पत्तन,पोत परिवहन और जलमार्ग मंत्रालय
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
GOVERNMENT OF INDIA

SAGARMALA
PORT-LED PROSPERITY

MARITIME AMRIT KAAL
VISION 2047

सत्यमेव जयते

प्रधान मंत्री
Prime Minister

MESSAGE

I am pleased to learn about the initiative by the Ministry of Ports, Shipping & Waterways to prepare a comprehensive Amrit Kaal Vision 2047 focused on the transformation of India's maritime sector.

India's rich maritime heritage has witnessed many cultural and commercial hubs thriving along our coasts, establishing connections with the world even in ancient times. Inspired by such an illustrious history, our nation is taking confident strides as a significant player in the Blue Economy of the region and the world.

The nation has witnessed our comprehensive endeavours in the maritime sector, particularly in the realm of port-led progress. We have adopted the 'Ports for Prosperity' approach to enhance the connectivity and efficiency of our ports.

India's maritime industry is making comprehensive progress due to a range of policy initiatives and reforms that are furthering 'Ease of Doing Business', creating state-of-the-art infrastructure of global standards, ensuring new age multi-modal connectivity.

The Maritime India Vision 2030 highlighted important themes and initiatives in ports, shipping, and waterways to stimulate the growth of the nation's maritime sector. Building upon this, the Amrit Kaal Vision 2047 underlines efforts to realise the holistic vision for India's maritime sector.

This vision recognizes the vital importance of the Blue Economy as one of the fundamental pillars of economic growth. It also outlines a roadmap for sustainable development related to oceans, rivers and coastal regions, while also focusing on equity, inclusivity and innovation.

The Amrit Kaal Vision 2047 will play a key role in tapping into the potential of India's 7,500-kilometer coastline, its extensive network of inland waterways, and the coastal districts. This vision will serve as a guiding force in shaping India's maritime sector and bolster the nation's endeavours to build a strong, inclusive and self-reliant India.

Working on fulfilling the Amrit Kaal Vision 2047, we will strengthen India's position as a leading global maritime player that boosts peace, progress and prosperity for the whole world.

(Narendra Modi)

New Delhi
आश्विन 22, शक संवत् 1945
14th October, 2023

सर्बानंद सोणोवाल
SARBANANDA SONOWAL

सत्यमेव जयते

मंत्री
पत्तन, पोत परिवहन और जलमार्ग एवं आयुष
भारत सरकार
Minister
Ports, Shipping & Waterways and AYUSH
Government of India

FOREWORD

The maritime sector plays a crucial role in the growth and development of a country. The Ministry of Ports, Shipping and Waterways, Government of India, has constantly been taking concrete measures which are aimed towards adding pace to capacity building and enhancing the efficiency of the Indian maritime sector. After already having progressed significantly with the implementation of Maritime India Vision 2030 which was launched in 2021, we have formulated AmritKaal Vision 2047 to be a broader, more comprehensive roadmap for maritime transformation in the next 25 years.

To shape India's capability in the maritime sector into a robust engine of the nation's development, the Ministry has given top priority to improving the efficiency of major ports by undertaking policy initiatives and reforms supporting trade and ease of doing business, creation of modern and sustainable infrastructure of global standards, promoting logistics by establishing multimodal terminals along inland waterways, expansion in ship-building & recycling activities and various other measures aimed at harnessing the immense potential of the country's coastline to the fullest.

The impact of these measures can be seen on the overall maritime ecosystem spread across ports, shipping, and waterways sectors. The notable areas include increased efficiency of Major Ports, policy measures and reforms aimed to support trade and Ease of Doing Business, multi-modal connectivity for logistic movement in the country through inland waterways, initiatives to attract flagging of vessels in India, and promoting ship repair, ship recycling and shipbuilding in India in line with Hon'ble PM's vision of Aatmanirbhar Bharat.

