements and creating an enabling framework for the efficient movement of cargo along India's coastline. Improved integration between ports, shipping services and coastal logistics chains is expected to enhance the attractiveness of coastal shipping as a sustainable and cost-effective mode of transportation.

The Bills of Lading Act, 2025 modernises the legal framework governing bills of lading, which constitute essential documents for the carriage and transfer of goods by sea. The

Act provides for the transfer of rights of suit and corresponding liabilities to the consignee named in a bill of lading or to an endorsee to whom the property in the goods passes through consignment or endorsement. It thereby ensures that contractual rights associated with the goods pass to the lawful holder of the bill of lading. The legislation also strengthens the evidentiary value of bills of lading by providing that a bill of lading held by a consignee or endorsee for valuable consideration may serve as conclusive evidence of shipment against the master or other person signing the document, subject to the conditions prescribed under the Act. By clarifying the legal status, enforceability and transferability of bills of lading, the Act promotes certainty in shipping documentation, protects the interests of lawful holders and facilitates smoother maritime trade transactions.

Collectively, these legislative reforms represent a significant shift from fragmented and legacy maritime regulation towards an integrated and future-ready maritime governance framework. By simultaneously addressing vessel regulation, maritime commerce, port administration and coastal transportation, the reforms establish a comprehensive legal foundation for the development of a safe, efficient, technologically advanced and globally competitive maritime ecosystem. The transformation is expected to strengthen India's maritime administration, improve ease of doing business, enhance compliance with international standards and support long-term growth across shipping, ports, coastal trade and related maritime sectors.

13. Jan Vishwas Siddhant

Jan Vishwas Siddhant

A transformative framework to clear regulatory blockages by placing trust in citizens and entrepreneurs.

WHAT IT IS

What is Jan Vishwas Siddhant?

The Jan Vishwas Siddhant is a transformative framework designed to systematically clear regulatory blockages by placing trust in citizens and entrepreneurs.

KEY PILLARS ARE:

1. **Self-Registration**
Moving away from the licence raj, most business licences will be converted to a one-time, self-registration system. This follows the principle that "everything is permitted until prohibited."
2. **Risk-Based Inspections**
Arbitrary "Inspector Raj" will be replaced by a modern system of random, risk-based inspections, which will largely be conducted by accredited third-party agencies.
3. **Decriminalisation & Proportionality**
Minor procedural and technical offenses will be decriminalized, substituting imprisonment with proportionate fines. This upholds the principle that punishment must fit the violation.
4. **Digitisation and Single Source of Truth**
Compliance filings will be digitized. The IndiaCode portal, integrated with the e-Gazette, is being developed as a single, live, comprehensive digital database of all Acts and rules for stakeholders.
5. **Predictable Regulatory Changes**
Future regulatory changes will ensure stability by being implemented only after public consultation, taking effect annually on a fixed date (e.g., January 1st) to allow businesses time to adapt.

Source: https://www.thehindubusinessline.com/news/lok-sabha-passes-jan-vishwas-amendment-bill/article70814212.ece

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The Jan Vishwas Siddhant is a transformative governance framework designed to systematically remove regulatory blockages by placing greater trust in citizens and entrepreneurs. It seeks to replace processes based on excessive permissions, discretionary inspections and punitive enforcement with a framework founded on self-compliance, proportionality, digitisation and regulatory predictability.

The first pillar is **Self-Registration**. Under this principle, most business licences would move away from the traditional licence-raj model and be converted into a one-time self-registration system. The approach is guided by the principle that **"everything is permitted until prohibited."** It is intended to reduce unnecessary administrative approvals while placing responsibility on businesses to comply with applicable requirements.

The second pillar is **Risk-Based Inspections**. Arbitrary inspections associated with the "Inspector Raj" would be replaced by random and risk-based inspections. These inspections would largely be undertaken by accredited third-party agencies. The purpose is to ensure that regulatory scrutiny is directed towards areas of genuine risk rather than being applied indiscriminately.

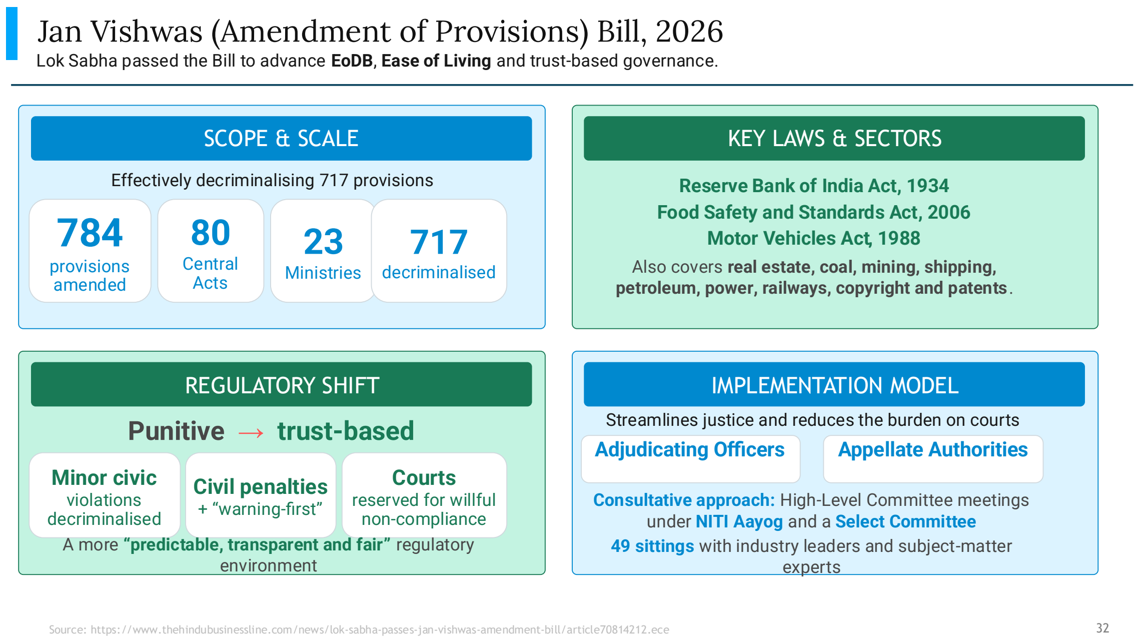
The third pillar is **Decriminalisation and Proportionality**. Minor procedural and technical offences would be decriminalised, with imprisonment replaced by proportionate financial penalties. This pillar is based on the principle that the punishment should correspond to the nature and seriousness of the violation, ensuring that minor non-compliance does not result in excessive criminal consequences.

The fourth pillar is **Digitisation and a Single Source of Truth**. Compliance filings would be digitised to make regulatory information more accessible and consistent. The **IndiaCode portal**, integrated with the **e-Gazette**, is envisaged as a single, live and comprehensive digital database containing all relevant Acts and rules. This would provide stakeholders with an authoritative source of current legal and regulatory information.

The fifth pillar is **Predictable Regulatory Changes**. Future changes would be introduced only after public consultation and would take effect annually on a fixed date, such as **1 January**. Providing advance notice and a consistent implementation schedule would give businesses sufficient time to understand new requirements, modify their processes and prepare for compliance.

Collectively, these five pillars establish a governance model based on trust in citizens and entrepreneurs. The framework seeks to simplify compliance, improve transparency, reduce discretion and create a stable regulatory environment that supports responsible economic activity.

Jan Vishwas (Amendment of Provisions) Bill, 2026



The Jan Vishwas (Amendment of Provisions) Bill, 2026 represents a significant legislative initiative aimed at strengthening the Ease of Doing Business and Ease of Living in India. Passed by the Lok Sabha, the Bill seeks to move the regulatory system away from an excessively punitive approach and towards a trust-based governance model. Its broader objective is to create a regulatory environment that is more predictable, transparent and fair for citizens, businesses and other stakeholders.

The Bill has an extensive scope, proposing amendments to **784 provisions across 80 Central Acts administered by 23 Ministries**. Through these amendments, **717**

provisions are proposed to be decriminalised. This large-scale exercise is intended to address minor, procedural and technical violations that do not necessarily warrant criminal prosecution, thereby reducing unnecessary legal exposure for individuals and businesses.

The legislation covers several important laws, including the **Reserve Bank of India Act, 1934**, the **Food Safety and Standards Act, 2006**, and the **Motor Vehicles Act, 1988**. Its impact also extends across sectors such as real estate, coal, mining, shipping, petroleum, power, railways, copyright and patents. The Bill therefore represents a broad regulatory reform rather than an amendment confined to a single industry or administrative area.

A central feature of the Bill is the replacement of criminal prosecution for minor civic violations with proportionate **civil penalties** and a **warning-first approach**. Criminal proceedings are intended to be reserved primarily for cases involving deliberate or wilful non-compliance. This approach seeks to ensure that enforcement remains effective while avoiding disproportionate punishment for procedural or technical lapses.

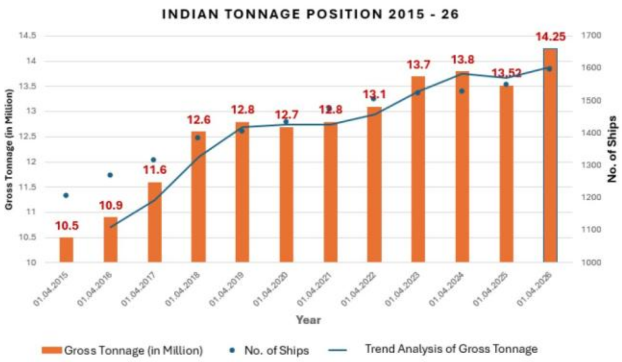
The Bill also proposes an institutional mechanism for administering the revised penalty framework. It provides for the appointment of **Adjudicating Officers** and the establishment of **Appellate Authorities**. These mechanisms are intended to streamline the resolution of regulatory matters, provide a structured appeal process and reduce the burden on the judicial system.

