पृथ्वी विज्ञान मंत्रालय
MINISTRY OF EARTH SCIENCES
सत्यमेव जयते

Transforming India's blue economy: Investment, innovation and sustainable growth

May 2025

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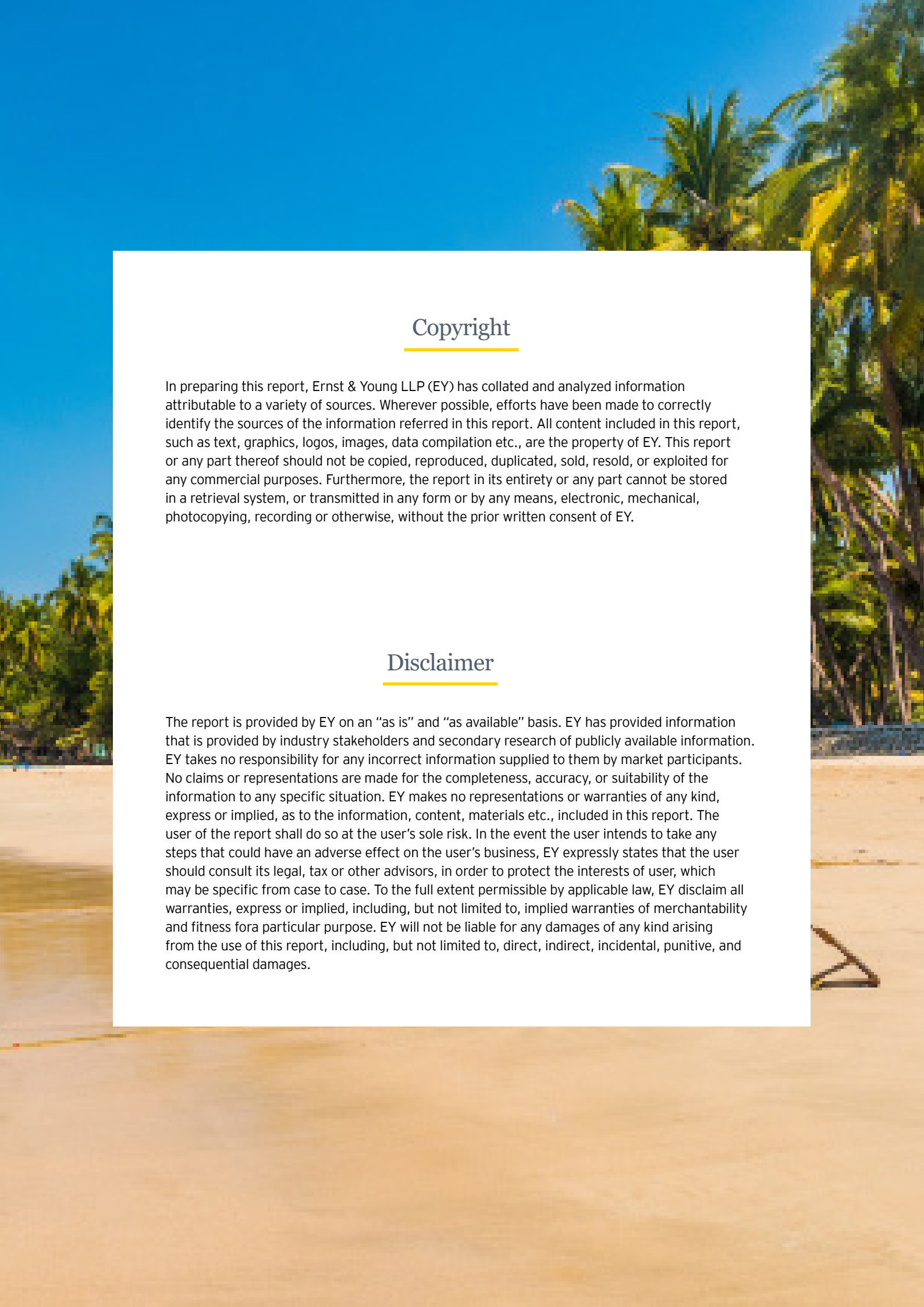

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डॉ. एम. रविचंद्रन
Dr. M. Ravichandran

सचिव
भारत सरकार
पृथ्वी विज्ञान मंत्रालय
पृथ्वी भवन, लोदी रोड़, नई दिल्ली–110003
SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF EARTH SCIENCES
PRITHVI BHAWAN, LODHI ROAD, NEW DELHI-110003

Foreword

India's Blue Economy is rapidly emerging as a potent engine for sustainable growth, unlocking immense potential to propel economic progress while safeguarding our precious marine ecosystems and empowering coastal communities. With its expansive maritime domain, strategic geographic positioning, and deep-seated cultural connections to the ocean, India stands uniquely poised to champion this vital frontier.

This report, "*Transforming India's blue economy: investment, innovation and sustainable growth*," underscores the inherent strengths and burgeoning opportunities that can firmly establish India as a global leader in ocean-based development. It meticulously examines the strategic pillars—spanning living and non-living resources and vital coastal infrastructure to groundbreaking innovation, mineral exploration, and transformative biotechnology—that collectively form the bedrock of India's ambitious Blue Economy vision.

India's robust scientific and technological prowess, coupled with an increasingly supportive policy landscape, is unlocking new horizons in critical areas such as deep-sea exploration, sustainable seaweed farming, cleaner shipping practices, and responsible fisheries management. These advancements, driven by collaborative endeavours across diverse sectors, are ensuring that growth within the maritime space is inclusive, resilient, and future-ready.

To fully realize this transformative potential, strategic and sustained investment will be paramount. Mobilizing capital for essential blue infrastructure, pioneering ocean innovation, and fostering sustainable marine industries is not merely an economic imperative—it is a fundamental necessity for the long-term well-being of our planet and its communities. Public-private partnerships, targeted financial mechanisms, and bolstered investor confidence in blue sectors must be actively cultivated to accelerate scalable solutions. The investments we make today will lay the enduring foundation for a thriving maritime economy tomorrow—one deeply rooted in equity, ecological integrity, and vibrant enterprise.

I extend my sincere appreciation to EY, our esteemed knowledge partner from the Ministry of Earth Sciences, for their invaluable contribution in producing this insightful report. I am confident that it will serve as a crucial reference point for all stakeholders actively engaged in shaping India's promising maritime future.

(M. Ravichandran)

Tel. : +91-11-24629771, 24629772 ❑ Fax : +91-11-24629777 ❑ E-mail : secretary@moes.gov.in

कमान्डर पी.के. श्रीवास्तव (Retd.)
सलाहकार/वैज्ञानिक 'जी'
Cdr. P.K. Srivastava (Retd.)
Advisor/Scientist 'G'

सत्यमेव जयते

पृथ्वी विज्ञान मंत्रालय
भारत सरकार
MINISTRY OF EARTH SCIENCES
GOVERNMENT OF INDIA

MESSAGE

India's Blue Economy represents a compelling convergence of scientific opportunity, strategic depth, and profound socio-economic relevance. As a scientist deeply immersed in the realms of oceanography, climate science, and marine technology, I view this sector not only as a powerful catalyst for sustainable development but also as a dynamic frontier for innovation-driven transformation.

The blue economy is a dynamic and interconnected realm, demanding a unified, whole-of government approach. Ministries spanning Earth Sciences, Fisheries, Shipping, Renewable Energy, Environment, and Commerce must converge. Recognizing the ocean as a shared global resources and responsibility, we must prioritize the needs of our coastal populations, whose livelihoods and cultural identities are deeply intertwined with marine ecosystems.

The Ministry of Earth Sciences has consistently been at the forefront of nurturing these advancements through pivotal initiatives such as the ambitious Deep Ocean Mission, the development of cutting-edge marine sciences applications, and the seamless integration of earth system sciences for enhanced forecasting and proactive risk management. These sophisticated tools are not only deepening our fundamental understanding of the complex ocean systems but are also driving tangible applications across vital sectors including fisheries, renewable energy, biodiversity conservation, and enhanced disaster resilience.

"*Transforming India's blue economy: investment, innovation and sustainable growth,*" is a significant publication which provides a comprehensive and insightful overview of our nation's evolving maritime strengths. It meticulously captures fundamental scientific and technological advancements that are shaping our national approach and provides insight into the challenges and opportunities in key sectors of blue economy through a study approach. This white paper also underscores India's strategic shift towards impactful interdisciplinary collaboration—effectively uniting leading ocean scientists, astute economists, skilled engineers, and visionary policy experts to forge actionable pathways towards a truly sustainable Blue Economy. The sector's inherent ability to significantly contribute to critical national priorities such as enhanced climate resilience, robust food security, and thriving coastal livelihoods firmly establishes it as a pivotal domain for India's long-term development strategy.

This timely and exceptionally profound publication stands as an invaluable knowledge resource that will undoubtedly benefit researchers, pioneering industry leaders, and strategic policymakers actively engaged in unlocking the full potential of India's vast marine domain.

20/5/25

(P. K. Srivastava)

Room No. 216, Prithvi Bhawan, Lodhi Road, New Delhi-110 003
Tel : (O) +91-11-24669552 , ® 0120 4290927 M.:+91-9810777248
E-mail:srivastava.pks@gov.in

Foreword

Rakesh K Mishra
Partner, Business Consulting
GPS, EY LLP

India stands at a pivotal moment, poised to harness the immense potential of its blue economy. As this insightful publication, Transforming India's blue economy: Investment, innovation and sustainable growth, articulates, our nation's extensive coastline and strategic maritime location present a unique opportunity to drive long-term economic prosperity while championing environmental sustainability.

The dynamism within India's ocean-based sectors is truly remarkable. From the sustainable harvesting of the seas and the growth of aquaculture to the transformative possibilities of offshore renewable energy, the allure of coastal tourism, the frontiers of deep-sea exploration, and the innovation of marine biotechnology, the blue economy is rapidly diversifying and maturing. The significant surge in investor interest witnessed in 2024, particularly in areas like efficient seaweed farming, sustainable shipping, and resilient coastal infrastructure, underscores the growing recognition of this sector's strategic importance.

These advancements are not occurring in isolation. They are being catalyzed by forward-thinking policy frameworks, groundbreaking scientific discoveries, and a deepening global understanding of the critical need for ocean sustainability. Furthermore, the sophisticated evolution of ocean data systems, marine spatial planning, and climate risk modelling, powered by intelligent technologies, is revolutionizing how we understand, manage, and sustainably develop our precious marine resources.

At EY, our commitment to fostering sustainable ocean economies is deeply ingrained. Our extensive experience spans the crucial pillars of this evolving landscape, from responsible fisheries management and the modernization of maritime infrastructure to the development of sustainable coastal tourism and the advancement of offshore renewable energy. We have had the privilege of collaborating with governments, multilateral institutions, and private sector leaders, providing strategic guidance to shape integrated blue economy strategies, strengthen regulatory environments, and unlock impactful and responsible investments. This comprehensive, cross-sectoral perspective allows us to effectively bridge the realms of scientific understanding, strategic policy formulation, and vital capital deployment, ultimately driving meaningful and positive change.

It is with immense pride that we at EY have collaborated with the Ministry of Earth Sciences as knowledge partners on this vital initiative. We firmly believe that "Transforming India's blue economy: Investment, innovation and sustainable growth" will serve as an invaluable resource for policymakers, strategic investors, dedicated researchers, and pioneering entrepreneurs who are united in their commitment to shaping India's dynamic and sustainable ocean-led growth story. We hope this report inspires collaborative action and unlocks the full potential of India's blue economy for generations to come.