The Government of India's vision of 2030 has highlighted Blue Economy as one of the 10 core dimensions of economic growth. To drive growth in the maritime sector and promote the GoI's vision, the Ministry of Ports, Shipping and Waterways has prepared the AmritKaal Vision 2047. For preparation of the roadmap & implementation plan, extensive consultations and brainstorming discussions have been undertaken with both public & private sector stakeholders. Further, multiple international benchmarks have been analyzed for policies, acts, and other regulatory provisions. Based on these consultations and assessments, the AmritKaal Vision 2047 has identified more than 300 actionable points across ports, shipping & waterways sectors which will be crucial for driving the Indian maritime sector's growth and promoting India's Blue Economy.

(Sarbananda Sonowal)

SAGARMALA
PORT-LED PROSPERITY

स्वच्छ भारत
एक कदम स्वच्छता की ओर

आज़ादी का अमृत महोत्सव

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राज्य मंत्री
पत्तन, पोत परिवहन, जलमार्ग एवं पर्यटन
भारत सरकार

SHRIPAD NAIK
Minister of State for
Ports, Shipping, Waterways & Tourism,
Government of India

Azadi Ka Amrit Mahotsav

Message

The maritime sector plays a crucial role in the growth and development of a country. The Ministry of Ports, Shipping and Waterways, Government of India, has constantly been taking concrete measures since 2014 which are aimed towards adding pace to capacity building and enhancing the efficiency of the Indian maritime sector.

Maritime sector plays a vital role in economic growth and recognizing the potential it presents the Ministry of Ports, Shipping and Waterways has been working continuously to promote the sector towards realizing the numerous opportunities the sector has on offer.

Amrit Kaai Vision 2047, encapsulating multi-dimensional growth initiatives across key themes has been prepared undertaking numerous consultations with stakeholders across industry and the government - bringing together a compilation of 300+ key initiatives identified as part of the development roadmap for India's ports, shipping, waterways while paving way for holistic development of India's costal districts and beyond.

Adding to the Ministry's marquee initiatives such as Sagarmala, Maritime India Vision 2030, the Amrit Kaai Vision 2047 sets a larger vision, targeting developments across areas such as world class port infrastructure, green shipping, promotion of shipbuilding and ship recycling sector while focusing institutional capacity building to promote centres of excellence across specializations in maritime sector aimed at driving growth through innovation.

The Amrit Kaai Vision 2047 with its charted development plan for the coming decades, is India's leap towards becoming a global maritime hub.

Snaik

(Shripad Naik)

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पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
भारत सरकार

सत्यमेव जयते

Minister of State
For Ports, Shipping and Waterways
Government of India

शांतनु ठाकुर
SHANTANU THAKUR

MESSAGE

Date:- 12-10-2023

Adding another milestone to our continued efforts towards development of India's vast maritime space, after extensive deliberations and consultations with stakeholders spanning across central ministries, state government departments, industry representatives from the private sector and more, the Ministry of Ports, Shipping & Waterways (MoPSW) has prepared the AmritKaal Vision 2047.

The Ministry of Ports, Shipping and Waterways, Government of India, has been focused at measures aimed at adding pace to capacity building and enhancing efficiency of the Indian maritime sector.

The AmritKaal Vision 2047 identifies 300+ initiatives identified across key themes, such as those to promote safe, sustainable & efficient maritime operations and infrastructure, initiatives across ports, shipping and waterways have been identified as part of AmritKaal Vision 2047, aimed at holistic development of India's maritime sector.

India's maritime interest is key to support the nation's economic growth with heavy reliance on the ocean, and with this vision document we foresee a cohesive maritime/ocean governance framework to ensure communication, coordination and clarity between multiple stakeholders and multiple level of administrative authorities and coastal communities, for achieving better outcomes.

I am hopeful that the AmritKaal Vision 2047 will guide the way ahead towards a robust maritime sector contributing to the country's economic and social growth and towards placing India among the leaders in global maritime sector.