The legislation was developed through a consultative process involving High-Level Committee meetings conducted under **NITI Aayog** and examination by a **Select Committee**. The process included **49 sittings with industry representatives and subject-matter experts**, reflecting an effort to incorporate stakeholder perspectives into the proposed regulatory reforms.

14. Indian Tonnage- competitive and global Building and Repairs

Increase in Indian Tonnage

Registry additions accelerated sharply, led by a record year for gross tonnage.



FY 2025–26 ADDITIONS

92 **vessels added** to the Indian registry

1.584M **GT added** 3× the prior FY

65% **of four-year additions landed in 2025–26**

OVERSEAS TONNAGE
Oil tankers, gas carriers, container ships and bulk carriers led additions.

COASTAL ADDITIONS
Tugs and supply / offshore vessels dominated the mix.

MILESTONE **India's registered fleet crossed 14.2 million GT in April 2026**

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The growth of Indian tonnage is a key indicator of the strength, competitiveness, and self-reliance of India's maritime sector. A larger Indian-flag fleet enhances the country's capability to carry its own trade, improves maritime security, generates maritime employment, and reduces dependence on foreign shipping lines. In line with the objectives of Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047, India has been undertaking concerted efforts to expand its national fleet and promote registration under the Indian flag. These efforts have yielded significant results, culminating in a historic increase in Indian tonnage during FY 2025-26.

Growth Trend in Indian Tonnage (2015-2026)

India's registered fleet has witnessed sustained growth over the last decade. Gross tonnage increased from 10.50 million GT in April 2015 to 14.25 million GT in April 2026, representing an overall growth of approximately 35.7%. During the same period, the number of Indian-registered ships increased from 1,210 vessels to 1,598 vessels, reflecting an increase of approximately 32.1%.

The growth trajectory demonstrates steady expansion with only a marginal slowdown during the pandemic period. Following this phase, the Indian fleet regained momentum, with the strongest acceleration recorded during FY 2025-26. This trend indicates increasing confidence among shipowners in the Indian registry and reflects the positive impact of maritime sector reforms and policy interventions.

Record Performance in FY 2025-26

FY 2025-26 marked a landmark year for the Indian maritime sector. During the year:

- 92 vessels were added to the Indian registry.
- 1.584 million GT was added to the national fleet.
- The tonnage added during the year was three times greater than that added in the previous financial year.
- Nearly 65% of all vessel additions recorded during the last four years occurred in FY 2025-26 alone.
- India's registered fleet crossed 14.25 million GT, the highest level ever recorded.

The tonnage increased from 13.52 million GT on 1 April 2025 to 14.25 million GT on 1 April 2026, while the number of ships increased from 1,549 to 1,598 vessels, reflecting a net addition of 49 ships during the year. The simultaneous rise in both gross tonnage and fleet size demonstrates that the growth was not merely numerical but was driven by the induction of larger and higher-capacity vessels. The FY 2025-26 additions reflected a balanced expansion strategy covering both international and domestic maritime requirements.

Overseas Fleet Additions

The overseas fleet contributed the major share of gross tonnage additions. Key vessel categories included:

- Oil Tankers
- Gas Carriers
- Bulk Carriers
- Container Ships

Particularly noteworthy was the addition of large crude oil tankers and gas carriers, which significantly enhanced India's carrying capacity in international trade and energy transportation. Oil tankers alone contributed the largest share of additional gross tonnage during the year.

Coastal Fleet Additions

The coastal fleet additions included:

- Tugs
- Offshore Supply Vessels
- Coastal Cargo Vessels
- Small Oil Tankers

- Passenger Crew Boats
- Dredgers

While coastal vessels contributed a comparatively smaller share of overall tonnage, they play a critical role in supporting port operations, offshore energy activities, coastal trade, maritime infrastructure development, and regional connectivity.

15. Significance of the Increase in Indian Tonnage

The increase in Indian tonnage has important economic, strategic, and operational implications.

a) Enhanced Maritime Self-Reliance

India conducts over 90% of its trade by volume through sea transport. However, a substantial portion of this cargo is still carried by foreign-flag vessels. Growth in Indian tonnage enables greater participation of Indian ships in national trade and reduces dependence on foreign shipping capacity.

b) Retention of Freight Earnings

A larger domestic fleet helps retain freight revenue within the country. Increased Indian ownership and registration of vessels can reduce the outflow of freight payments to foreign operators while strengthening the domestic maritime economy.

c) Strengthened Energy Security

The induction of crude oil tankers, gas carriers, and bulk carriers improves India's ability to transport strategic cargoes under its own flag, thereby enhancing resilience against global market disruptions and geopolitical uncertainties.

d) Employment Generation and Maritime Ecosystem Development

Fleet growth generates demand for seafarers, maritime professionals, ship managers, insurers, port services, and maritime ancillary industries, contributing to the overall development of the maritime ecosystem.

Drivers Behind the Growth

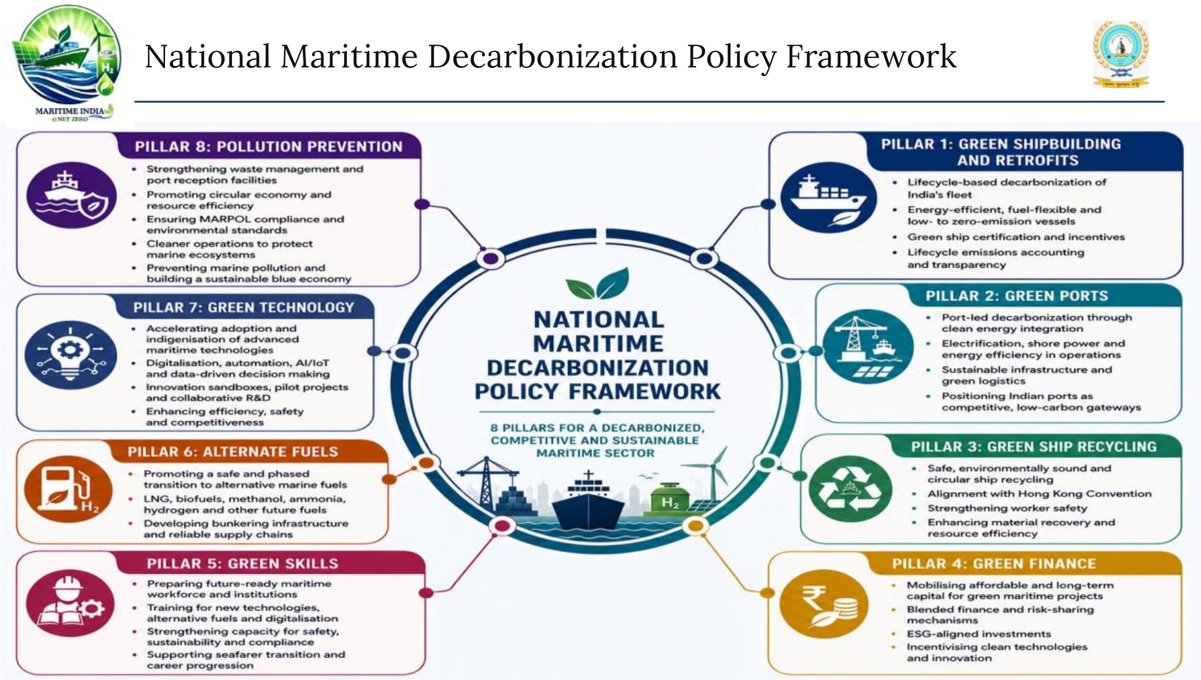
The accelerated growth in FY 2025-26 may be attributed to several factors, including:

- Government initiatives aimed at promoting Indian-flag registration.
- Regulatory reforms to improve ease of doing business in shipping.
- Expansion of maritime financing mechanisms and incentives.
- Increasing attractiveness of the Indian registry.

- Growing confidence among shipowners and investors.
- Policy emphasis under Maritime India Vision 2030 and Maritime Amrit Kaal Vision 2047.

The increase in Indian tonnage to **14.25 million GT as of April 2026** represents a significant milestone in the development of India's maritime sector. The addition of **92 vessels and 1.584 million GT during FY 2025-26** reflects the strongest annual expansion in recent years and demonstrates the success of ongoing policy interventions aimed at strengthening the Indian flag fleet. The growth underscores India's progress towards maritime self-reliance, enhanced cargo-carrying capability, energy security, and long-term strategic resilience. Sustained momentum in fleet expansion will remain critical for achieving the nation's vision of becoming a major global maritime power by 2047.

16. 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.

17. 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.

18. 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

18.1. 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.

18.2. 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.

18.3. 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.

18.4. 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.

18.5. 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.

18.6. 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.

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.

18.7. 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

19. 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.

19.1. 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

20. 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.

20.1. 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**

20.2. 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**

20.3. 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)**

20.4. 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**

21. 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.

22. 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.

23. 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.

24. 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.

25. 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.

25.1. Strategic Rationale for Nuclear Marine Propulsion

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.

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.

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.

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.

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

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.

25.2. 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.

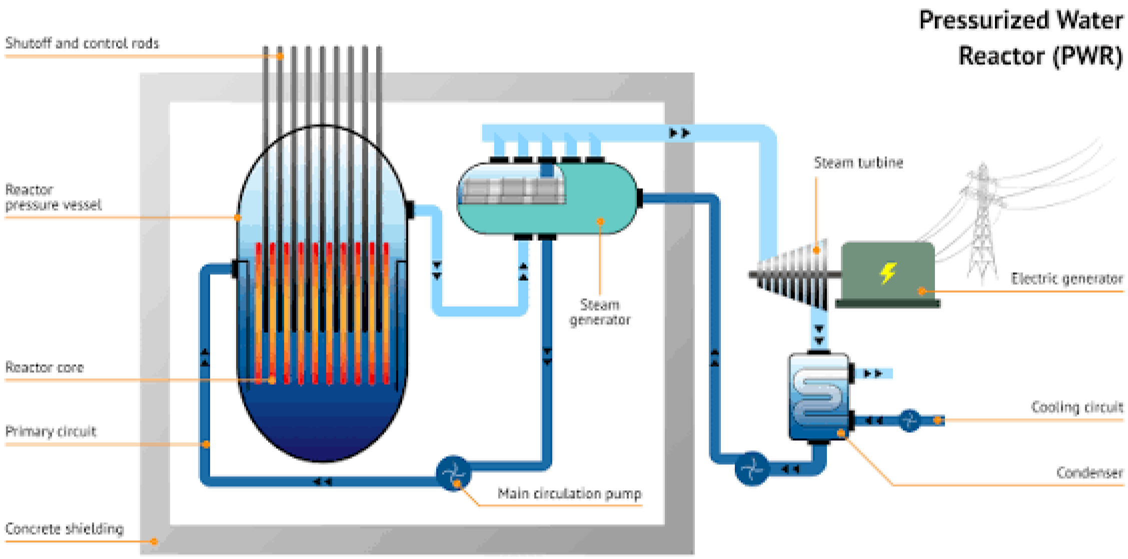
Sevmorput

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.