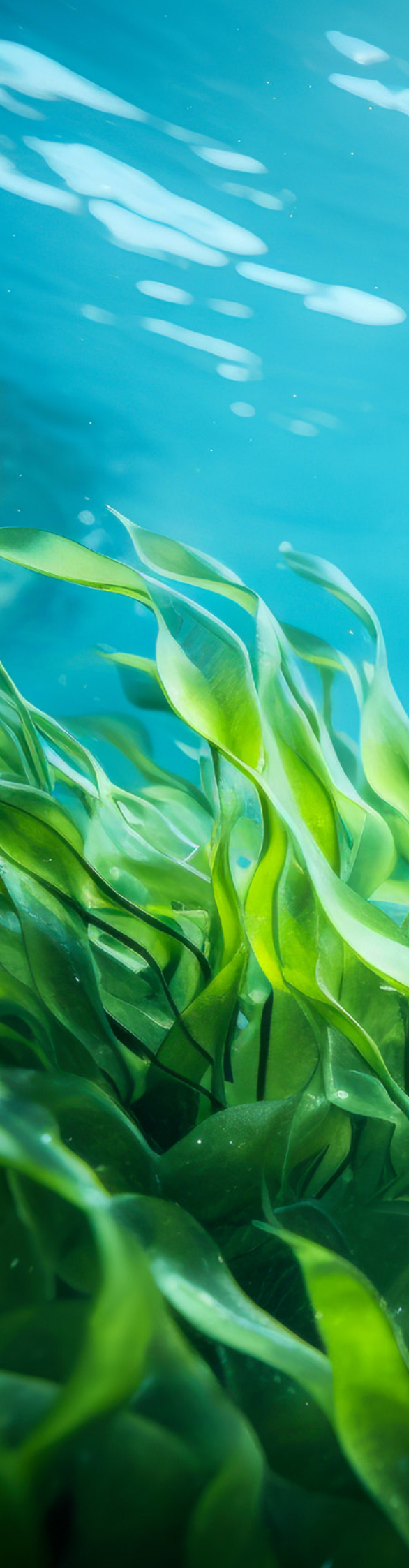
Foreword

Abhishek Gupta
Partner, Strategy and Transactions
GPS, EY LLP

India's blue economy is rapidly emerging as a cornerstone of sustainable economic growth and environmental preservation, creating significant opportunities across various ocean-based sectors. With its extensive coastline, strategic maritime positioning, and growing investments in marine science and technology, India is uniquely placed to lead in the global maritime landscape. Encompassing diverse, dynamic sectors, the scope of the blue economy is broadening rapidly with remarkable surge in interest from both domestic and international investors. This is primarily driven by enabling policies, groundbreaking scientific innovation, and a heightened global awareness of the need for ocean sustainability. Advancements in ocean data systems and AI driven tools, marine spatial planning, and climate risk modeling are further revolutionizing the management and development of marine resource.

This publication, Transforming India's blue economy: Investment, innovation and sustainable growth, offers invaluable insights into India's strategic capabilities and the opportunities that lie ahead for creating a competitive, sustainable and resilient maritime future. There is a need to move beyond the traditional investment and financing approach to leverage new and unique cross sectoral opportunities that are emerging—unlocking the massive untapped potential of the blue economy.

As a partner specializing in the blue economy, we have worked with governments, multilateral organizations, and private sector leaders to design and implement integrated blue economy strategies, improve regulatory frameworks, and unlock responsible investments for shaping sustainable and impactful ocean economies. Now, as knowledge partners to the Ministry of Earth Sciences, Government of India, we look forward to creating waves of impact as the blue economy, with its multiple growth avenues for enhanced GDP, exports and inclusive employment, plays a pivotal role in India progressively moving towards its target of a developed economy by 2047.



Executive summary

India's blue economy is rapidly ascending as a vital engine for national development, strategically leveraging the nation's extensive 11,098 km-coastline and a vast 2.4 million square km Exclusive Economic Zone (EEZ). The Ministry of Earth Sciences, as the nodal agency, defines it as "a subset of the national economy comprising the entire system of ocean resources and man-made economic infrastructure in marine, maritime, and onshore coastal zones within India's legal jurisdiction, aiding the production of goods and services, with clear linkages to economic growth, environmental sustainability and national security".

In addition to the Ministry of Earth Sciences, 24 ministries form an integral part of the blue economy including the Ministry of Ports, Shipping and Waterways; Ministry of Fisheries; and Ministry of Environment, Forest and Climate Change. These ministries are undertaking various initiatives such as the Blue Revolution (2020) for sustainable fisheries, the Deep Ocean Mission (2021) and various programs under the Maritime India Vision 2030. Multiple state level initiatives are also being undertaken by nine coastal states and four coastal union territories.

During India's G20 Presidency in 2023, world leaders committed to conserving, protecting, restoring and sustainably using the world's ocean and marine ecosystems, thereby mainstreaming the need to build a sustainable and resilient blue economy. The Chennai High Level Principles for Blue/ Ocean-based Economy were adopted at the G20 Environment and Climate Ministers meeting to promote sustainable growth of the blue economy. It is also recognized as a key focus pillar within India's Viksit Bharat vision for 2047. The vision of New India by 2030 lists the blue economy as one of 10 core growth areas, with a targeted US$100 billion blue economy, supported through the Deep Ocean Mission and enhanced ocean resource utilization.

The Biodiversity Beyond National Jurisdiction (BBNJ) Agreement, adopted in June 2023, is a landmark international treaty aimed at protecting marine biodiversity in areas beyond national borders through conservation, sustainable use, and equitable benefit-sharing of marine genetic resources. This aligns with India's commitments under the United Nations Convention on the Law of the Sea (UNCLOS) to promote sustainable ocean governance and marine conservation. The high seas treaty builds upon the Convention on the Law of the Sea, 1982, and the Convention on Biological Diversity, 1992, ratified by India on 29 June 1995 and 18 February 1994, respectively. Bilateral collaborations, including the Maritime Memorandum of Understanding (MoU) with France (2018) and the Task Force on MSP with Norway (2020)[1], further enhance research and sustainability. India's role is further strengthened by global partnerships such as the World Bank's PROBLUE program and the Asian Development Bank's Blue Bond guidelines (2022), positioning India as a regional leader in ocean governance.

While strong sectoral progress exists, there is a need for a unified and coordinated approach aligning government actions, cross sectoral synergies and greater investment. Multiple issues such as overfishing, pollution, and climate risks (e.g., rising sea levels) impact both ecosystems and livelihoods. Fragmented governance, poor coordination, lack of data sharing, low private investment, and technology gaps—especially in offshore wind and deep-sea exploration—limit progress. With multiple stakeholders and diverse, complex and inter-related initiatives underway, this report attempts to consolidate India's blue economy into a single framework—highlighting additionality, existing cross sectoral initiatives, impediments to further growth and development, and pragmatic interventions to truly unlock the full potential of the blue economy.

Case studies of potential, scalable and replicable models are also presented, including women-led seaweed farming in Odisha; smart port in Kochi; and green ship recycling and eco-tourism in the Andaman Islands—all of which demonstrate the potential to meet the twin objectives of economic growth and sustainable development.

While identifying the enablers to catapult growth in India's blue economy, the critical role of a robust investment strategy cannot be overestimated. The report not only covers potential sources of "blue finance"—such as blue bonds, blended finance, sovereign guarantees, and public-private partnerships but also offers detailed sub sector-wise opportunities to invest in a robust project pipeline.

A strategic investment roadmap to 2035, highlights short-, medium- and long-term priorities across sectors and systems while identify priority actions to:

1. Improve coordination between ministries and institutions

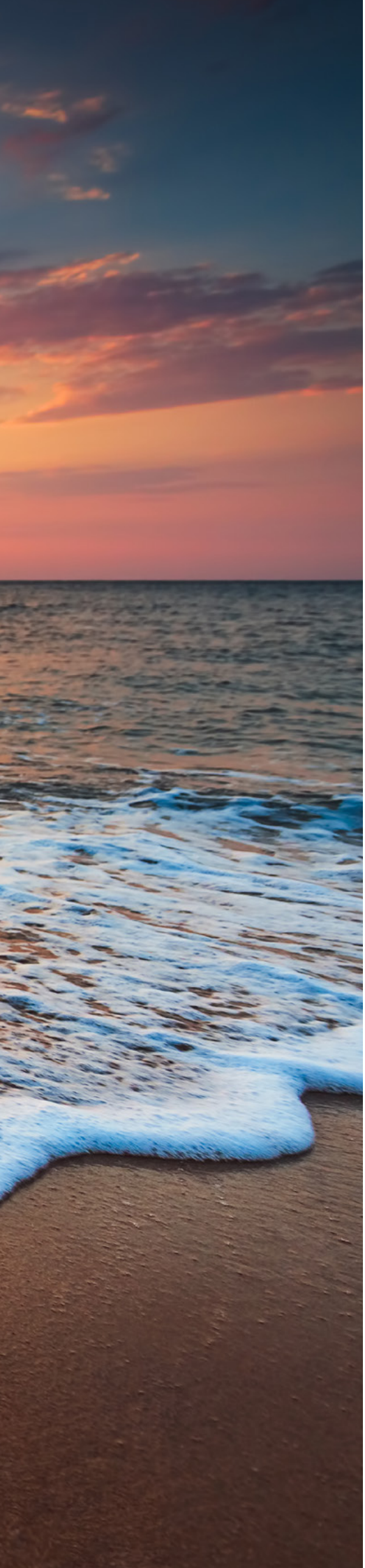
2. Attract more private and global investment

3. Scale successful and replicable state and local models

4. Ensure growth includes women, youth, and vulnerable groups

5. Strengthen India's global leadership in ocean governance

India's blue economy is more than just an opportunity—it is fundamental to achieving India's vision of becoming a developed nation by 2047. With strong leadership, a shared vision, and partnership across sectors, India can unlock its full ocean potential and create a sustainable, inclusive and resilient future.



CHAPTER 1

Understanding the blue economy

1.1 Blue economy: A paradigm for sustainable ocean management

The blue economy represents a transformative paradigm shift in managing ocean resources, moving decisively beyond traditional exploitation towards an integrated model that harmonizes sustainable economic growth with environmental stewardship and social equity. It stands in sharp contrast to conventional maritime activities by demanding a deliberate balance between economic development, ecosystem health, and inclusive livelihoods across a diverse spectrum of sectors. This holistic approach encompasses established industries, such as fisheries and shipping, alongside emerging fields such as marine renewable energy, biotechnology and coastal tourism—all fundamentally anchored in sustainable practices.

While a single, universally codified definition remains elusive, a strong consensus exists around the blue economy's core principles. The World Bank defines it as the "sustainable use of ocean resources for economic growth, improved livelihoods and jobs while preserving the health of the ocean ecosystem". The Asian Development Bank (ADB) emphasizes a "sustainable ocean economy that balances economic development with the health of marine and coastal ecosystems, supporting inclusive growth and resilience". The United Nations aligns the concept intrinsically with Sustainable Development Goal 14 (SDG 14), framing it as an approach to "conserve and sustainably use the oceans, seas, and marine resources for sustainable development". These influential perspectives collectively underscore the blue economy's unwavering commitment to sustainability, inclusivity and long-term ecological integrity.

In India, the blue economy is rapidly ascending as a vital engine for national development, strategically leveraging the nation's extensive 11,098 km coastline and a vast 2.4 million sq. km EEZ. The MoES, serving as the nodal agency[2], has drafted a Draft National Policy for blue economy defining it as "a subset of the national economy comprising the entire system of ocean resources and man-made economic infrastructure in marine, maritime and onshore coastal zones within India's legal jurisdiction, aiding the production of goods and services with clear linkages to economic growth, environmental sustainability and national security"[3]. This definition uniquely incorporates both natural assets and man-made infrastructure, explicitly linking economic and environmental goals with national security imperatives.