25.3. Nuclear Reactor Technology Options

Pressurised Water Reactors

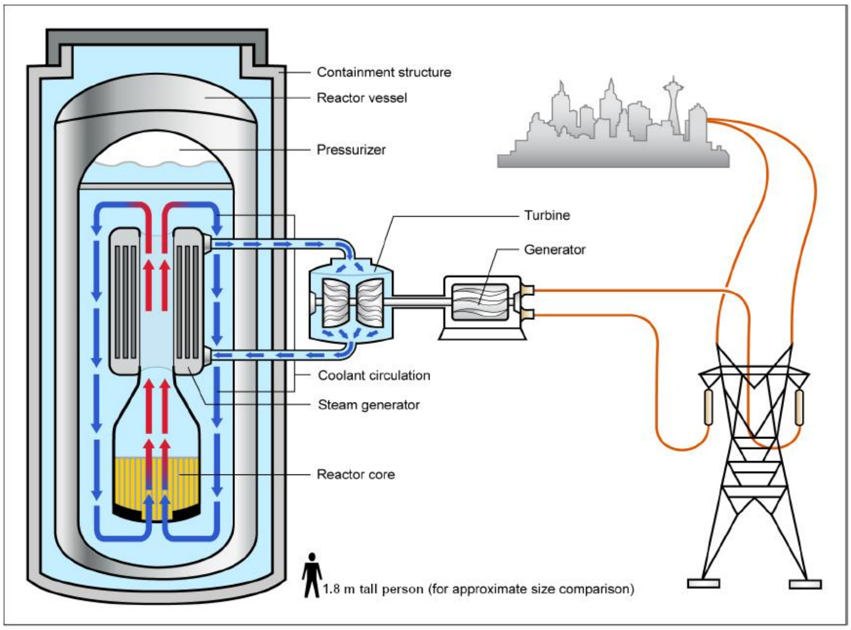


PWRs have the most extensive marine operating history. Their advantages include technological maturity, established safety experience and a well-understood power-conversion system.

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

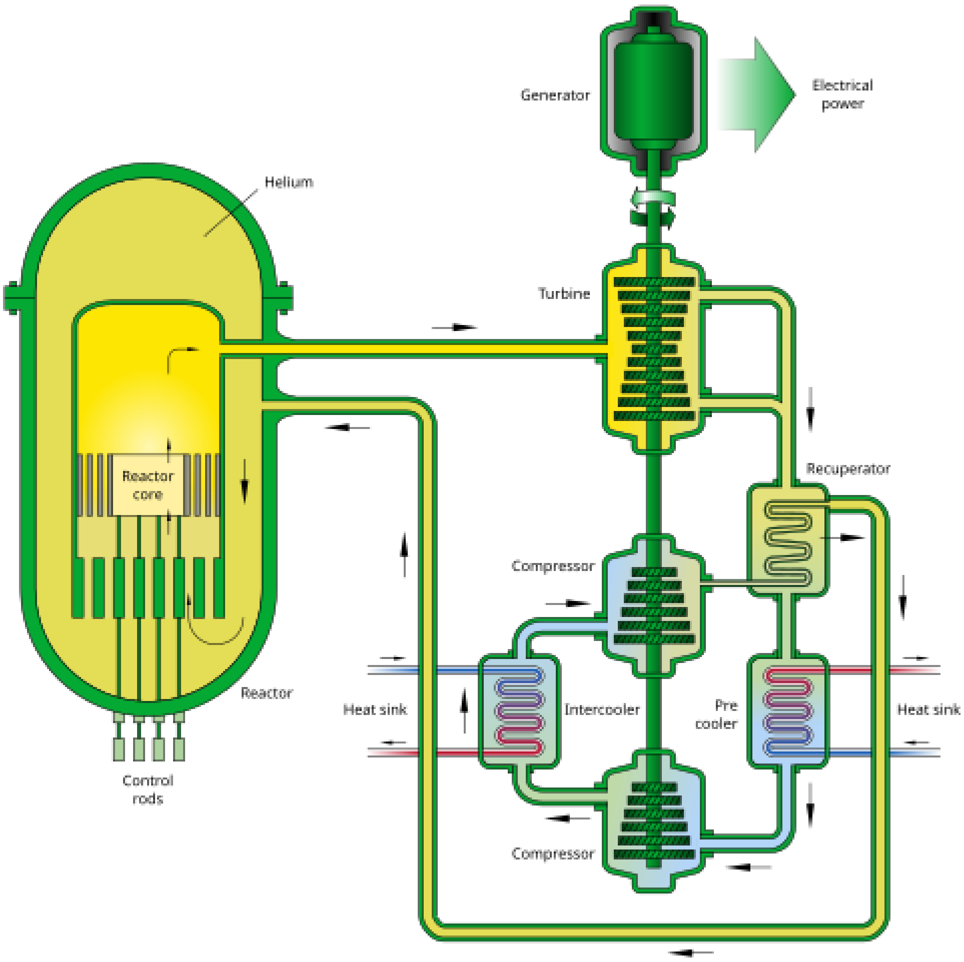
SMRs are advanced reactors generally designed to generate up to 300 MWe per module. Their compact size, modular construction and factory-manufacturing potential make them particularly relevant to future maritime applications.

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



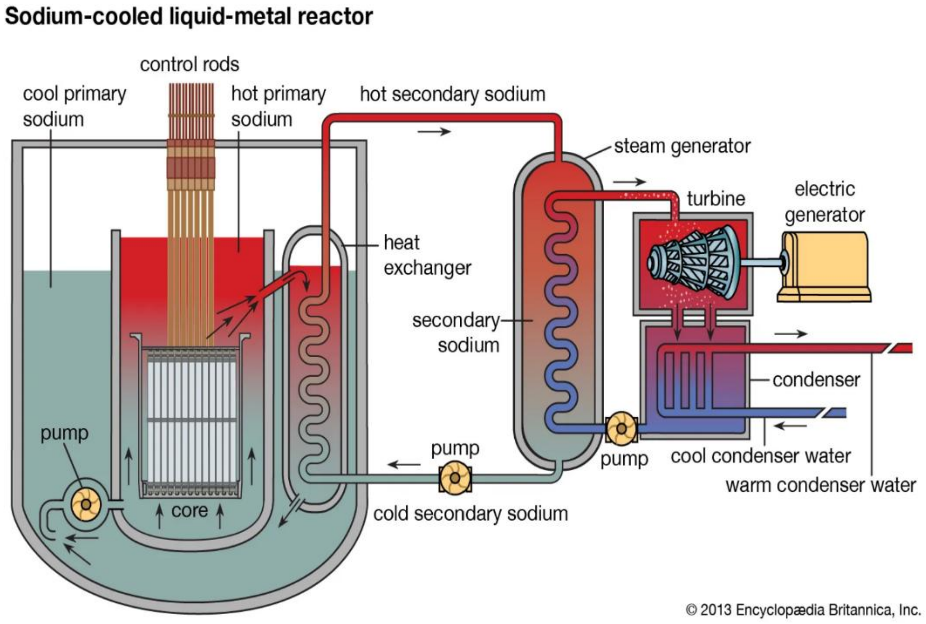
HTGRs use gas, generally helium, as coolant and can operate at higher temperatures. They may offer improved thermal efficiency and passive safety characteristics.

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

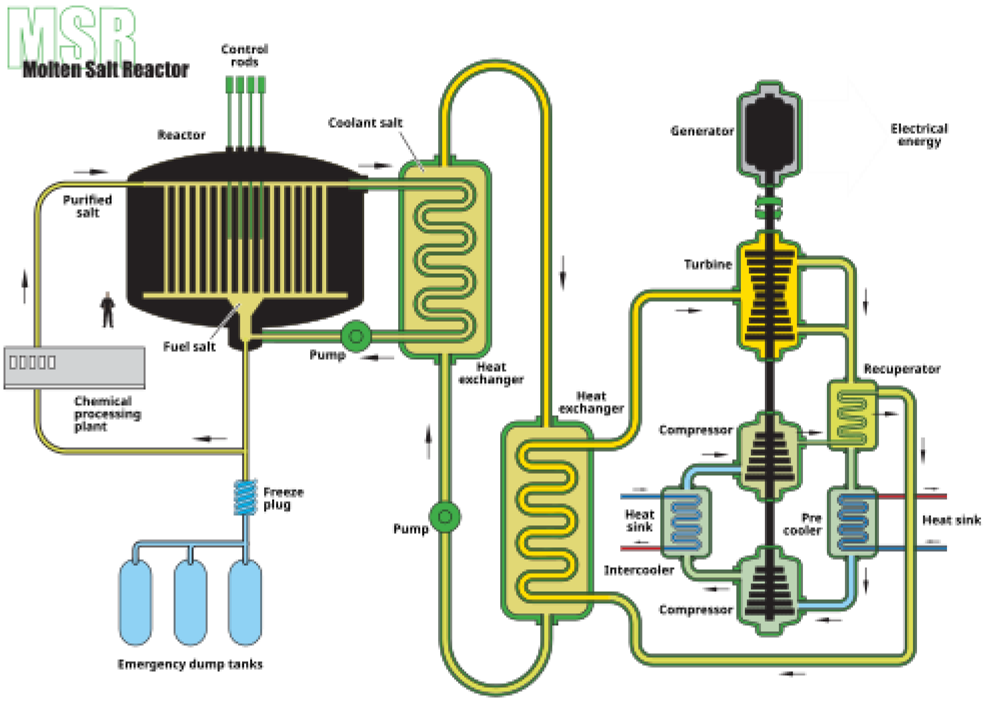


Sodium, lead or lead-bismuth may be used as reactor coolants. These technologies can provide:

- 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.

25.4. 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.

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

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

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.

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.

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.

Indian Defence Marine Nuclear Experience

India's experience with nuclear-powered naval platforms provides an important marine dimension to its wider nuclear capability. India currently operates **three indigenously built Arihant-class nuclear-powered ballistic missile submarines—INS Arihant, INS Arighaat and INS Aridhaman**. Developed under the Advanced Technology Vessel (ATV) programme, these submarines constitute the sea-based leg of India's strategic deterrence while demonstrating the country's indigenous capability in nuclear propulsion, submarine design, marine systems integration and advanced naval engineering.

Indian Nuclear-Powered Vessels

INS Arihant is India's first indigenously developed nuclear-powered ballistic missile submarine. ***Its development marked India's entry into the select group of countries possessing the capability to design and build nuclear-powered submarines***. The vessel was launched in 2009 and subsequently inducted into service. Official Ministry of Defence material identifies Arihant as an indigenously built nuclear-propelled strategic submarine.

INS Arighaat, the second Arihant-class submarine, was commissioned into the Indian Navy on **29 August 2024 at Visakhapatnam**. As per the Ministry of Defence, its construction involved advanced design and manufacturing technologies, special materials, complex engineering and highly skilled workmanship. Its systems and equipment were conceptualised, designed, manufactured and integrated through the combined efforts of Indian scientists, industry and naval personnel. The technological advancements incorporated in INS Arighaat make it more advanced than INS Arihant.

These submarines were developed under India's Advanced Technology Vessel programme and represent the convergence of nuclear science, naval architecture, marine engineering, specialised materials and indigenous manufacturing.

NS Aridhaman, the third Arihant-class nuclear-powered ballistic missile submarine, was commissioned into the Indian Navy in **April 2026**, further strengthening India's indigenous nuclear-powered submarine fleet and sea-based strategic deterrence. Developed under the Advanced Technology Vessel (ATV) programme, INS Aridhaman represents the continued evolution of India's indigenous submarine-building capability and reflects the growing maturity of the country's expertise in nuclear propulsion, complex marine engineering, advanced manufacturing and systems integration. Together with INS Arihant and INS Arighaat, it reinforces India's experience in operating nuclear-powered vessels in demanding maritime environments and provides an important technological foundation for future advancements in marine nuclear engineering

Significance of the Arihant-Class Programme

The Arihant-class programme demonstrates India’s capability to integrate nuclear propulsion within a complex marine platform. A nuclear-powered submarine requires the reactor and its associated systems to operate reliably within a compact vessel while being exposed to vessel motion, vibration, pressure variations and prolonged submerged operations.

The programme has contributed to national experience in areas such as:

- integration of a nuclear reactor with a marine platform
- compact machinery and power-system arrangements
- operation of nuclear systems within confined spaces
- radiation protection and shielding
- heat removal and power conversion at sea
- operation under rolling, pitching and vibration
- use of specialised materials and complex engineering systems
- indigenous design, manufacturing and systems integration
- specialised personnel training and operating procedures
- security of the reactor and nuclear material
- maintenance and emergency preparedness in a marine environment

Nuclear propulsion enables such vessels to remain submerged for extended periods without the frequent refuelling requirements associated with conventional propulsion. This provides high endurance and sustained availability for long-duration marine operations.

Relevance to Civilian Nuclear Propulsion

Civilian merchant vessels would operate under different commercial, regulatory and international conditions. However, the technological and institutional experience developed through the Arihant-class programme provides a valuable national reference for examining civilian nuclear applications.

This experience can support future work relating to:

- assessment of reactor technologies suitable for merchant vessels
- integration of compact reactors with ship propulsion and electrical systems
- marine safety and risk assessment
- shielding, structural protection and heat-removal arrangements
- development of nuclear-marine training and competency frameworks
- specialised shipbuilding, maintenance and servicing requirements
- coordination between nuclear, maritime, defence and industrial institutions

A civilian programme would build upon this broader marine experience while developing dedicated arrangements for:

- civilian design approval and classification
- flag-State certification and regulatory oversight
- international port access and port acceptance
- internationally recognised nuclear safety and safeguards
- commercial insurance and liability
- civilian crew competency and certification
- commercial repair, servicing and refuelling
- compatibility with cargo and passenger operations

India's nuclear-powered submarine programme therefore constitutes an important component of the country's overall foundation for undertaking structured research, technology assessment and eventual development of nuclear propulsion for civilian maritime applications.

International Cooperation

India has established a broad framework of international engagement in the peaceful use of nuclear energy. India has entered into intergovernmental agreements on civil nuclear cooperation with **18 countries**.

This cooperation provides opportunities for knowledge exchange and collaboration in areas such as:

- advanced reactor technologies
- Small Modular Reactors
- nuclear safety and regulation
- nuclear-grade materials and equipment
- fuel-cycle arrangements
- safeguards and security
- radioactive-waste management
- floating nuclear power platforms
- research, training and capacity building

International cooperation assumes particular importance for nuclear-powered merchant shipping because commercial vessels operate across national jurisdictions and rely on recognition by flag States, port States and coastal States.

Future maritime cooperation may therefore involve:

- engagement with the IAEA and IMO
- harmonisation of nuclear and maritime safety requirements
- common principles for classification and certification
- port-entry and emergency-response arrangements
- crew competency and training standards
- liability and insurance mechanisms
- international recognition of vessel and reactor approvals

India's established civil nuclear partnerships and active participation in international maritime institutions provide a suitable platform for initiating such dialogue.

25.5. 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

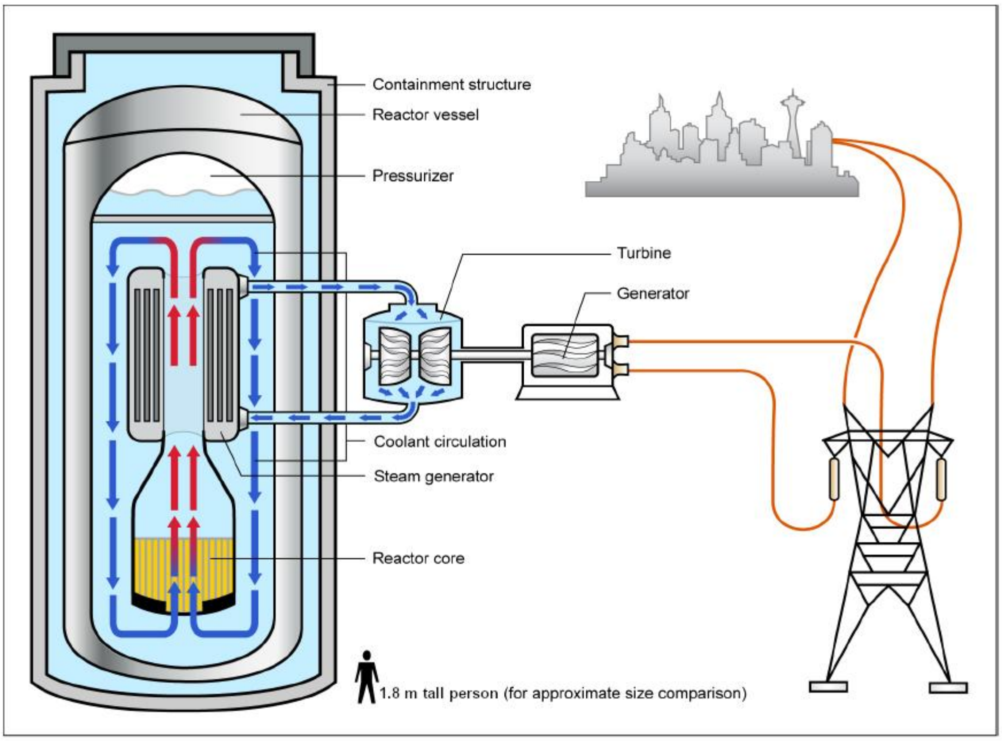
- civilian nuclear-marine competency standards
- training and certification of reactor operators
- specialised training for marine engineers and deck officers
- training of surveyors, port personnel and emergency responders

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.

26. 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.

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.