MoES coordinates a broad spectrum of activities, driving India's leadership in sustainable ocean governance. In addition to the MoES, 24 ministries are involved, including the Ministry of Ports, Shipping and Waterways; Ministry of Fisheries; and Ministry of Environment, Forest and Climate Change. These ministries are undertaking various initiatives, such as the Blue Revolution unveiled in 2020 on sustainable fisheries, the Deep Ocean Mission of 2021, and various initiatives under the Maritime India Vision 2030. Multiple state-level initiatives are also being undertaken by nine coastal states and four coastal union territories. During India's G20 Presidency in 2023, world leaders committed to conserving, protecting, restoring and sustainably using the world's oceans and marine ecosystems, thereby mainstreaming the need to build a sustainable and resilient blue economy. The Chennai High Level Principles for Blue/ Ocean-based Economy were adopted at the G20 Environment and Climate Ministers meeting for sustainable growth of the blue economy.

The blue economy is also recognized as a key focus pillar within India's vision of Viksit Bharat 2047. The vision of New India by 2030 lists the blue economy as one of ten core growth areas, with a targeted $100 billion blue economy through its Deep Ocean Mission and ocean resources. The Biodiversity Beyond National Jurisdiction Agreement (BBNJ), adopted in June 2023, is a landmark international treaty aimed at protecting marine biodiversity in areas beyond national borders through conservation, sustainable use, and equitable benefit-sharing of marine genetic resources. This aligns with India's commitments under the United Nations Convention on the Law of the Sea (UNCLOS) to promote sustainable ocean governance and marine conservation. The high seas treaty builds upon the Convention on Law of the Sea, 1982, and Convention on Biological Diversity, 1992, ratified by India on 29 June 1995 and 18 February 1994, respectively.

Bilateral collaborations, including the Maritime Memorandum of Understanding (MoU) with France (2018) and the Task Force on MSP with Norway (2020)[4]— further enhance research and sustainability. These efforts position India as a regional leader in ocean governance, strengthened by global partnerships such as the World Bank's PROBLUE program and the ADB's Blue Bond guidelines (2022).

1.2 Institutional framework and sectoral contributions

A complex yet crucial institutional framework underpins India's blue economy, involving multiple ministries, each contributing specialized oversight across specific sectors and mandates. The following table illustrates this multi-stakeholder architecture:

Table 1: Mapping central ministries to blue economy sectors and activities

S.no	Ministry/ Department	Mandate (blue economy)	Relevant sector/activity
1.	Ministry of Earth Sciences	Oceans research, marine technology development, advisory services	Marine biotechnology (research, technology) Minerals (exploration technology) Marine renewable energy (research, technology development) Marine manufacturing (technology development) Marine ICT (oceans research, advisory services), education and research (R&D) Marine construction (technology development)
2.	Ministry of Defence	Maritime security	Marine tourism and leisure (coastal security aspects)
3.	Ministry of Ports, Shipping and Waterways	Port infrastructure development	Marine manufacturing (ship repair/building) Shipping, port and maritime logistics (port infrastructure) Marine tourism and leisure (boating infrastructure/safety) Marine construction (port infrastructure)
4.	Department of Science and Technology	Research and academic capacity development	Marine biotechnology (research) Marine ICT (research links) Education and research (academic capacity development)
5.	Ministry of Skill Development and Entrepreneurship	Capacity building	Marine manufacturing Shipping, port and maritime logistics (training), Education and research (training)
6.	Ministry of Agriculture & Farmers Welfare	Coastline agriculture	Coastline agriculture
7.	Ministry of Rural Development	Improve coastal rural areas	Fishing (benefits for coastal rural areas)
8.	Ministry of Environment, Forest and Climate Change	Coastal conservation, pollution control	Fishing (conservation/pollution aspects) Carbon capture Marine biotechnology (regulation) Minerals (impact assessment) Marine renewable energy (impact assessment), Marine tourism and leisure (coastal reserves) Marine ICT (environmental consultancy)
9.	Ministry of Mines	Deep sea mining	Minerals (deep sea mining)
10.	Ministry of Housing & Urban Development	Develop urban coastal areas	Marine construction (urban coastal infrastructure)
11.	Ministry of Tribal Affairs	Support coastal tribal communities	Fishing (benefits for tribal communities)

S.no	Ministry/ Department	Mandate (blue economy)	Relevant sector/activity
12.	Ministry of Food Processing Industries	Processing and value addition of marine products	Fishing (seafood processing) Marine biotechnology (seaweed/bioproducts processing)
13.	Ministry of Home Affairs	Enhance coastal security	Marine tourism and leisure (coastal security)
14.	Ministry of Fisheries, Animal Husbandry and Dairying	Fisheries and aquaculture	Fishing (capture fishery, aquaculture) Marine manufacturing (aquaculture technology)
15.	Ministry of Tourism	Coastal and marine tourism	Marine tourism and leisure
16.	Ministry of New and Renewable Energy	Offshore wind and solar	Marine renewable energy (offshore wind)
17.	Ministry of Petroleum and Natural Gas	Offshore drilling and exploration	Minerals (offshore oil and gas)
18.	Ministry of External Affairs	Blue diplomacy	Blue diplomacy (International cooperation)
19.	Ministry of Finance	Blue finance	Shipping, port and maritime logistics (customs) Marine commerce (insurance, ship finance)
20.	Ministry of Commerce and Industry	Maritime trade and marine industries	Fishing (trade) Marine biotechnology (trade) Marine manufacturing (industries) Shipping, port and maritime logistics (trade), Marine construction (industries) Marine commerce (charterers)
21.	Ministry of Law and Justice	Coastal regulation, maritime laws	Marine commerce (legal services)
22.	Ministry of Information and Broadcasting	Awareness and promotion	Marine commerce (media, awareness)
23.	Ministry of Jal Shakti	Link inland waterways to seas	Desalination, inland waterways
24.	Ministry of Health and Family Welfare	Health and wellness of coastal communities	Well-being of coastal populations
25.	Ministry of Labor and Employment	Regulate labor practices, safety standards	Fishing (labor practices) Shipping, port and maritime logistics (safety standards)

This coordinated framework aims to integrate diverse sectors, ranging from traditional mainstays to cutting-edge fields. However, as the blue economy evolves, new domains such as marine robotics, blue carbon markets, and ocean-based climate technologies are emerging. These advancements will necessitate further adaptation and expansion of institutional structures to enable effective governance and sustainable progress

1.3 Essential tools for blue economy management

Effective stewardship of the blue economy hinges on the strategic deployment of sophisticated tools that balance economic pursuits with environmental protection and social priorities.

Marine Spatial Planning (MSP):

A foundational tool, MSP provides a public process for analyzing and allocating marine space across various human activities to achieve specified ecological, economic, and social objectives. It guides the allocation of marine areas to minimize conflicts and optimize resource use. Pilot projects in Puducherry and Lakshadweep, spearheaded by the National Centre for Coastal Research (NCCR) under MoES, are demonstrating MSP's potential to harmonize sectoral interests within the Indian context[5].

Integrated Coastal Zone Management (ICZM):

Complementing MSP, ICZM focuses on coordinating policies and actions across the critical coastal land–sea interface. It promotes sustainable coastal development by managing land–based impacts on marine ecosystems and addressing issues such pollution and habitat degradation[6].

Marine Protected Areas (MPAs):

MPAs are geographically defined areas vital for conserving biodiversity hotspots and critical habitats such as coral reefs and mangroves. They support sustainable fisheries by protecting nursery and spawning grounds and enhance overall ecosystem resilience. India's MPAs, including those in the Gulf of Mannar, reflect a strong commitment to marine conservation[7].

Ocean Observation Systems:

Robust, data-driven decision making depends on comprehensive monitoring networks, such as the ones that the Indian National Centre for Ocean Information Services (INCOIS) manages. These systems provide crucial real-time data on ocean conditions, weather patterns, and resource distribution, supporting fisheries management, hazard warnings (such as tsunami alerts), climate monitoring, and maritime safety[8].

Ocean Accounting:

Aligned with the System of Environmental–Economic Accounting (SEEA), frameworks are being developed to integrate environmental health metrics (e.g., fish stocks, habitat condition, pollution levels) with economic performance indicators. This holistic approach provides a more accurate assessment of sustainable wealth creation by accounting for natural capital alongside economic output. India's draft policy includes provisions for a National Accounting Framework for the blue economy.

Blue Carbon Valuation:

Recognizing and valuing the significant carbon sequestration capacity of coastal ecosystems such as mangroves and seagrasses (blue carbon habitats), and their crucial role in climate mitigation, is increasingly vital. Valuing these services links marine conservation directly to climate action goals and potentially opens avenues for carbon financing.

The integrated application of these diverse tools provides a robust framework for navigating the inherent complexities of the blue economy and guiding its growth toward outcomes that are equitable, resilient, and sustainable.

CHAPTER 2

India's blue economy imperatives: Priorities and progress

Increasingly recognized as a cornerstone of India's sustainable development, the blue economy leverages vast maritime assets to significantly contribute to economic growth, employment, and livelihoods through established sectors such as fisheries, shipping, port infrastructure and coastal tourism. India's blue economy is at a turning point, with a strong opportunity to drive sustainable growth while addressing climate change, resource stress and inequality. Achieving these goals necessitates a focus on expanding economic opportunities, environmental protection, fairness, maritime security and smart technology use. This aligns with government programs and international efforts such as SDG 14, the BBNJ Agreement, and the 30x30 target to build a strong, inclusive ocean economy and lead globally. The blue economy holds tremendous potential with relevance across various growth, development and sustainability related parameters, including:

Economic diversification imperative: Crucial economic diversification can be achieved through sectors such as fisheries, marine biotechnology, offshore renewables, coastal tourism and marine mining. Fisheries exports are significant and initiatives such as the establishment of fishing harbors and landing centers are supporting the sector. Coastal tourism, promoted under schemes such as Swadesh Darshan, attracts substantial domestic visitors and PPPs support tourism projects. The Deep Ocean Mission is exploring polymetallic nodules. NIOT has efforts underway to tap offshore wind and ocean thermal energy. Studies regarding blue bonds are also in progress to enhance economic resilience and global blue economy leadership.

Environmental sustainability imperative: Protecting the health and integrity of marine ecosystems is paramount for the long-term viability of the blue economy. Addressing challenges such as marine pollution (plastics, effluents), overfishing, and climate change impacts (sea-level rise,

ocean acidification, coral bleaching) is non-negotiable. Government initiatives, including the CRZ Notification, 2019[9], and the expansion of MPAs, aim to conserve critical habitats. Investing in blue carbon ecosystems (mangroves, seagrasses) and promoting green shipping technologies, supported by policies such as the Harit Sagar Guidelines, directly align with India's net-zero emissions target by 2070 and global sustainability standards.

Social equity imperative: Inclusive development lies at the heart of a just blue economy transition, particularly for the estimated 14 million coastal community members, including fishers, women and tribal groups[10]. Empowering these stakeholders through targeted skill development, improved access to credit (a focus of PM-MKSSY), and meaningful participation in decision-making processes ensures equitable distribution of benefits. Initiatives such as PMMSY and the Swadesh Darshan Scheme support livelihoods by modernizing fisheries infrastructure and promoting community-based tourism. Scaling these efforts to specifically include women-led enterprises and tribal cooperatives is essential for enhancing socio-economic resilience and addressing deep-seated gender and regional disparities.

Strategic and security imperative: India's extensive coastline and strategic location on vital global shipping lanes underscore the blue economy's critical role in national security and regional influence. Strengthening maritime presence through secure sea lanes, enhanced energy security (via offshore resources), and proactive blue diplomacy is vital. Coastal security programs led by the Ministry of Defence and the Ministry of Home Affairs, coupled with the Ministry of External Affairs' diplomatic initiatives (e.g., Indo-Pacific collaborations), enhance India's geopolitical standing. The Deep Ocean Mission further supports strategic resource exploration, aiming to ensure sovereignty over critical minerals and energy resources in the long term.