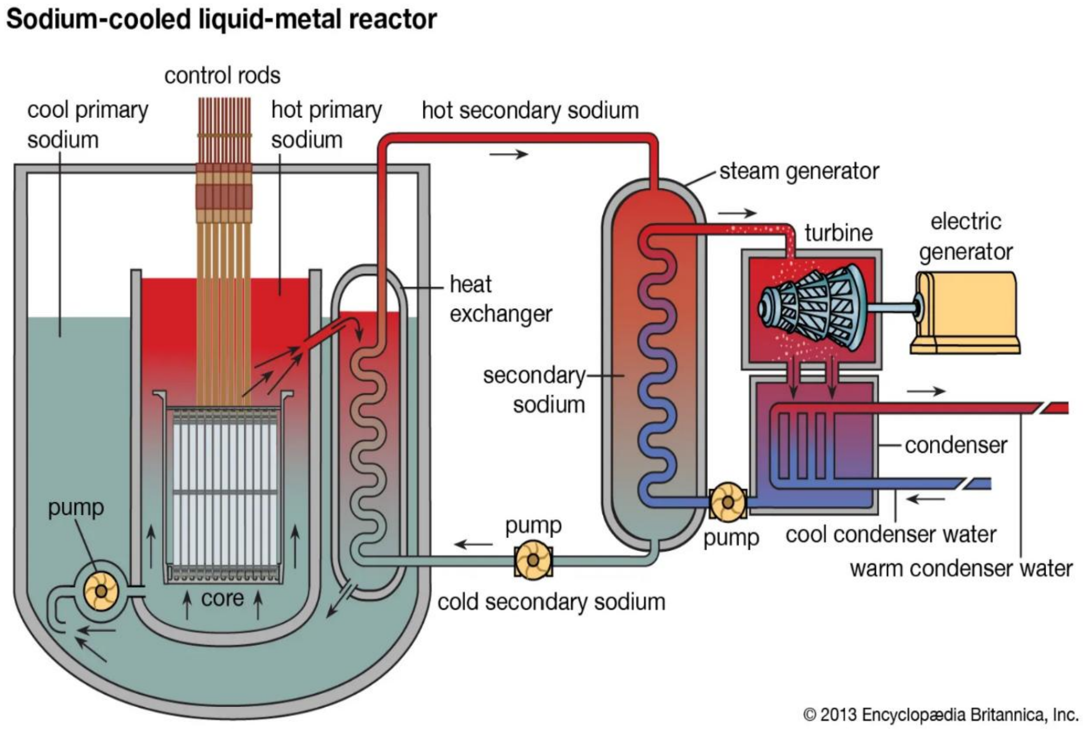
Hydrogen, Ammonia and Synthetic Fuel Production

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.

27. 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.

28. 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.

28.1. 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.

29. 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.

30. 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.

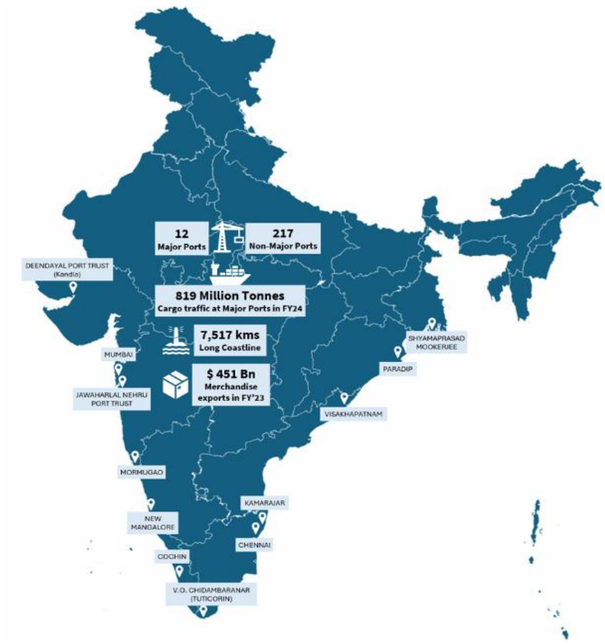


Figure 1 Ports of India

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.

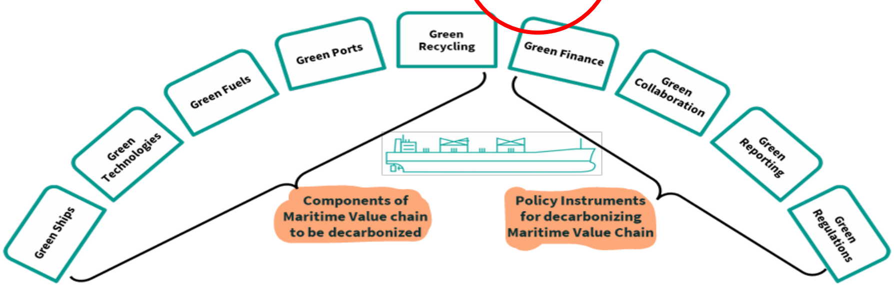


Figure 2 Core areas of NGSP

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 CO_2 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."

30.1. 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.

30.2. 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

30.3. 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

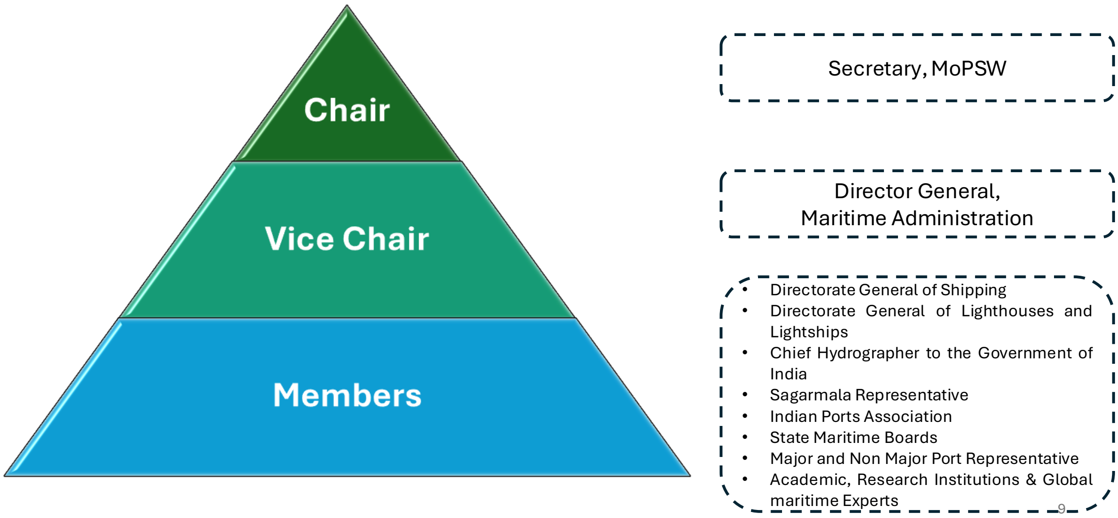
The central argument of the concept note is that India presently has policy intent, individual initiatives and broad sustainability ambitions, but does not yet have a unified national framework that can consistently assess readiness, compare port performance and link sustainability with compliance, investment 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.

30.4. 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.

31. 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.

32. 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.

33. Sagar Aankalan - National Benchmarking Guidelines for Mapping Logistics Performance of Indian Ports

India's ports are critical nodes in the national logistics network, connecting maritime trade with road, rail, inland waterways, industrial clusters and hinterland markets. Port competitiveness depends not only on installed capacity and cargo volumes but also on the speed, reliability and efficiency with which vessels and cargo are handled.

To establish a uniform national framework for assessing these aspects, the Ministry of Ports, Shipping and Waterways issued the **"Sagar Aankalan – National Benchmarking**

Guidelines for Mapping Logistics Performance of Indian Ports" in February 2024. The Guidelines provide a standard methodology for evaluating and comparing the logistics performance of Indian ports through the **Logistics Port Performance Index (LPPI)**.

The framework is aligned with the **PM Gati Shakti National Master Plan** and the **National Logistics Policy**, which emphasise integrated logistics planning, improved productivity and competitive service delivery. It seeks to move port-performance assessment beyond individual statistics by combining operational efficiency, cargo productivity, user experience and renewable-energy utilisation within a common benchmarking framework.

Objectives and Applicability

Sagar Aankalan has three principal objectives:

- assessing the logistics performance of Indian ports through operational performance-based inter-port comparison;
- improving the efficiency, competitiveness and overall performance of ports; and
- aligning national evaluation and assessment procedures with globally recognised norms, standards and definitions.

The Guidelines apply to all Indian ports, including major and non-major ports, notified under the Indian Ports Act, 1908, as referred to in the document. Ports are assessed under two categories:

1. **Bulk Cargo**, including dry and liquid bulk; and
2. **Container Cargo**.

The assessment is to be conducted annually in April for the preceding financial year. The separate categorisation recognises that bulk and container ports have different operational characteristics. Container-port assessment therefore includes container dwell time as an additional indicator, while bulk-port assessment places comparatively greater weight on vessel turnaround time.

Logistics Port Performance Index

The LPPI is a composite index derived through a multi-criteria evaluation methodology using both quantitative operational data and qualitative stakeholder feedback.

It assesses port performance across the following broad dimensions:

- cargo throughput;
- vessel and berth efficiency;
- cargo evacuation efficiency;

- quality of services provided to users; and
- share of renewable energy in total energy consumption.

The index does not rank ports solely on the basis of cargo handled. A port handling high cargo volumes may still perform poorly in vessel turnaround, berth productivity or customer satisfaction. Conversely, a smaller port may demonstrate efficient operations and significant year-on-year improvement. The LPPI seeks to capture these differences through weighted indicators.

Key Performance Indicators

Customer Satisfaction

Customer Satisfaction carries a weightage of **20 per cent** in both the bulk and container categories, making it one of the two highest-weighted indicators.

It is evaluated through a survey of port users, shipping lines, exporters, importers, logistics service providers, industry representatives, regulatory bodies and other stakeholders. Responses are rated on a scale of 1 to 5, ranging from Poor to Excellent.

The survey covers:

- logistics tracking and punctuality;
- quality-price ratio;
- communication and professional conduct of staff;
- safety and security of cargo handling;
- quality of services and technical support;
- after-sales service;
- reliability of operations and management;
- accuracy of invoices and documentation;
- port infrastructure, including berths, yards, warehouses and hinterland connectivity; and
- digital infrastructure.

The indicator ensures that performance assessment includes service reliability, stakeholder experience and institutional responsiveness, rather than relying only on physical operational data.

Cargo Handled

Cargo Handled carries a weightage of **20 per cent** in both categories. It comprises the aggregate cargo loaded, unloaded and transshipped during the financial year.

It represents the scale of port activity but is balanced by efficiency and service-quality indicators so that larger cargo volumes alone do not determine the final ranking.

Idle Time at Berth

Idle Time at Berth is the total idle time spent by cargo vessels at berth, expressed as a percentage of the total time spent at berth. It carries a weightage of **10 per cent** in both categories.

Idle time represents periods during which a vessel occupies a berth but productive cargo operations are not taking place. It is treated as a negative-impact indicator, meaning that a lower value represents better performance.

Average Turnaround Time

Average Turnaround Time represents the total period spent by a vessel at the port from arrival at the reporting station to departure for its onward journey. It includes pre-berthing delay, cargo-operation time and idle time. Certain delays arising from litigation, fire, repair, dry-docking or dismantling-related decisions may be deducted.

It carries a weightage of:

- **15 per cent** for Bulk Cargo Ports; and
- **7 per cent** for Container Ports.

A lower turnaround time reflects more efficient vessel movement and port operations.

Average Pre-Berthing Waiting Time

Average Pre-Berthing Waiting Time is the period from a vessel's arrival at the anchorage or reporting station until it is berthed at an operational berth.

It carries a weightage of **10 per cent** in both categories and is treated as a negative-impact indicator. Lower waiting time indicates better berth planning, vessel scheduling and marine-service coordination.

Average Ship Berth-Day Output

Average Ship Berth-Day Output is calculated by dividing the aggregate cargo handled by the total number of berth-days spent by cargo ships during the financial year.

It measures berth productivity and carries a weightage of **15 per cent** in both categories. A higher output indicates more efficient use of berth time, cargo-handling equipment and terminal resources.

Average Container Dwell Time

Average Container Dwell Time applies only to the Container Cargo Category and carries a weightage of **8 per cent**.

For imports, it is the time spent by a container inside the port before it is gated out. For exports, it is the time spent inside the port before being loaded onto a vessel. The Guidelines prescribe a calculation combining the respective shares and dwell times of import and export containers.

A lower dwell time supports faster cargo movement, reduced congestion and better utilisation of storage and terminal infrastructure.

Share of Renewable Energy

Share of Renewable Energy carries a weightage of **10 per cent** in both categories. It is calculated as the ratio of renewable-energy consumption to total energy consumption.

The calculation must include energy consumed at terminals and berths operated through PPP or captive arrangements. This ensures that the indicator captures the wider operational energy footprint of the port and not only consumption directly controlled by the port authority.

A higher renewable-energy share contributes positively to the LPPI score.

KPI Weightage Structure

KPI	Bulk Cargo	Container Cargo	Impact
Customer Satisfaction	20%	20%	Positive
Cargo Handled	20%	20%	Positive
Idle Time at Berth	10%	10%	Negative
Average Turnaround Time	15%	7%	Negative
Average Container Dwell Time	—	8%	Negative
Average Pre-Berthing Waiting Time	10%	10%	Negative
Average Ship Berth-Day Output	15%	15%	Positive
Share of Renewable Energy	10%	10%	Positive

Positive-impact indicators are those where a higher value represents better performance. Negative-impact indicators are those where a lower value represents better performance.

Absolute Performance and Incremental Improvement

A significant feature of Sagar Aankalan is that most operational KPIs are evaluated on the basis of both present performance and improvement over time.

For all indicators other than Customer Satisfaction and Share of Renewable Energy:

- 50 per cent of the respective KPI weight applies to absolute performance; and
- 50 per cent applies to year-on-year incremental improvement.

This approach prevents the assessment from favouring only ports with historically large capacity or traffic. It recognises ports that achieve measurable improvements in turnaround time, waiting time, berth productivity, cargo handling and other operational parameters.

Customer Satisfaction and Share of Renewable Energy are assessed entirely on absolute performance.

Evaluation Methodology

The LPPI is derived through a seven-step multi-criteria evaluation process.

First, an evaluation matrix is created in which ports constitute the alternatives and the applicable KPIs constitute the criteria.

Second, the performance values are normalised between 0 and 1. Normalisation is necessary because the KPIs are measured in different units, such as tonnes, TEUs, hours, percentages and survey ratings.

Third, each normalised value is multiplied by its prescribed weight to create a weighted decision matrix.

Fourth, the best and worst performance values are identified for each KPI. For a positive-impact indicator, the highest value generally represents the best alternative. For a negative-impact indicator, the lowest value represents the best alternative.

Fifth, the Euclidean distance of each port from the best and worst alternatives is calculated.

Sixth, an evaluation score is generated based on the port's relative proximity to the best-performing alternative and its distance from the worst-performing alternative.

Finally, ports are ranked in descending order according to their scores within the applicable Bulk Cargo or Container Cargo category.

Strategic Significance

Sagar Aankalan creates a common performance language for Indian ports. It shifts the focus from reporting isolated statistics towards an integrated assessment of logistics performance.

The framework can support:

- identification of operational bottlenecks;

- reduction of vessel waiting and turnaround time;
- improvement in berth productivity;
- reduction in container dwell time;
- better utilisation of existing port infrastructure;
- stronger customer service and digital systems;
- greater transparency and comparability of performance; and
- increased adoption of renewable energy.

The year-on-year improvement component encourages continuous performance enhancement, while the Customer Satisfaction indicator ensures that the experience of port users remains central to the assessment.

Sustainability Dimension

Sagar Aankalan is primarily a logistics and operational benchmarking framework. Its principal focus is on vessel efficiency, cargo movement, berth productivity and service quality.

The inclusion of Share of Renewable Energy introduces a sustainability dimension. However, the present Guidelines do not separately assess greenhouse gas emissions, air quality, water quality, waste management, shore power, alternative-fuel readiness or carbon intensity.

Accordingly, Sagar Aankalan should not be treated as a comprehensive green-port rating or environmental certification framework. It is a logistics performance index that incorporates renewable-energy utilisation as one of its indicators.

Implementation Considerations

Effective implementation requires ports to maintain reliable and consistent data on:

- cargo handled;
- vessel arrival, berthing and departure times;
- berth occupancy and idle time;
- berth-day output;
- container dwell time;
- total and renewable-energy consumption; and
- consumption at PPP and captive terminals.

Ports must also conduct the Customer Satisfaction Survey using a consistent stakeholder base and rating methodology.

The Guidelines establish the broad methodology but do not provide detailed provisions regarding independent data verification, minimum survey sample size, treatment of missing data or assessment of ports handling both bulk and container cargo. Such issues may require further clarification or implementation instructions from MoPSW.

The Guidelines provide for periodic review based on feedback and learning from the national benchmarking exercise. MoPSW also retains the power to interpret and clarify any ambiguity within the overall framework and spirit of the Guidelines.

Conclusion

Sagar Aankalan establishes a uniform, data-driven national framework for benchmarking the logistics performance of Indian ports through the Logistics Port Performance Index.

It combines cargo throughput, vessel efficiency, berth productivity, container evacuation, customer satisfaction and renewable-energy consumption within a weighted multi-criteria assessment. Its key strength lies in balancing absolute performance with year-on-year improvement, thereby recognising both established high-performing ports and ports demonstrating measurable progress.

Properly implemented, Sagar Aankalan can serve not merely as a ranking exercise but as a management and policy tool for identifying performance gaps, improving port operations, reducing logistics delays and strengthening the overall competitiveness of India’s maritime logistics ecosystem.

34. 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.

35. 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.

36. 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.

37. 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.

38. 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.

39. 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.

40. Ship Recycling – to lead globally

Ship recycling forms the terminal stage of a vessel's operational life and has historically been treated as a downstream industrial activity. However, in the present regulatory and sustainability environment, it has evolved into a strategically important maritime segment with implications for industrial policy, environmental governance and international compliance.

Ships typically operate for 25 to 30 years. At the end of this lifecycle, dismantling must be carried out in a manner that ensures safe handling of hazardous materials, recovery of recyclable components and minimal environmental impact. A modern ocean-going vessel contains large quantities of high-grade steel along with non-ferrous metals, machinery, electrical systems and reusable equipment. When dismantled under controlled conditions, a significant proportion of this material re-enters the industrial supply chain.

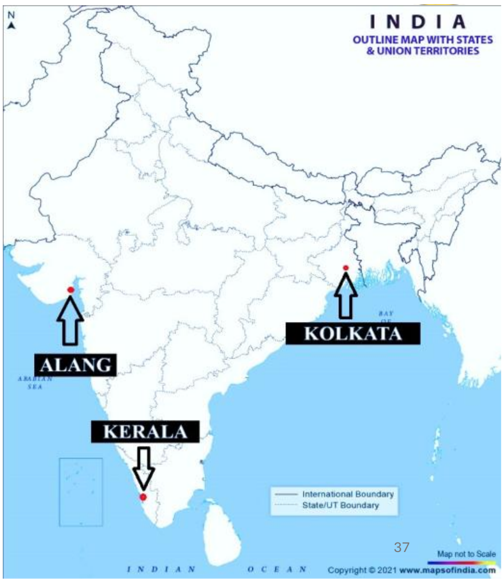
The global regulatory framework governing this activity changed materially with the entry into force of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships on 26 June 2025 .

Post-HKC, ship recycling is no longer a loosely regulated industrial activity; it is now a structured compliance-based system requiring lifecycle documentation, certification and facility authorisation.

India has aligned its domestic legal framework accordingly through the Recycling of Ships Act, 2019 and related Rules, positioning itself as an early mover in the post-HKC regime.

Yard	Total Number of Plots	Operational Plots	HKC Compliant yards
Alang, Bhavnagar (Gujarat)	150	128	115
Steel Industries Limited (Kerala)	1	1	0
Amar Iron Udyog, Kolkata (West Bengal)	1	1	0

Timeline	No of Vessels	Total LDT
March 1983 – March 2026	8956	71328850.09
FY 2025 - 2026	119	1087447.01



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.

40.1. 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.

40.2. 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.

40.3. 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.

40.4. Ship Recycling Credit Note

The **Ship Recycling Credit Note (SRCN)** is a strategic financial incentive mechanism introduced under the **Shipbuilding Financial Assistance Scheme (SBFAS) 2.0** to promote a **circular maritime economy in India**.

It aims to **link ship recycling with shipbuilding**, incentivising ship owners to:

- Recycle vessels in India (HKC-compliant yards)
- Reinvest in new shipbuilding within Indian shipyards

This initiative strengthens India's position as a **global hub for sustainable ship recycling and domestic shipbuilding**.