Technological innovation imperative: Innovation serves as the backbone of a future-ready blue economy, driving crucial advancements in marine biotechnology, offshore renewables, sustainable aquaculture and advanced ocean observation. The Deep Ocean Mission and the National Biotechnology Development Strategy are fostering research in areas such as deep-sea mining technologies, marine-derived pharmaceuticals, and AI-driven ocean monitoring. By strategically investing in Centres of Excellence, specialized incubators, and integrated digital platforms, India can accelerate technology adoption, reduce import dependency, and firmly establish itself as a global hub for blue innovation.

These imperatives are actively supported by a robust framework of government initiatives, as detailed in the matrix below. This matrix maps key programs and policies to each blue economy sector, highlighting their specific objectives, reported impacts, and clear alignment with overarching sustainable development goals. By effectively leveraging these initiatives and proactively addressing implementation gaps, India can build a blue economy that is economically vibrant, environmentally sustainable, and socially inclusive for generations to come.

Table 2: Sector-wise government initiatives and their impacts

Sector	Key government initiatives	Objectives	Key impacts (2023–24)	Alignment with strategic imperatives
Marine living resources	**PMMSY (INR20,050 crore, 2020–2025)[11]:** Promote sustainable fisheries and aquaculture **FIDF (INR7,522 crore)[12]:** Modernize landing centers and cold storage **National Fisheries Policy, 2020[13]:** Reduced post-harvest loss; Promote sustainable practices **Blue Revolution (INR3,000 crore)[14]:** Support seaweed farming and mariculture **CRZ Notification, 2019[15]:** Regulate fishing in sensitive areas	Enhance fish production and exports Reduce post-harvest losses Promote sustainable aquaculture/mariculture Conserve marine ecosystems	1,050 fish feed plants, 320 cage culture units established[16] 17.25 MMT (DoF, 2024) production[17] 85 fish landing centers sanctioned: losses reduced by 10% in targeted areas, 12 seaweed farms, 150 mariculture projects supported[18] 7,517 km coastal areas, conserving 20% mangrove habitats (MoEFCC, 2019) protected[19]	**Economic:** Exports Boost (INR60,104 crore), 1.2 lakh jobs [20 21] **Environmental:** Sustainable practices helped reduce overfishing (15% zones)[22] **Social:** Empowered 4.8 million fisherfolk (30% women beneficiaries)[23] **Innovation:** Advanced mariculture/seaweed tech
Maritime transport and shipping	**Sagarmala Programme (INR5.79 lakh crore)[24]:** Enhanced port-led development **Maritime India Vision 2030[25]:** Targets 2,500 MTPA capacity, green shipping **National Logistics Portal[26] (Marine) (2023):** Streamlining trade **Ship Building Financial Assistance Policy[27], 2016:** Subsidized Indian vessels **Harit Sagar Guidelines[28], 2023:** Promote green ports (60% RE by 2030)	Modernize port infrastructure Reduce logistics costs Promote domestic shipbuilding Transition to green shipping	Completed 155 projects, cargo capacity at 1,534 MTPA (MoPSW, 2024) Launched portal, reduced trade processing time 20% Subsidized 50 vessels, boosted domestic shipbuilding 5% 10% ports adopted RE, cut emissions 8% (MoPSW, 2023)[29]	**Economic:** Enhanced trade (INR18.2 lakh Crore exports)[30] **Environmental:** Reduced port emissions, aligning with IMO **Strategic:** Strengthened trade routes (95% trade volume) **Innovation:** Advanced digital logistics, green tech

Sector	Key government initiatives	Objectives	Key impacts (2023–24)	Alignment with strategic imperatives
Offshore renewable energy	**National Offshore Wind Energy Policy, 2015[31]:** MNRE nodal agency **VGF scheme (INR7,453 crore, 2024)[32]:** Supports 1 GW offshore wind **Strategy for Offshore Wind (Revised 2023)[33]:** Plans 30 GW by 2030 **Guidelines for Offshore Wind Assessment, 2018:** Standardizes data **Deep Ocean Mission OTEC Pilots[34]:** Targets 10 MW OTEC by 2027	Develop 30 GW offshore wind capacity Promote tidal/wave energy pilots Ensure data-driven planning Support clean energy goals	Deployed LiDAR off Gujarat (36 GW potential mapped)[35] Sanctioned 1 GW wind projects (target 3.72 billion units (kWh) annually)[36 37] Initiated OTEC pilots (advancing 10 MW capacity)[38] Standardized data for 10% EEZ renewable zones[39]	**Economic:** Foundation for INR15,000 crore renewable market **Environmental:** Supports net-zero 2070 goal **Strategic:** Enhances energy security **Innovation:** Pioneers floating wind, OTEC tech
Coastal tourism and heritage conservation	**Swadesh Darshan Scheme (INR1,200 crore, 2014–2024):** Develops coastal circuits[40] **PRASHAD Scheme (INR300 crore):** Upgrades heritage sites[41] **CRZ Notification, 2019:** Facilitates sustainable tourism **Iconic Tourist Sites Initiative, 2020:** Restores tourist sites **Sagarmala Programme (Cruise Tourism):** Develops 5 cruise terminals	Promote coastal/ heritage tourism Conserve maritime cultural assets Develop cruise infrastructure Ensure sustainable tourism	Developed 15 coastal circuits (12.5 million tourists) (Min Tourism, 2024)[42] Restored 10 heritage sites (INR250 crore revenue)[43] Certified 12 Blue Flag beaches[44] Built 5 cruise terminals (1.2 million passengers)	**Economic:** Generated INR1.2 lakh crore tourism revenue **Environmental:** Promoted low-impact tourism (protected 10% coastal ecosystems) **Social:** Created 8.1 million jobs (20% local) **Strategic:** Enhanced India's global tourism appeal

Sector	Key government initiatives	Objectives	Key impacts (2023–24)	Alignment with strategic imperatives
Marine biotechnology and blue innovation	**National Biotechnology Development Strategy, 2021–2025 (INR2,000 crore):** Funds marine biotech[45] **Deep Ocean Mission (Bioprospecting) (INR500 crore):** Identifies novel compounds[46] **BioRRAP Portal, 2023:** Streamlines regulatory approvals[47] **Blue Revolution Scheme (Seaweed):** Promotes seaweed farming[48] **Atal Innovation Mission:** Supports 25 blue tech startups (INR50 crore)[49]	Advance marine biotech R&D Commercialize bioresources Streamline regulations Foster blue tech startups	Funded 15 R&D projects (200 novel compounds identified) (DBT, 2024) Reduced regulatory processing time 30% (DBT, 2024) Established 10 seaweed farms (boosted production 5%) (DoF, 2024) Supported 30 startups (12 products commercialized) (NITI Aayog, 2024)[50]	**Economic:** Grew biotech exports (INR3,500 cr) **Environmental:** Developed algae-based carbon solutions **Social:** Created 10k skilled jobs **Innovation:** Positioned India as marine biotech hub
Non-living resources	**HELP, 2016:** Awards offshore blocks **Deep Ocean Mission (Mineral Mapping) (INR4,000 crore, 2021–2026):** Maps polymetallic nodules **National Mineral Policy, 2019:** Promotes sustainable seabed mining **Sagarmala Programme (Port Projects):** Supports hydrocarbon logistics **CRZ Notification, 2019:** Regulates offshore extraction	Enhance offshore oil/gas production Develop deep-sea mining capacity Ensure sustainable extraction Strengthen port logistics	Awarded 28 offshore blocks (attracted INR50,000 cr)[51] Mapped 30,000 km² for nodules (target 10% mineral needs by 2030)[52] Built 15 port projects for hydrocarbon handling[53] Regulated 20% offshore activities for ecosystem protection[54]	**Economic:** Contributed INR4.5 lakh crore petroleum exports **Environmental:** Promoted sustainable mining practices **Strategic:** Secured 25% energy needs via offshore fields **Innovation:** Advanced deep-sea exploration tech

While key government initiatives, such as the MoES-driven Deep Ocean Mission (which mapped 94.54% of India's EEZ by 2023[55]) and MSP pilots in Puducherry and Lakshadweep, are enhancing infrastructure and boosting key sectors, attracting sufficient private investment and mitigating environmental degradation require focused attention.

CHAPTER 3

Navigating sectoral bottlenecks across blue economy sectors

Unlocking the full potential of the blue economy requires overcoming a range of challenges. While sector-specific issues vary, common themes include the need for integrated governance, sustainable practices and inclusive development. Marine sectors face pressures such as overfishing, high logistics costs, infrastructure gaps and regulatory hurdles. Promising areas such as offshore renewables and marine biotechnology are held back by high capital costs, technology dependence and limited scale-readiness. Addressing these barriers through coordinated action and innovation is key to enabling sustainable and resilient growth. The table below outlines key sector-specific challenges across the blue economy, highlighting environmental, policy, financial, technological and social challenges.

Table 3: Sector-specific challenges framework

Sector	Environmental	Policy and governance	Technological and infrastructure	Financial and investment	Social and equity
Marine living resources	Overfishing affecting fish stocks and threatens biodiversity Marine pollution resulting in ecosystem damages such as mangroves and coral reefs Climate change impacting fish yields in tropical waters	There is scope to further enhance inter-ministerial coordination to support the effective implementation of sustainable fishing regulation	Limited cold chain facilities resulting in post-harvest losses Limited adoption of modern fishing tech Evolving infrastructure for seaweed farming and cage aquaculture	Low private sector investment limiting infrastructure development Inadequate insurance for high-seas ventures deter capital intensive operations Limited credit access for small-scale fishers/ startups	Limited access to modern training and equipment Inadequate inclusion of women in decision-making roles across Displacement risks faced by coastal tribal communities
Coastal tourism and heritage conservation	Port pollution affecting coastal ecosystems Climate change impacting existing port infrastructure IMO carbon intensity regulation resulting in higher compliance cost for vessels	Improved collaboration between central and state port authorities may contribute to smoother and more timely project execution	High logistics cost Limited shipbuilding capacity Slow adoption of digital platforms	Limited private investments Limited financing for ship leasing/ feet expansion Limited capital in transshipment hubs	Shortage of skilled labor Limited high skill jobs for coastal communities Limited inclusion of women
Offshore renewable energy	Environmental risks such as seabed disruption affecting marine habitats Climate change resulting in cyclones increasing operational risks Limited comprehensive EIAs	A more harmonized policy framework across relevant agencies could facilitate efficient project implementation, particularly in areas like seabed leasing	High project costs due to import reliance Evolving transmission infrastructure Low tech readiness for tidal/wave energy projects	Limited private investment Limited long-term financing models High capital intensity deterring institutional investors	Skill shortages with demand far exceeding trained technicians Limited engagement of coastal communities Low representation of women in technical roles
Coastal tourism and heritage conservation	Coastal erosion threatens many heritage sites; few have climate adaptation plans Over-tourism and pollution harm a significant portion of protected beaches and marine ecosystems Unplanned development puts sensitive coastal areas at risk	Opportunities exist to encourage greater alignment among tourism, cultural, and environmental bodies to strengthen coastal planning and heritage conservation efforts	Significant infrastructure gaps in coastal destinations, with many lacking proper sanitation and transport Underdeveloped cruise infrastructure with limited terminals supporting international liners Most heritage sites lack digital tools such as AR/VR and online booking platforms	Low private investment in Swadesh Darshan projects Fragmented and insufficient funding for coastal heritage sites managed by ASI Limited access to financing for community-based tourism cooperatives	Heavy reliance on low-wage jobs in tourism Limited economic benefits reaching local communities Persistent gender gap with women underrepresented in leadership roles