Policy Objective

The SRCN mechanism is designed to:

- Promote **safe and environmentally sound ship recycling** in India
- Encourage **domestic shipbuilding demand**
- Create a **closed-loop maritime ecosystem (Recycle → Build → Operate)**
- Support India's commitments under the **Hong Kong Convention (HKC)**
- Enhance **circular economy linkages (steel reuse and resource efficiency)**

Key Features of the Scheme

Credit Value

- Ship owner receives a **Credit Note equivalent to 40% of Fair Scrap Value (FSV)**
- FSV determined based on notified **price per LDT (quarterly basis)**

Validity

- Credit Note valid for **3 years from date of scrapping completion**

Redemption Limit

- Redeemable amount is the **lower of**:
    - Credit Note value
    - **5% of Fair Price of new vessel**

Mode of Benefit

- Redeemed as **financial assistance/subsidy**
- Paid directly to **Indian shipyard constructing the vessel**

Eligibility Criteria

Vessel Eligibility

- Indian or foreign-flagged vessels
- Must be scrapped in **India**
- Recycling yard must be:
    - **HKC-compliant**
    - Certified by recognised organisations / State Maritime Boards

Regulatory Conditions

- Permission for recycling issued **on or after 24 September 2025**
- Mandatory:
    - Certificate of Recycling / Demolition Completion
    - Approval from State Maritime Board / State Government

Operational Mechanism

Step 1: Recycling

- Vessel scrapped in certified Indian recycling yard

Step 2: Application

- Ship owner applies via **designated online portal**
- Submission within **3 months of scrapping completion**

Step 3: Verification

- Competent Authority verifies:
    - Vessel details
    - Scrapping proof
    - Compliance documentation

Step 4: Credit Note Issuance

- Digital SRCN issued with:
    - Unique serial number
    - Credit value
    - Validity period
    - Vessel details

Step 5: Redemption

- Used for:
    - New vessel construction in Indian shipyard
- Redemption allowed:
    - After vessel launch
    - Before final subsidy tranche is released

Flexibility & Market Features

Transferability

- SRCN can be:
    - **Sold or transferred** to another entity
- Executed through:
    - Online portal
    - Legally documented transfer agreement
- Pricing:
    - **Market-driven**

Stacking Mechanism

- Multiple SRCNs can be combined
- Applicable to:

- Single vessel
- Series shipbuilding orders

- Subject to:
  - **5% cap on vessel value**

Partial Utilisation

- Unused balance remains valid within original timeline

Risk & Compliance Safeguards

- Mandatory:
  - Digital tracking via portal
  - Documentation verification
- Security:
  - Redemption backed by **security instruments**
- In case of:
  - Cancellation → refund with **9% interest**
  - Non-utilisation → expiry after 3 years
- Ensures:
  - Transparency
  - Accountability
  - Financial discipline

Financial Outlay

- Allocated under SBFAS: **₹ 4,001 crore**

This allocation supports both:

- Shipbuilding incentives
- Ship recycling-linked credit mechanism

Strategic Impact

For Ship Recycling Sector

- Boosts demand for **HKC-compliant recycling yards (Alang ecosystem)**
- Encourages **formalisation and compliance**

For Shipbuilding Sector

- Generates **direct order pipeline**
- Improves utilisation of Indian shipyards

For Maritime Economy

- Strengthens **circular economy (steel reuse → shipbuilding)**
- Reduces dependency on imports
- Enhances domestic value creation

For Global Positioning

- Positions India as:
  - **Leader in sustainable ship recycling**
  - Emerging hub for **green shipbuilding ecosystem**

Key Challenges

- Awareness among global ship owners
- Price competitiveness vs international yards
- Efficient digital implementation and tracking
- Alignment with financing and leasing ecosystem

40.5. Green Steel

- "Green Steel" is defined by its CO_2 emission intensity — less than 2.2 tonnes CO_2 emission per tonne of finished steel (tfs).
- Greenness is expressed as a percentage reduction below the threshold of 2.2 2.2 tonnes CO_2 emission per tonne of finished steel
- The certification done via NISST (National Institute of Secondary Steel Technology) under the Bureau of Energy Efficiency (BEE) Measurement, Reporting and Verification (MRV) methodology.

Star Rating System

- Five-Star: < 1.6 tCO_2e/tfs ★★★★★
- Four-Star: 1.6 – 2.0 tCO_2e/tfs ★★★★
- Three-Star: 2.0 – 2.2 tCO_2e/tfs ★★★
- > 2.2 tCO_2e/tfs → Not eligible for green rating (Threshold reviewed every 3 years)

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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.

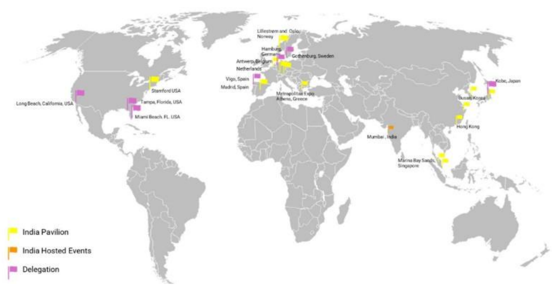
The emphasis going forward will be on maintaining documentation integrity, strengthening digital systems and ensuring that worker safety and environmental safeguards remain embedded in operations.

41. The India Pavillion

The India Pavillion

Showcasing India's Maritime Might at the International Stage

- Key Participation in Nor-Shipping (Norway), Posidonia (Greece), SMM Hamburg, Sea Asia- Singapore, Marintec China, Shanghai with target and host countries (like India-Norway
- Highlight the maritime partnership) and its growth under the Maritime Vision 2030 & MAKV-2047 initiative.
- Enhanced international visibility for Indian maritime companies and increased business opportunities.
- Strengthening of the Global partnerships, particularly in areas like green shipping.
- Increased collaboration with global maritime players in shipbuilding, port development, and marine technologies

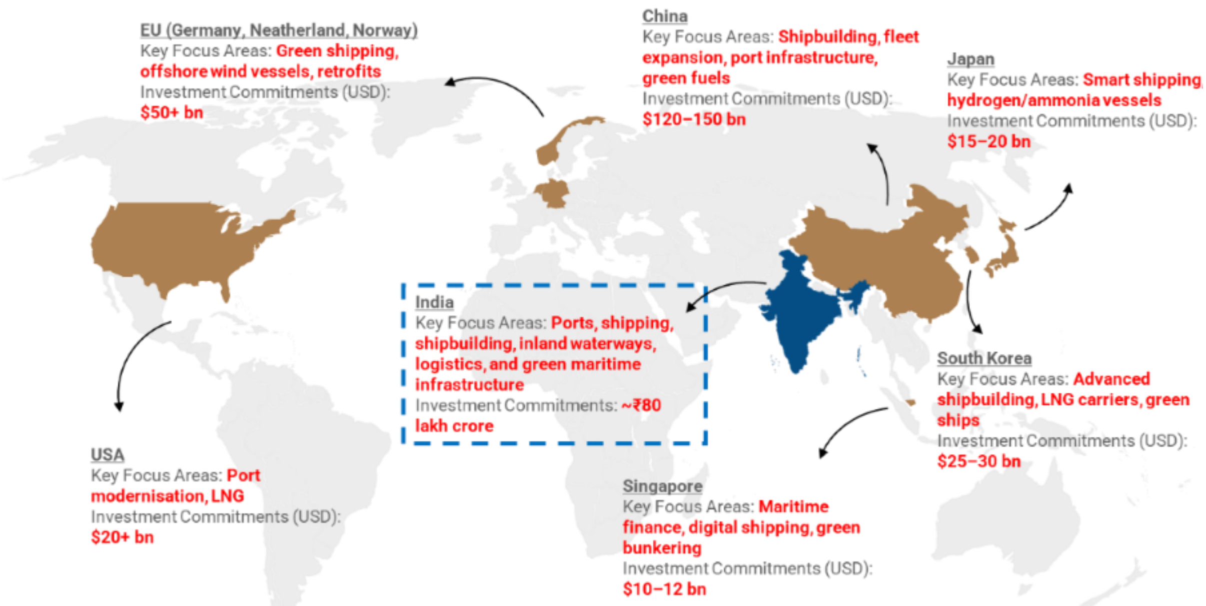


A. **Background and Strategic Context**

Global maritime nations have collectively committed over USD 300 billion in investment pipelines till 2030, focused on:

- Shipbuilding and fleet expansion
- Port modernization and logistics integration
- Sustainable energy transition (LNG, hydrogen, ammonia)
- Green shipping and decarbonisation
- Maritime finance and digitalisation

Countries such as China, Japan, South Korea, Singapore, the United States, and European maritime economies are aggressively positioning themselves at global maritime platforms to attract capital, shape regulation, and influence standards.



....**India** could be that **One-stop destination** with the potential of tapping into this Global investment through **Strategic Positioning and Unified Representation** at Global Maritime forums and events

India, meanwhile, has articulated a transformative maritime agenda through:

- Maritime India Vision (MIV) 2030
- Maritime Amrit Kaal Vision 2047
- Sagarmala Programme
- PM Gati Shakti National Master Plan

With an overall maritime investment ambition of approximately ₹80 lakh crore, India is entering a decisive growth phase in:

- Ports and logistics
- Shipbuilding and repair
- Ship recycling
- Tonnage augmentation
- Maritime finance
- Green shipping and energy transition

However, India's representation at global maritime forums remains fragmented across ministries, PSUs, ports, and private industry stakeholders. There exists a need to move from passive participation to strategic positioning and deal facilitation.

The Unified India Pavilion Strategy addresses this gap.

B. **What is the Unified India Pavilion Strategy?**

The Unified India Pavilion is not merely a country booth at international events. It is a **policy-driven, investment-oriented, diplomatically anchored platform** designed to present India as a single integrated maritime ecosystem.

C. Strategic Pillars / Themes envisaged for the **"Unified India Pavilion"**

P1: Maritime Safety & Ocean Accident Response

- **1,500+ Indian-owned vessels.**
- In 2024, **10 Collison incidents** were registered in Indian Waters
- Recent maritime accidents (e.g., container vessel accident near Kerala coast) highlight need for enhanced salvage, monitoring and pollution response systems.