Sector	Environmental	Policy and governance	Technological and infrastructure	Financial and investment	Social and equity
Marine biotechnology and blue innovation	Ecological stress in key marine zones affecting bioresource potential Pollution impacting quality and availability of marine bioproducts Climate change reducing access to valuable ocean-based compounds	Streamlining regulatory processes and fostering stronger inter-agency cooperation could help accelerate marine research, environmental permitting, and commercialization pathways	Limited infrastructure for marine biotechnology Heavy dependence on imported specialized equipment Low rate of research commercialization	High research and development costs limit private investment Limited venture capital available for biotech startups Majority of funding comes from public grants, with few dedicated blue biotech funds	Insufficient skilled workforce trained for marine biotechnology Low engagement of coastal communities Minimal female participation in technical roles
Non-living resources	Oil spills and seabed activities threaten marine ecosystems; most of the EEZ remains unassessed Deep-sea mining risks damaging ocean habitats, with limited mitigation plans in place Climate change heightens risks for offshore infrastructure and operations	Clarifying regulatory frameworks and advancing deep-sea mining governance may support more strategic alignment and enhance overall project efficiency	Heavy reliance on imported deep-sea equipment Declining offshore resource potential Limited access to advanced deep-sea exploration technology	High capital costs limit private investment Deep-sea mining largely publicly financed Lack of dedicated funds for critical mineral processing	Gaps in skilled workforce for deep-sea operations Low community participation in emerging ocean sectors Limited inclusion of women in technical roles

Addressing these multifaceted challenges demands a multi-pronged and integrated approach. Integrated policy frameworks are critical to streamline coordination across ministries, reducing overlaps and ensuring alignment with national goals such as Viksit Bharat @ 2047 and international commitments such as SDG 14. Targeted investments in green technologies, resilient infrastructure, and focused skill development programs can bridge financial and technological gaps, particularly in emerging sectors such as offshore renewables and marine biotechnology. Sustainable resource management, underpinned by robust data and tools such as MSP and ocean accounting, is essential to balance economic growth imperatives with long-term ecosystem health. Inclusive participation, ensuring that coastal communities and marginalized groups such as women and traditional fishers are active partners in development, is fundamental for social equity and strengthening local resilience. Leveraging PPPs and innovative financing models, such as blue bonds and potentially carbon credit markets, can mobilize necessary capital while de-risking investments. Finally, continuous capacity building through targeted training and research initiatives will empower stakeholders across the board to adopt modern, sustainable practices and technologies, fostering long-term competitiveness and resilience. While addressing these diverse challenges is paramount, India's blue economy also presents significant investment frontiers across its various sectors, offering opportunities for both economic growth and environmental sustainability.

CHAPTER 4

Pioneering blue economy pathways: Scalable models of innovation, inclusion and impact

Building upon the strategic investment areas identified, the Indian blue economy is poised to witness the emergence of pioneering pathways that exemplify scalable models of innovation, inclusion and impactful outcomes. These initiatives, driven by community engagement and technological advancements, offer valuable lessons for realizing the full potential of India's ocean resources. The subsequent section captures some successful interventions with possible potential to replicate and scale while building on learnings for conceptualizing other innovative models

4.1 Community-led seaweed cultivation in Odisha: A model for sustainable coastal livelihoods

Chilika Lake, Asia's largest brackish water lagoon situated along Odisha's coast, has traditionally sustained thousands of fishing families. However, by 2021, these communities were facing growing socio-economic vulnerability due to dwindling fish stocks, attributed to overfishing and climate change impacts. The declining catches and increasingly erratic climatic conditions experienced by the late 2010s severely impacted the economic stability of Odisha's traditional fisherfolk, pushing many towards poverty. Amidst this challenge, seaweed cultivation emerged as a promising, low-investment, high-impact alternative livelihood strategy. Spearheaded by the communities themselves, particularly women, this initiative is transforming coastal villages in Odisha into pioneers of sustainable development within the blue economy framework. Recognizing the burgeoning global market for seaweed—valued as a food source, phycocolloid producer (such as agar), and biofertilizer input—both state and central governments identified its cultivation potential along Odisha's coast. While proposals such as a model seaweed farm in Chilika (targeting species

such as Gracilaria verrucosa) surfaced around 2021, the fundamental challenge lay not merely in introducing a new aquaculture practice, but in designing and implementing a model that prioritized genuine community ownership and leadership over top-down intervention.

- The initiative gained significant traction, and by 2023, over 200 SHGs were actively engaged in seaweed farming across coastal districts including Puri, Ganjam and Balasore[56]. The state government and associated bodies such as the Technology Information, Forecasting and Assessment Council (TIFAC) played a crucial supportive role by providing necessary inputs such as rafts and nets, and importantly, facilitating market linkages for the harvested seaweed, primarily destined for agar production and biofertilizer manufacturing. A key element distinguishing Odisha's model was the deliberate focus oncommunity autonomy; SHGs were largely empowered to determine suitable cultivation sites and operational schedules, promoting a strong sense of local ownership. This empowerment was particularly impactful for women, traditionally holding marginal roles in offshore fishing, who became central figures in the planting, tending and harvesting activities within the lagoon.

Socio-economic and environmental impacts:

By 2025, the community-led efforts yielded tangible results, with Odisha's annual seaweed output reaching approximately 5,000 tons (wet weight). While representing only a fraction of India's vast potential (estimated at 9.7 million tons), this marked a significant beginning. The harvested seaweed provided crucial supplementary income for over 10,000 coastal households, with dried seaweed fetching prices around INR50 to INR55 per kilogram[57]. Extrapolating this potential, it was estimated that scaling seaweed cultivation nationally to one million hectares could generate up to one million green jobs by 2030[58]. Environmentally, seaweed farming presented significant co-benefits; as seaweed grows, it absorbs dissolved carbon dioxide, contributing to climate change mitigation, and takes up excess nutrients, potentially improving water quality. It also offered an alternative to fishing, reducing pressure on Chilika's stressed fish stocks and allowing the fragile lagoon ecosystem opportunities for recovery.

Fostering a local bioeconomy and future vision:

The initiative has spurred nascent bioeconomic activity, with local entrepreneurs and startups beginning to explore value addition, producing seaweed-based biofertilizers and food products such as snacks for niche markets. This aligns with Odisha's broader strategic goals, such as the Green Odisha Initiative unveiled at the 2025 Utkarsh Odisha Conclave, which aims to integrate seaweed into the state's circular economy. Looking ahead, Odisha plans ambitious expansion along its 480-km coastline, targeting an output of 50,000 tons by 2030[59]. Challenges persist, including ensuring consistent supply of quality seed material and mitigating risks associated with monsoon intensity and climate variability. However, proposed national-level support, such as dedicated insurance and credit schemes for seaweed farmers suggested by NITI Aayog, could provide critical enabling conditions. Odisha's experience stands as a powerful testament to the efficacy of community-led, bottom-up approaches in achieving sustainable coastal development and offers a valuable, replicable model for empowering coastal communities across India.

4.2 Kochi's smart port transformation through digital twin integration

Kochi Port (Cochin Port Authority –CoPA), strategically located on India's southwest coast, serves as a crucial maritime gateway and hosts the country's first International Container Transshipment Terminal (ICTT) at Vallarpadam. Faced with rising global trade volumes, intensifying competition from regional ports, and the need for greater operational efficiency and sustainability, CoPA has launched a major digital transformation. Central to this effort– gaining momentum by 2025– is the integration of smart port technologies centered around the development and deployment of a comprehensive digital twin: a dynamic virtual replica of the port's physical assets, processes and environment.

As a major hub handling diverse cargo and significant transshipment traffic, Kochi Port faced multifaceted operational challenges typical of large maritime facilities. These included optimizing vessel turnaround times, reducing berth congestion, efficiently managing complex yard operations and multimodal logistics connecting to the hinterland, ensuring high standards of safety and security across vast operational areas, and minimizing environmental impact amid growing traffic. Coordinating the activities of numerous stakeholders–including shipping lines, terminal operators (such as DP World at ICTT), customs authorities, trucking companies, and railways– added another layer of complexity. Traditional operational methods often relied on siloed data and reactive decision-making, limiting predictive capabilities and hindering optimal resource allocation.

To address these challenges, Kochi Port initiated the development of a Digital Twin platform, integrating data from various existing and newly deployed systems. This involved harnessing real-time information streams from diverse sources: Internet of Things (IoT) sensors fitted on critical equipment such as quay cranes, Rubber Tyred Gantry cranes (RTGs), and vehicles; Automatic Identification System (AIS) data tracking vessel movements; RFID tags monitoring container and truck locations; inputs from the Terminal Operating System (TOS) and the Port Community System (PCS 1x); weather monitoring stations; and environmental sensors measuring air and water quality. This torrent of data feeds into a sophisticated platform that creates a live, dynamic virtual replica of the entire port ecosystem. Key functionalities developed by 2025 include real-time 3D visualization of port activities, predictive algorithms for optimizing berth allocation and vessel scheduling, AI-powered tools for efficient container stacking and yard management, simulation capabilities allowing operators to test 'what-if' scenarios (e.g., impact of weather disruptions or equipment downtime), and predictive maintenance alerts for key assets based on sensor data analysis, aiming to prevent failures and reduce downtime.

Early impacts - Towards enhanced efficiency and resilience:

Although full-scale implementation is ongoing, the integration of the digital twin components by early 2025 has started yielding tangible benefits, demonstrating the value of this data-driven approach. Early observations indicate improvements in operational efficiency, including reductions in vessel waiting times and more streamlined cargo handling processes at ICTT. Resource utilization has improved, with better allocation of berths, cranes and yard equipment, leading to potential energy savings and cost reductions. The system's predictive capabilities enhance planning accuracy for both the port authority and its stakeholders, improving coordination. Simulation tools support better preparedness for disruptions, improving operational resilience. Furthermore, the digital twin enhances situational awareness for security personnel and enables more precise monitoring of environmental parameters, supporting CoPA's sustainability goals.

Future outlook - An intelligent, connected maritime hub:

The vision for Kochi Port's digital twin extends beyond current functionalities. Future plans involve deepening the integration with hinterland logistics, potentially providing end-to-end supply chain visibility for shippers. Incorporating more advanced Artificial Intelligence (AI) and Machine Learning (ML) algorithms is expected to unlock deeper operational insights and further automate decision-making processes. The digital twin will serve as a critical tool for long-term strategic planning, allowing CoPA to simulate the impact of future infrastructure expansions or changes in trade patterns. Integration with broader smart city initiatives in Kochi could also create synergies in areas such as traffic management and utility monitoring. By continuing to invest in and expand its digital twin capabilities, Kochi Port aims to strengthen its position not just as a key transshipment hub, but as a leading example of an intelligent, efficient, resilient and sustainable smart port in the Indian Ocean Region.

4.3 Alang, Gujarat: Transforming shipbreaking into a circular economy model

Along the coast of Gujarat's Bhavnagar district lies Alang, globally recognized as the world's largest ship recycling yard. Historically synonymous with the challenging process of dismantling end-of-life vessels, Alang employed thousands while recycling vast quantities of steel. However, by the early 2000s, it faced significant criticism for its environmental impact and hazardous working conditions. Over the past decade, Alang has undergone a remarkable transformation. Driven by policy interventions, industry collaboration and technological adoption, it is emerging as a key example of Gujarat's circular economy strategy, balancing industrial activity with environmental stewardship and social responsibility.

For years, shipbreaking at Alang involved beaching vessels directly onto the tidal flats, where manual labor dismantled them piece by piece. This method led to severe environmental consequences, including oil spills contaminating shorelines, uncontrolled release of hazardous materials such as asbestos, heavy metals, and ozone-depleting substances, and significant risks to worker safety. By the late 2000s, growing international awareness and regulatory pressure, crystallized by the International Maritime Organization's Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC), adopted in 2009, pushed for higher global standards. This presented Gujarat with both a challenge and an opportunity to transform Alang from an environmental liability into a model for sustainable resource recovery.