Opportunity

- Marine safety technology partnerships (AI monitoring, vessel tracking).
- Oil spill containment cooperation.
- Salvage and emergency-response MoUs

Benchmark

- Leading maritime administrations such as Singapore (MPA), United Kingdom (MCA), Norway, and Japan maintain advanced maritime safety frameworks - Low vessel detention rates, Real-time vessel monitoring systems, Integrated accident investigation frameworks

Government Targets

- Strengthen Port State Control performance ranking.
- Improve marine casualty response time and inter-agency coordination.
- Digitise inspection and monitoring systems under maritime reform initiatives.

P2: Augmentation of Indian Shipbuilding Capability and Capacity

- Gross tonnage of ships built in India:**27,000 GT.**
- Globally, India ranks **21th in ship building**
- Annual Tonnage Produced **- 30,000 GT**
- Total Number of Shipyards **– 53 Nos**

Opportunity

- Showcase Make-in-India ship types (shortsea, ferries, LNG/green vessels),
- Shipyard modernization PPPs
- Platform for different Ship Building Companies (Mazagon Dock Shipbuilders (MDSL), Cochin Shipyard (CSL), and Garden Reach Shipbuilders & Engineers (GRSE)

Investment Required

INR 3 Lakhs – 3.5 Lakh Cr.

Benchmark

- Global ship building market is estimated ton be approx. USD 70 Billion
- China, South Korea, Japan dominate with 89% of global commercial ships

Government Targets

- Improve Gross tonnage of ships built in India to 0.6 Mn GT by 2030
- Improve the Ranking from 21st to top 10 ship building & repairs (aligns with target by MIV 2030).
- Employment Generation of 20+ Lakhs

P3: India as the powerhouse of Maritime Human Capital

- India is among the top global suppliers of seafarers with **30,800 total in 2024 with 2% of women seafarers**
- India currently contributes to **10-12% of world seafarers**
- **17% Growth Rate** from 2017 - 2020

Opportunity

- Run accredited DGS/IMO training labs at Pavilion, launch scholarship & twinning programmes with WMU/IMO, promote Indian seafarer certification services and training exports.

Benchmark

- Norway / Singapore / Philippines focus on high-end maritime R&D + shipping management,
- UK/Norway lead in maritime finance & managerial roles.

Government Targets

- Increase share of Indian seafarers in managerial/officer roles from ~10% to 20% by 2030 (aligns with target by MIV 2030).

P4: Training of Seafarers (Sagar Mein Yog & Sagar Mein Samman)

- India currently contributes to **10-12% of world seafarers**
- Strong DG Shipping approved training ecosystem
- **Sagar Mein Yog** – Seafarer wellness initiative.
- **Sagar Mein Samman** – Dignity and recognition framework.

Opportunity

- Launch global maritime skill alliance.
- MoUs with WMU / IMO for advanced leadership programmes.
- Promote Indian seafarer certification and training exports.
- Position India as Global South maritime skill anchor.

Benchmark

- Philippines (volume supplier),
- Norway / Singapore (management & R&D leadership),
- UK (maritime governance & certification leadership).

Government Targets

- Expand India as a global maritime training export hub under Maritime India Vision (MIV) 2030.

P5: Maritime Sustainability & Pollution Management

- India is a signatory to **MARPOL Convention**
- **Indian Coast Guard** acts as the nodal authority for **marine pollution response**, supported by **DG Shipping and port authorities**.
- India has developed **National Oil Spill Disaster Contingency Plan (NOSDCP)** for responding to marine pollution incidents.

Opportunity

- Promote India as a responsible maritime nation committed to clean oceans and pollution prevention
- Showcase India's institutional frameworks such as NOSDCP and Coast Guard pollution response capabilities.

Benchmark

- Norway, Singapore, and EU maritime administrations maintain advanced systems for: Real-time marine pollution monitoring, Rapid oil spill response mechanisms, Integrated maritime environmental protection frameworks, Strict enforcement of MARPOL compliance

Government Targets

- Expand oil spill response infrastructure and coastal monitoring systems
- Ensure full compliance with MARPOL pollution prevention standards
- Enhance port waste reception facilities and promote environmentally responsible maritime practices

P6: Coastal Shipping & Multimodal Logistics

- India currently operates around **50+ notified coastal shipping routes / services**
- Transports **~110–130 million tonnes of cargo annually** and **~2 million passengers annually**
- Routes connect **major industrial clusters and ports** such as Kandla, Mumbai, Goa, Kochi, Chennai, Visakhapatnam, Paradip and Kolkata.

Opportunity

- Pavilion shall showcase Investment in coastal vessel construction, Technology for short-sea & Ro-Ro vessels, Digital cargo aggregation partnerships, Promote coastal economic zones.
- Showcase opportunities under Sagarmala and coastal economic zones to attract logistics and shipping investments.

Benchmark

- European Union promotes short-sea shipping as a key sustainable transport mode.
- Japan maintains efficient coastal cargo transport networks linking major industrial regions.

Government Targets

- Increase coastal cargo share significantly under Sagarmala.
- Reduce logistics cost from ~13–14% of GDP toward global benchmark
- Improve multimodal connectivity under PM Gati Shakti.
- Promote coastal Ro-Ro / Ro-Pax vessel deployment.

D. Case in Point | Indicative Unified Pavilion Strategy for **Singapore Maritime Week 2026**

Singapore Maritime Week (SMW) is one of the **largest maritime gatherings in Asia**, organised annually by the Maritime and Port Authority of Singapore (MPA). It brings together global maritime leaders, policymakers, shipping companies, ports, and technology firms to discuss the future of shipping, ports, and ocean industries.

The **Singapore Maritime Week (SMW)** provides an important platform for India to engage with global maritime stakeholders, policymakers, and industry leaders from across the Asia-Pacific region. Participation in the event through a coordinated India Pavilion and targeted engagements enables India to showcase its maritime initiatives, strengthen international partnerships, and promote opportunities in shipping, ports, maritime training, and sustainable ocean practices.

The following table outlines the **key maritime activities proposed for India's participation during Singapore Maritime Week, along with their objectives and the responsible institutions leading these engagements.**

Maritime Activity	Description	Responsible Institution(s)
India Pavilion at Singapore Maritime Week	Establish a unified India Pavilion showcasing Maritime India Vision 2030, Indian ports, shipbuilding, ship recycling, coastal shipping, and maritime training initiatives to attract investment and partnerships.	Ministry of Ports, Shipping & Waterways (MoPSW), Directorate General of Shipping (DGS), Major Port Authorities

India–Singapore Maritime Leadership Roundtable	High-level dialogue with Singapore maritime authorities, global shipping companies, and investors to explore cooperation in port development, green shipping, and maritime logistics.	MoPSW, Maritime and Port Authority of Singapore (MPA), High Commission of India in Singapore
Maritime Safety & Pollution Control Dialogue	Technical session on maritime safety frameworks, accident response mechanisms, and marine pollution management to promote cooperation in safe shipping practices and environmental protection.	Directorate General of Shipping (DGS), Indian Coast Guard, Maritime and Port Authority of Singapore
Seafarer Training & Welfare Showcase	Promote India's maritime human capital initiatives including Sagar Mein Yog and Sagar Mein Samman, highlighting India's training ecosystem and seafarer welfare programmes.	Directorate General of Shipping (DGS), Indian Maritime University (IMU)
Coastal Shipping & Logistics Collaboration Meeting	Promote India's coastal shipping opportunities under Sagarmala and PM Gati Shakti to attract technology and logistics partnerships for short-sea shipping and multimodal transport.	Sagarmala Development Company Ltd., Major Port Authorities, Ministry of Ports, Shipping & Waterways
Green Shipping & Energy Transition Dialogue	Discussion with global stakeholders on green corridors, alternative fuels, and decarbonization of shipping to align India with global maritime sustainability goals.	MoPSW, Directorate General of Shipping, Port Authorities
India Maritime Networking Reception	Networking event hosted by the High Commission of India bringing together global maritime leaders, shipping companies, investors, and policymakers to strengthen India's maritime partnerships.	High Commission of India in Singapore, MoPSW, DGS
B2B Meetings with Global Maritime Companies	Pre-arranged meetings between Indian maritime stakeholders and international shipping companies, shipbuilders, and technology providers to explore collaboration opportunities.	MoPSW, Directorate General of Shipping, Industry Associations

E. **Funding model** for the "Unified India Pavilion"

Ministry of Ports, Shipping & Waterways
Government of India

Base Corpus – MoPSW's budget for Unified India Pavilion

Indicative costing for setting up a pavilion of approximately 100 sq.m = **INR 45 Lakhs / pavilion**

Cost may vary depending on the event organizer and the provisions

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Additional Funding – From the Investment Promotion budget of All major ports, PSUs (SCI, DCI, IMU etc.), Regulatory bodies (IPA, DGS, DGLL etc.)

The contribution from these agencies may be specific to a specific event / geography

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Additional Funding – From Private Maritime Sector Players

- *The contribution from these agencies may be specific to a specific event / geography*
- *Within the India Pavilion, designated portions can be rented out to Private players for showcasing expertise and experience*
- *Also may support in On-ground coordination*

Note: This funding model has been proposed benchmarking with Indian participation in other Global events like World Economic Forum, G20 etc.

F. **Targeted Outcomes** through the Unified India Pavilion

The strategy aims to deliver measurable outcomes:

Diplomatic Outcomes

- India recognized as maritime influencer
- Pavilion as Global South convening platform

Institutional Outcomes

- Unified maritime narrative
- Increased Indian leadership in global institutions

Investment Outcomes

- USD 10–20 billion annual maritime investment pipeline
- 5–10 shipbuilding/acquisition deals per year
- 20–30% increase in recycling contracts

Industry Outcomes

- Technology transfer partnerships
- Greater visibility for Indian ports and shipyards
- Maritime finance tie-ups