Beginning in the late 2010s, a concerted effort by the Gujarat government, the Gujarat Maritime Board, ship recyclers' associations, and individual yard owners initiated Alang's pivot towards sustainability. A major focus was compliance with HKC standards. By 2020, a significant number of Alang's operational plots (reportedly over 90 out of approximately 120 active yards) had obtained statements of compliance (SoC) with HKC guidelines from recognized classification societies, signifying adherence to stricter environmental and safety protocols, including

impermeable floors and crane usage for dismantling. Central to this transformation was a circular economy approach focused on maximizing resource recovery and minimizing waste. Steel, which typically makes up 70% to 80% of a ship's weight, is systematically recovered and channeled back into India's domestic market, mainly for construction and manufacturing. Non-ferrous metals such as copper, aluminum and brass are also extracted and reused in electrical, automotive, and other industries. In addition, machinery, engine parts, furniture and fittings salvaged from ships are refurbished and traded in extensive secondary markets, extending their usable life.

Innovations in waste management and value addition:

A critical component of Alang's circular model is improved waste management, especially hazardous waste. Dedicated hazardous waste storage, treatment, and disposal facilities (TSDF) were set up to handle substances such as asbestos, waste oils, contaminated sludge and toxic paints, preventing the indiscriminate dumping common in the past. Post-2023, advanced techniques such as bioremediation—using microbial consortia to break down oil contaminants in soil—have helped mitigate ecological damage more effectively. This focus has also spurred local innovation, with entrepreneurs, repurposing non-hazardous ship waste into insulation materials, paving blocks, and decorative items, adding economic value and strengthening the circular economy.

4.4 Andaman and Nicobar Islands: A model for sustainable coastal and marine tourism in India's blue economy

The Andaman and Nicobar Islands (ANI), with a 1,962 km coastline within India's 2.02 million sq. km Exclusive Economic Zone (EEZ), are emerging as a prime example of how sustainable coastal and marine tourism can contribute meaningfully to India's blue economy. Renowned for unspoiled beaches, vibrant coral ecosystems and rich biodiversity, ANI attracted approximately 500,000 tourists in 2023, generating around INR800 crore for the local economy[60]. Through strategic policy implementation, community engagement, and environmentally friendly infrastructure, ANI is transitioning into a model that balances tourism growth with environmental protection and social inclusion, aligning with India's blue economy policy and SDG 14 (Life Below Water).

Historically, ANI's tourism thrived on its natural assets, including the Mahatma Gandhi Marine National Park and Radhanagar Beach. However, by the early 2010s, the islands faced the challenge of expanding tourism while preserving ecosystems. Unregulated tourism practices caused an estimated 10% annual damage to coral reefs[61], while airport capacity and other infrastructure

posed limitations. Indigenous communities, such as the Nicobarese, reported reduced access to coastal resources (about 20%) and large development projects raised displacement concerns[62]. Climate change vulnerabilities, such as cyclones and sea-level rise, also put infrastructure and livelihoods at risk. The core challenge was achieving sustainable tourism that emphasized environmental protection, community inclusion and resilience, while addressing coordination delays between the central government and the union territory— especially for projects such as Sagarmala cruise terminals.

Innovative approaches - A community-driven and eco-friendly model:

Since 2016, ANI has pursued a sustainable tourism framework under initiatives such as Swadesh Darshan 2.0 and Sagarmala, led by the Ministry of Tourism and the UT administration. Key strategies include investing INR99.2 crore in eco-friendly infrastructure such as boardwalks, solar-powered facilities and waste management systems— leading to Blue Flag certification for Radhanagar Beach[63]. Community-led programs empower Self-Help Groups (SHGs), especially women, to manage eco-tours and approximately 200 homestays, supported by MUDRA loans and hospitality/diving training for about 500 locals[64]. Marine Spatial Planning (MSP) regulates tourism in Marine Protected Areas (MPAs), preserving 90% of coral reefs[65], following the Great Barrier Reef model. Digital and policy support, such as e-visa liberalization and "Dekho Apna Desh" webinars, boosted foreign arrivals by 43.5% (2022–23)[66]. A proposed State/UT blue economy Cell will coordinate efforts and address central-UT project delays.

Tangible impacts - Economic, environmental and social gains:

ANI's focus on sustainable tourism has delivered significant outcomes. In 2023, tourism revenue reached INR800 crore with ~500,000 arrivals, supporting roughly 5,000 direct and indirect jobs[67]. Environmentally, single-use plastic bans and waste segregation have cut tourist-zone waste by 40%, and MPAs have preserved 90% of coral reefs[68]. Socially, around 60% of tourism jobs benefit women and youth. Homestays and eco-tours empower Nicobarese communities, while training programs improve service quality. Climate adaptation efforts include solar-powered infrastructure and cyclone-resistant facilities.

Future prospects - Scaling sustainable tourism leadership:

ANI aims to double tourist arrivals to 1 million by 2028, positioning itself as a global leader in sustainable tourism[69]. Future plans involve expanding MSP, using GIS and AI to protect 80% of coral reefs by 2030, developing a second cruise terminal and upgrading Port Blair airport via PPPs and Blue Bonds targeting INR2,000 crore in revenue. ANI also plans to scale homestays to 500 units by 2027 with 2,000 locals trained, launch virtual reef tours to reach 1 million online viewers by 2026, and establish a Central-UT blue economy Task Force to fast-track five projects annually[70]. By leveraging the IMCCBE's monitoring framework and drawing from global examples such as Indonesia, ANI's strategy offers a replicable model for advancing the sustainable blue economy across India's coastal states.

CHAPTER 5

Blue economy investment frontiers

India's ocean economy presents clear and diverse investment opportunities across key sectors. Marine fisheries support a large workforce and have significant potential for value addition, infrastructure upgrades and sustainable aquaculture expansion. Ports and maritime trade are central to India's global connectivity, with increasing demand for modernization, digitalization, and logistics efficiency. Coastal and marine tourism is growing steadily, with scope for eco-tourism models, cruise infrastructure, and local enterprise development. Offshore energy - including wind and tidal—is gaining traction as India looks to diversify its renewable energy portfolio. Meanwhile, marine biotechnology is opening new investment areas in bio-resources, pharmaceuticals and sustainable materials.

As India shifts to a more integrated and future-focused approach in managing its ocean sectors, there is a rising need for timely, well-aligned investments that can support long-term economic growth and environmental stability. The focus must be on quality investments—those that create jobs, build resilience, and align with both national goals and global sustainability standards. The decisions made today will shape the strength and direction of India's blue economy in the years to come. An overview of possible strategic investment opportunities across the multiple sectors of the blue economy is presented in the table below.

Table 4: Sectoral investment opportunities in blue economy

Sector	Sub-sector / focus area	Strategic investment area
Fisheries and aquaculture	Deep sea and southern ocean fisheries	Modern fleets, offshore storage, monitoring tech, port infra for southern ocean
	Seaweed farming	Seed banks, tissue culture labs, rafts, cluster farming, credit/ insurance, strain research
	Cage aquaculture	Cage manufacturing, surveillance, seabass/cobia focus, marine spatial zoning
	Shellfish and bivalve farming	Hatcheries, spat collectors, water testing, value-added products
	Fresh fish exports	Traceability, insulated transport, EU/US-compliant processing units
	Ornamental fisheries	Hatcheries, disease management, digital platforms, women-led enterprise scaling
	Ecosystem restoration	Mangrove/coral/seagrass restoration, blue carbon credits
	Cold chain and infrastructure	Solar cold rooms, packhouses, marine harbor upgrades, digital linkages
	Bycatch reduction and sustainable gear	Selective gear, turtle excluders, real-time data, eco-label readiness
Maritime transport and shipping	Port modernization	Berth expansion, mechanization, night navigation, digital ports
	Fleet expansion and renewal	LNG carriers, clean tankers, VGF, maritime leasing and financing
	Coastal and inland waterways	Barges, Ro-Ro terminals, intermodal hubs, modal shift to waterways
	Transshipment hubs	Vizhinjam, Galathea Bay, reduce reliance on foreign ports
	Green shipping and decarbonization	Green fuels, vessel retrofits, shore power, green ports
	Shipbuilding and breaking	Dry docks, electric ferries, Gujarat/Goa clusters, 3D printing
	Digitization and port logistics	Single window, drone surveillance, blockchain for documentation
	Maritime financing ecosystem	Ship leasing hubs, dedicated credit lines, maritime funds
Offshore renewable energy	Offshore wind farms	Tamil Nadu/Gujarat pilots, VGF, substations, undersea cabling
	Port infrastructure	Offshore terminals, laydown yards, wind manufacturing hubs
	Floating wind technology	Prototypes, manufacturing base, deepwater expansion
	Wave and tidal energy pilots	Kutch/Khambhat/Lakshadweep pilots, off-grid desalination, concessional capital
	Blue hydrogen	Offshore wind coupling, port electrolysers, hydrogen storage infrastructure
	R&D and marine spatial planning	Environmental impact, GIS tools, zonation, investor data

Sector	Sub-sector / focus area	Strategic investment area
Coastal tourism and heritage	Eco-tourism infrastructure	Nature centers, coral zones, boardwalks, green transport
	Blue flag beaches	Scale to 200, invest in testing, waste systems, renewable integration
	Cruise tourism and marinas	75 terminals, luxury ships, shore excursions
	Heritage site revitalization	Coastal monuments, AR/VR trails, ASI-private partnerships
	Island tourism	Eco-resorts, snorkeling, cultural circuits, zero-emission logistics
	Community-based tourism	Homestays, souvenirs, cuisine tours, digital platforms
	Coastal trails and blue corridors	Walking/cycling routes (e.g., Konkan, East Coast), cultural tourism
Marine biotechnology and innovation	Blue biotech parks	Parks near R&D hubs with testing and processing infra
	Seaweed bio-refineries	Product clusters: fertilizers, bioplastics, cosmetics, nutraceuticals
	Marine-derived pharmaceuticals	Bioprospecting anti-viral/cancer compounds, clinical trials
	Aquaculture health and genomics	Vaccines, diagnostics, probiotics
	Startup and IP ecosystem	Accelerators, seed funds, global buyer access, Blue Innovation Fund
	Blue bioeconomy partnerships	South-South and North-South collaboration (e.g., Norway, Japan)
	Digital platforms for bioinformatics	Genomic AI platforms, biodiversity databases, simulation labs
Non-living resources	Deep sea mining systems	AUVs, risers, R&D partnerships (e.g., Japan, Germany), ESG frameworks
	Critical minerals processing	Domestic refining for batteries, electronics, rare earths
	Gas hydrates	Krishna-Godavari and Andaman pilots, simulation studies, clean energy roadmap
	Offshore oil and gas expansion	Ultra-deep platforms, FDI in mature blocks, seismic imaging
	Blue infrastructure	Floating units, offshore ports, bunkering for new supply chains
	Environmental safeguards	Green mining, restoration bonds, transparent EIA mechanisms

As evident, the investment frontiers in the blue economy offer immense potential to drive sustainable development, enhance marine resource management, and foster economic resilience. Strategic investments in innovative technologies, sustainable aquaculture and coastal infrastructure are pivotal to unlocking these opportunities while addressing environmental challenges. The promise of the blue economy lies in its ability to balance economic growth with ecological stewardship, supported by targeted funding and collaborative initiatives that demonstrate tangible success.

CHAPTER 6

Enablers for blue economy transformation

Realizing the blue economy's significant potential hinges on a connected system of strategic investment, efficient governance and strong institutional collaboration. These elements are crucial for overcoming divisions, attracting necessary funding, and encouraging innovation across key ocean-based sectors, all while supporting India's national development goals and international sustainability commitments. This section will examine these vital enablers and outline strategies for strengthening investment, governance and institutional capacity for a robust and inclusive blue economy.

6.1 Investment: Fueling sustainable growth

Investment serves as the backbone of India's burgeoning blue economy, necessitating a strategic blend of public and private finance to effectively scale infrastructure development, technological adoption and sustainable practices across all sectors. Despite significant contributions to national GDP from multiple sectors such as fisheries, shipping and tourism, there remain substantial funding gaps. A fragmented policy landscape and limited private sector engagement (evidenced by only 15% of Sagarmala projects involving private funding) further hinder progress[71]. Addressing these financial challenges requires India to adopt an integrated investment approach, actively leveraging innovative financing mechanisms, empowering DFIs, and promoting PPPs to unlock large-scale, high-impact investments.

6.1.1 Public finance, blue bonds and innovative financing

Public finance remains cornerstone, with flagship programs such as Sagarmala and PMMSY driving initial development[72]. However, these funds represent only a fraction of the total capital required by 2030. Bridging this gap necessitates increased public spending, with prioritization of high-impact sectors such as offshore wind and marine biotechnology. Drawing on the success of green bonds, which have raised over INR1.75 lakh crore in India since 2015 for renewable energy and green infrastructure, blue bonds emerge as a promising asset class. Globally, blue bonds have mobilized over $5 billion since 2018[73], and India could explore a sovereign blue bond to fund sustainable fisheries, seaweed farming and offshore wind projects. Debt-for-nature swaps in areas such as the Sundarbans could support mangrove restoration, sequestering carbon while reducing fiscal strain. Innovative instruments, including blended finance vehicles, sustainability-linked credit lines and a dedicated Blue Innovation Fund, can further drive investment in aquaculture, logistics and biotech startups, bolstered by tax incentives and streamlined regulations that enhance the ease of doing business.

6.1.2 Institutional frameworks and the role of development finance institutions (DFIs)

DFIs such as the National Bank for Financing Infrastructure and Development (NaBFID) (formed in 2021) and Power Finance Corporation (PFC) possess significant lending capacities, often due to under-prioritization and lack of specialized expertise[74]. Mandating DFIs to dedicate a specific portion their portfolios to marine projects, supported by government guarantees and Viability Gap Funding (VGF), is crucial. Crucially, equipping DFI staff with specialized training in marine science, energy, and infrastructure is vital for informed capital deployment and for ensuring that the projects they finance adhere to high standards of sustainability and ease of implementation.

6.1.3 Role of PPPs and international collaborations

PPPs are essential for scaling infrastructure, as exemplified by the Vizhinjam Port project (INR7,525 crore, 75% private participation). However, PPP adoption remains low often hindered by complex approvals and land lease issues[75]. To boost PPPs, incentives such as extended tax holidays, longer land leases, and streamlined clearances are needed. A dedicated PPP Blueprint for Marine Sectors by 2027 could provide standardized templates and risk-sharing models. While India has secured support (e.g., World Bank $500 million for fisheries, Japan $1 billion for ports[76]), this represents only a fraction of the requirement. Hosting an Annual Blue Economy Investment Forum (starting 2027) could attract significant international capital (aiming for $5 billion by 2030) by showcasing India's potential (e.g., 71 GW offshore wind, 9.7 million ton seaweed capacity). Strategic partnerships (e.g., with Norway, Australia, Indonesia) can facilitate technology transfer and co-financing.

6.2 Governance and institutional alignment: Steering towards sustainability

Effective governance and robust institutional alignment are critical for India's blue economy, ensuring that substantial investments translate into tangible and sustainable outcomes on the ground. Despite the launch of several ambitious initiatives, the pace of progress has occasionally been moderated by the need for greater coordination across institutions, streamlined regulatory processes and enhanced implementation capacity. A unified governance framework, underpinned by strong central-state coordination, effective multi-ministerial collaboration, and targeted institutional reforms, is paramount to streamline processes, enhance investor confidence and deliver measurable, sustainable results.

Role of central and state governments in investment enablement:

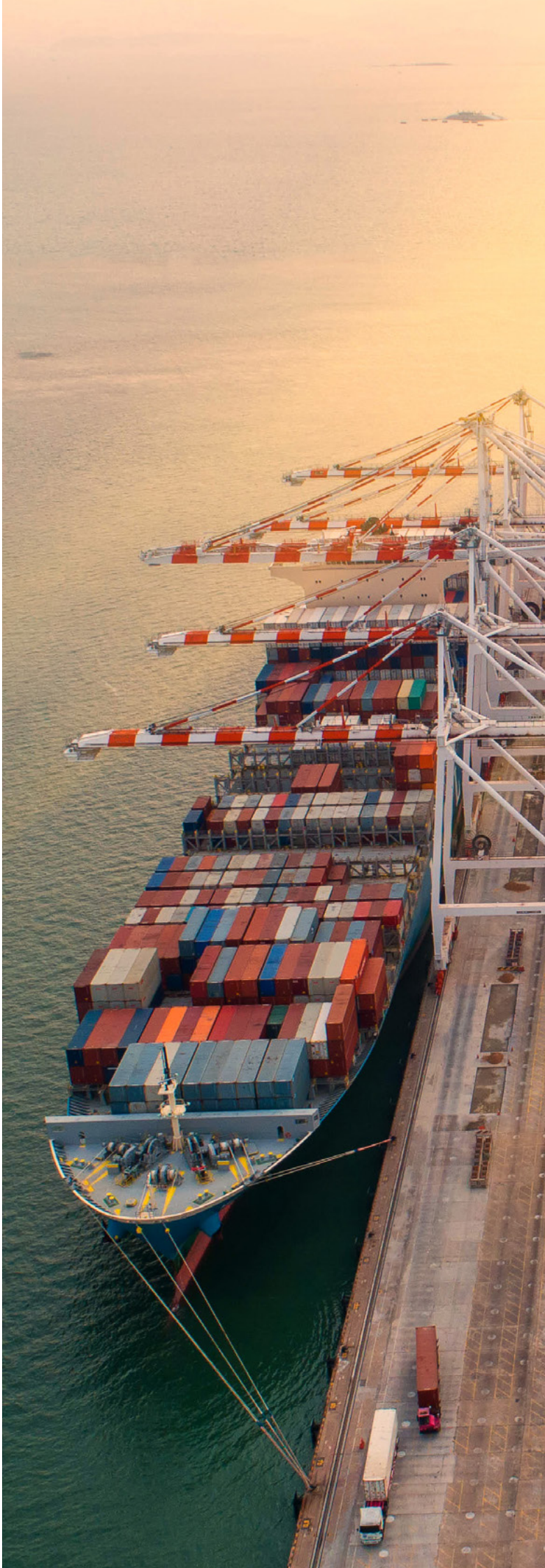
To ease financial and administrative constraints, an Inter-Ministerial Coordination Council on Blue Economy (IMCCBE) can be proposed to be established by 2026, co-chaired by MoES and state representatives, to fast-track strategic projects. Drawing on successful models internationally including from Brazil, Mexico and South Africa, the IMCCBE can facilitate cohesive and effective governance of blue economy initiatives. This council can promote both, vertical alignment (between central and state governments) and horizontal alignment (across various sectors). Developing state-specific blue economy plans, aligned with national goals but leveraging local strengths, is also crucial.

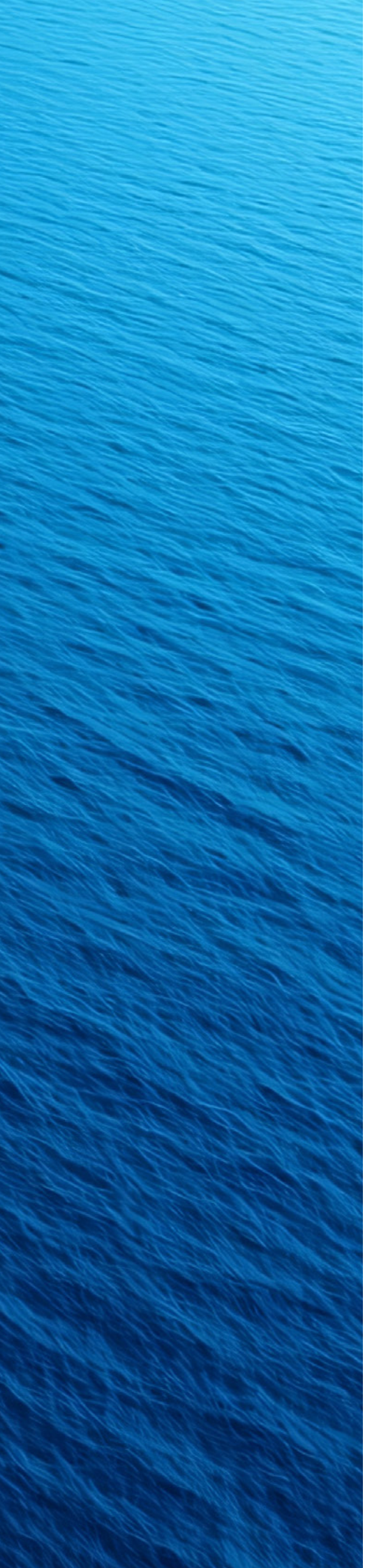
Multi-ministerial coordination for investment readiness:

The blue economy inherently spans multiple ministries (ports, fisheries, environment, energy, tourism, mines, etc.), often resulting in siloed operations and significant approval delays (6–12 months reported for some projects). Launching a dedicated Blue Economy Coordination Council by 2026, chaired by a senior official, could streamline cross-sectoral approvals, potentially reducing processing times by 50%. Assigning shared key performance indicators (KPIs), such as achieving 5% annual growth in blue economy investments, across relevant ministries would foster accountability. A digital Blue Economy Dashboard, operational by 2027, integrating data from existing portals (such as the National Logistics Portal – Marine, BioRRAP), could enhance transparency and investor confidence by providing a single-window interface. Aligning ministerial mandates ensures policies such as the CRZ Notification, 2019, and Maritime India Vision 2030 work synergistically, potentially unlocking INR1 lakh crore in marine investments by 2030.

Institutional reforms and capacity building:

Institutional capacity remains a critical bottleneck. DFIs often lack sectoral expertise, leading to under-allocation to blue economy projects. Field staff managing key programs frequently lack specialized marine or coastal domain training. Implementing a National Blue Skills Program by 2028, aiming to train 50,000 workers in essential areas such as port logistics, offshore wind maintenance, marine biotechnology and sustainable aquaculture, is essential. This program could partner with institutions such as the Indian Maritime University and CMFRI. Reorienting DFIs to prioritize blue economy lending, supported by de-risking funds, is necessary. Establishing a blue economy Research Hub by 2027, collaborating with premier institutions (IITs, IISc, NIO), would drive data-driven solutions in MSP, blue carbon, and ocean observation. Equipping institutions with skilled personnel and cutting-edge research capabilities will transform them into powerful enablers, accelerating India's blue economy towards a projected INR 5 lakh crore contribution by 2035.





CHAPTER 7

Roadmap to 2035: Unlocking blue economy investments

India's blue economy requires a well-structured, pragmatic approach that leverages existing strengths and sectoral cross-linkages. The objective is to leverage and enhance the current system while reinforcing successful elements and addressing existing gaps. This roadmap outlines a clear, actionable path to attract investment, prioritize feasible projects and build investor confidence, all within the nation's institutional and financial capacity.

7.1 National blue economy investment strategy

A clear, national strategy that is sharp, focused and fully in sync with current capacities is proposed to attract significant cumulative investments over the coming years. The focus would initially be on key sectors with a proven track record, including fisheries, ports, and coastal tourism, while eventually exploring and building on the big bets. The strategy would be anchored in realistic fiscal planning where, for instance, a small reallocation from current infrastructure budget would help generate significant funding for blue economy projects to provide a strong start without straining finances. By leveraging public investment, it would enable de-risking and crowding in private capital. The strategy will further define clear, measurable targets and performance benchmarks—such as increased fisheries output, increased coastal tourism revenues and port cargo capacity. Mechanisms for regular progress reviews and performance audits would also be included for adaptive planning and policy adjustments to ensure effective use of funds and sustained growth.

7.2 Priority projects and pipeline development

At this stage, it is crucial to develop a clear and credible pipeline of investable projects along the coastline. The focus should be on identifying a mix of high-impact, ready-to-launch initiatives such as port upgrades, offshore renewable energy pilots, and coastal tourism development plans. Successful public-private partnership models can be expanded to more coastal regions, with each state prioritizing key projects and completing necessary approvals and viability assessments promptly. Emphasizing early wins with projects that are manageable yet attractive to investors will help create a reliable and scalable project pipeline. For long-term capital in the blue economy, priority is to de-risk investments with ease of operations for investors. A Blue Loan Guarantee Scheme can be launched for in blue economy projects. This can be financed through NaBFID, requiring no new institution-building.

7.3 Investment facilitation mechanisms and incentive structures

Establishing a Blue Investment Helpdesk under the Ministry of Earth Sciences can be a significant step towards fostering investment in the blue economy. The team would focus on helping investors navigate regulations and fast-track approvals. The team could also develop comprehensive investor guides or 'Blue Starter Kits,' designed to assist new entrants in understanding potential investment opportunities, the application process and available incentives. At the same time, an online portal can be launched with details of permits and clearances to be tracked and processed. Annual progress dashboards—showcasing number of projects completed, jobs created, exports earned—would also help raise awareness and build credibility.

7.4 Charting the course: Way ahead

India's blue economy represents a dynamic opportunity to transform the nation's maritime resources into a powerful engine for sustainable economic growth, environmental resilience and social inclusion. The report has illuminated the complex challenges confronting key sectors, underscoring the need for strategic investments to harness the vast potential of India's extensive coastline and Exclusive Economic Zone, fostering economic diversification and global competitiveness.

To fully realize the blue economy's potential, India must adopt a cohesive investment strategy supported by robust governance and institutional collaboration. Public finance, innovative mechanisms such as blue bonds, and public-private partnerships can mobilize the necessary capital to drive growth in high-impact sectors. A streamlined governance framework, potentially through a coordinated inter-ministerial body, will ensure efficient resource allocation and policy coherence. Capacity-building initiatives will further equip stakeholders with the tools and knowledge to adopt modern, sustainable practices, strengthening the blue economy's foundation. By channeling resources into modernizing fishing infrastructure, enhancing port operations, advancing renewable energy projects, promoting sustainable tourism, and fostering innovation in marine biotechnology, India can create robust economic opportunities while ensuring environmental stewardship. Such investments will empower coastal communities, especially marginalized groups, by providing access to skills, resources, and markets, thereby driving inclusive growth and reducing regional disparities. By prioritizing strategic investments, India can position its blue economy as a global leader, aligning with the Viksit Bharat vision and international commitments such as SDG 14 and the BBN Agreement.

List of abbreviations

Abbreviation	Full Form
ADB	Asian Development Bank
AI	Artificial Intelligence
AIS	Automatic Identification System
ANI	Andaman and Nicobar Islands
AR/VR	Augmented Reality/Virtual Reality
ASI	Archaeological Survey of India
AUV	Autonomous Underwater Vehicle
BBNJ	Biodiversity Beyond National Jurisdiction
BIG	Biotech Ignition Grant
CEEW	Council on Energy, Environment and Water
CII	Carbon Intensity Indicator
CMFRI	Central Marine Fisheries Research Institute
CoPA	Cochin Port Authority
CRZ	Coastal Regulation Zone
DBT	Department of Biotechnology
DFI	Development Finance Institution
DG Shipping	Directorate General of Shipping
DOM	Deep Ocean Mission
DoF	Department of Fisheries
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EQUATIONS	Equitable Tourism Options
EU	European Union
FDI	Foreign Direct Investment
FIDF	Fisheries and Aquaculture Infrastructure Development Fund
FPO	Farmer Producer Organization
GDP	Gross Domestic Product
GIS	Geographic Information System
GSI	Geological Survey of India
HELP	Hydrocarbon Exploration and Licensing Policy
HKC	Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships
ICAR	Indian Council of Agricultural Research

List of abbreviations

Abbreviation	Full Form
ICZM	Integrated Coastal Zone Management
ICT	Information and Communication Technology
ICTT	International Container Transshipment Terminal
IIT	Indian Institute of Technology
IMCCBE	Inter–Ministerial Coordination Council on blue economy
IMO	International Maritime Organization
INCOIS	Indian National Centre for Ocean Information Services
IOC	Indian Oil Corporation
ISA	International Seabed Authority
IUU	Illegal, Unreported, and Unregulated (Fishing)
KPI	Key Performance Indicator
LiDAR	Light Detection and Ranging
ML	Machine Learning
MMP	Million Metric Tons
MNRE	Ministry of New and Renewable Energy
MoEFCC	Ministry of Environment, Forest and Climate Change
MoES	Ministry of Earth Sciences
MoPNG	Ministry of Petroleum and Natural Gas
MoPSW	Ministry of Ports, Shipping and Waterways
MPA	Marine Protected Area
MPEDA	Marine Products Export Development Board
MSP	Marine Spatial Planning
MTPA	Million Tons Per Annum
MUDRA	Micro Units Development and Refinance Agency
NaBFID	National Bank for Financing Infrastructure and Development
NCCR	National Centre for Coastal Research
NFDB	National Fisheries Development Board
NIO	National Institute of Oceanography
NIOT	National Institute of Ocean Technology
NIWE	National Institute of Wind Energy
ONGC	Oil and Natural Gas Corporation
OTEC	Ocean Thermal Energy Conversion

List of abbreviations

Abbreviation	Full Form
PCS	Port Community System
PFC	Power Finance Corporation
PGCIL	Power Grid Corporation of India Limited
PIB	Press Information Bureau
PM-MKSSY	Pradhan Mantri Matsya Kisan Samridhi Yojana
PMMSY	Pradhan Mantri Matsya Sampada Yojana
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PRASHAD	Pilgrimage Rejuvenation and Spiritual, Heritage Augmentation Drive
R&D	Research and Development
RE	Renewable Energy
RFID	Radio Frequency Identification
RTG	Rubber Tyred Gantry (Crane)
SDG	Sustainable Development Goal
SEE	System of Environmental-Economic Accounting
SHG	Self-Help Group
SME	Small and Medium Enterprise
SoC	Statement of Compliance
TIFAC	Technology Information, Forecasting and Assessment Council
TOS	Terminal Operating System
TSDF	Treatment, Storage, and Disposal Facility
UNEP	United Nations Environment Programme
UT	Union Territory
VGF	Viability Gap Funding

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Contact us

Cdr P K Srivastava (Retd.)
Scientist G,
Ministry of Earth Sciences
Email: Srivastava.pks@gov.in

Rakesh K Mishra
Partner,
Business Consulting, GPS
Email: rakesh.k.mishra@in.ey.com
Ph: +91 9910022353

Abhishek Gupta
Partner,
Strategy & Transactions, GPS
Email: abhishek12.gupta@in.ey.com
Ph: +91 9811901981

Bhavna Rathee
Senior Manager,
Business Consulting, GPS
Email: bhavna.rathee@in.ey.com
Ph: +91 9971998789

NOTES

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EY Offices

Ahmedabad
22nd Floor, B Wing, Privilon
Ambli BRT Road, Behind
Iskcon Temple
Off SG Highway,
Ahmedabad - 380 059
Tel: + 91 79 6608 3800

8th Floor, Building No. 14A
Block 14, Zone 1
Brigade International
Financial Centre
GIFT City SEZ
Gandhinagar – 382
355, Gujarat
Tel: + 91 79 6608 3800

Bengaluru
12th & 13th Floor
"UB City", Canberra Block
No.24 Vittal Mallya Road
Bengaluru - 560 001
Tel: + 91 80 6727 5000

Ground & 1st Floor
11, 'A' wing
Divyasree Chambers
Langford Town
Bengaluru - 560 025
Tel: + 91 80 6727 5000

3rd & 4th Floor
MARKSQUARE
#61, St. Mark's Road
Shantala Nagar
Bengaluru - 560 001
Tel: + 91 80 6727 5000

1st & 8th Floor, Tower A
Prestige Shantiniketan
Mahadevapura Post
Whitefield, Bengaluru
- 560 048
Tel: + 91 80 6727 5000

Bhubaneswar
8th Floor, O-Hub, Tower A
Chandaka SEZ, Bhubaneswar
Odisha – 751024
Tel: + 91 674 274 4490

Chandigarh
Elante offices, Unit
No. B-613 & 614
6th Floor, Plot No- 178-178A
Industrial & Business
Park, Phase-I
Chandigarh - 160 002
Tel: + 91 172 6717800

Chennai
6th & 7th Floor, A Block,
Tidel Park, No.4, Rajiv
Gandhi Salai
Taramani, Chennai - 600 113
Tel: + 91 44 6654 8100

Delhi NCR
Aikyam
Ground Floor
67, Institutional Area
Sector 44, Gurugram - 122 003
Haryana
Tel: + 91 124 443 4000

3rd & 6th Floor, Worldmark-1
IGI Airport Hospitality District
Aerocity, New Delhi - 110 037
Tel: + 91 11 4731 8000

4th & 5th Floor, Plot No 2B
Tower 2, Sector 126
Gautam Budh Nagar, U.P.
Noida - 201 304
Tel: + 91 120 671 7000

Hyderabad
THE SKYVIEW 10
18th Floor, "SOUTH LOBBY"
Survey No 83/1, Raidurgam
Hyderabad - 500 032
Tel: + 91 40 6736 2000

Jaipur
9th Floor, Jewel of India
Horizon Tower, JLN Marg
Opp Jaipur Stock Exchange
Jaipur, Rajasthan - 302018

Kochi
9th Floor, ABAD Nucleus
NH-49, Maradu PO
Kochi - 682 304
Tel: + 91 484 433 4000

Kolkata
22 Camac Street
3rd Floor, Block 'C'
Kolkata - 700 016
Tel: + 91 33 6615 3400

6th floor, Sector V, Building
Omega
Bengal Intelligent Park, Salt
Lake Electronics Complex,
Bidhan Nagar
Kolkata - 700 091
Tel: + 91 33 6615 3400

Mumbai
14th Floor, The Ruby
29 Senapati Bapat Marg
Dadar (W), Mumbai - 400 028
Tel: + 91 22 6192 0000

5th Floor, Block B-2
Nirlon Knowledge Park
Off. Western Express Highway
Goregaon (E)
Mumbai - 400 063
Tel: + 91 22 6192 0000

3rd Floor, Unit No.301
Building No.1,
Mindspace-Gigaplex
IT Park, MIDC, Plot No. IT-5
Airoli Knowledge Park
Airoli West, Navi
Mumbai - 400 708
Tel: + 91 22 6192 0003

18th Floor, Altimus
Pandurang Budhkar
Marg, Worli
Mumbai - 400 018
Tel: + 91 22 6192 0503

Pune
C-401, 4th Floor
Panchshil Tech Park, Yerwada
(Near Don Bosco School)
Pune - 411 006
Tel: + 91 20 4912 6000

10th Floor, Smartworks
M-Agile, Pan Card Club Road
Baner, Pune - 411 045
Tel: + 91 20 4912 6800

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