(Shantanu Thakur)

टी.के.रामचन्द्रन
T.K.Ramachandran

सत्यमेव जयते

सचिव
SECRETARY
भारत सरकार
GOVERNMENT OF INDIA
पत्तन, पोत परिवहन और
जलमार्ग मंत्रालय
MINISTRY OF PORTS,
SHIPPING AND WATERWAYS

Preface

The **Amrit Kaal Vision 2047,** crafted by the Ministry of Ports, Shipping & Waterways (MoPSW), stems from extensive consultations with stakeholders across central ministries, State Government departments, private sector, financial institutions, and academia. Building upon Maritime India Vision 2030 (MIV 2030), it not only advances existing initiatives but also introduces new ones for the creation of world-class ports, facilitation of inland water transport & coastal shipping, and the advancement of a green and sustainable maritime sector. The report delineates aspirations and initiatives in Logistics, Infrastructure, and Shipping, aligning with key maritime themes for the promotion of the 'Blue Economy' in India.

For preparation of the roadmap & implementation plan, 13 Working Groups (WG) were constituted for deliberations wherein more than 150 consultations with public and private sector stakeholders were held. Further, more than 50 international benchmarks for infrastructure, policies, acts and other regulatory provisions were analyzed apart from reviewing various Vision documents of leading international maritime nations. Based on the above, the **Amrit Kaal Vision 2047** delineates more than 300 initiatives/actionable points for ports, shipping and waterways.

Port sector initiatives focus on developing safe, smart, secure and sustainable ports in India by promoting the use of technology, digitalization and renewable energy. Initiatives have also been proposed for developing world class ports in India by increasing capacity of existing ports, developing new ports, developing maritime clusters and by enhancing efficiency of ports with incorporation of latest technology in operation.

Initiatives identified for **shipping sector** focus on increasing the Indian flagged fleet and reducing dependency on foreign flagged vessels. The prominent theme of promotion of ship building, recycling & repair in India is in line with Hon'ble PM's vision of Aatmanirbhar Bharat. Other areas in focus include strengthening India's global maritime presence and providing world class education, research, and training facilities to the Indian seafarers.

For the **Inland Waterways sector** - promoting ocean, coastal & river cruise sector, promoting multi-modal connectivity at the ports and subsequently improving the modal share of coastal shipping & inland waterways have been the target areas.

Based on extensive stakeholder consultations, best-practice bench-marking, policy assessment and analysis, action items classified into 11 key themes were identified. These

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initiatives under the **Amrit Kaal Vision 2047** are aimed at enhancing overall performance and efficiency of the Indian maritime sector and at unlocking the potential of Blue Economy in India - making it a significant contributor to India's overall economy.

The **Amrit Kaal Vision 2047** took shape because of the vision and conviction of our Hon'ble Prime Minister who has always encouraged the pursuit of excellence in striving towards Aatmanirbharta. I am grateful to NITI Aayog for assigning us the task of preparing Amrit Kaal Vision 2047. I also thankfully acknowledge the support provided by the members of Committee on 'Logistics, Infrastructure & Shipping- Promotion of Blue Economy'- Advisor (Transport) NITI Aayog and representatives from MEA, Dept. of Fisheries, Ministry of Steel, Ministry of Finance, Department of Commerce, Ministry of Defence (Indian Navy), DPIIT, MoEFCC, MSME, HRD apart from representatives from Coastal States & UTs.

I am grateful to the coordinators of the 13 Working Group committees: DG Shipping, Vice Chancellor IMU, Chairman CoPA, Chairman VoCPA, Chairman JNPA, Managing Director IPA, Chairman SMPA, Chairman DPA, CMD KPL, Chairman ChPA & Chairman & Managing Director CSL, and Chairman, MbPA - for their support and insights on various aspects of India's maritime sector (ports, shipping & logistics ecosystem) both at the Central and State levels.

None of this would have materialized without the unflinching support and guidance of our Hon'ble Union Minister of PSW & AYUSH- Shri Sarbananda Sonowal, who inspired us and guided us in our endeavour to prepare the action plan. We are also thankful for the suggestions and inputs received from Hon'ble MoS, Shri Shantanu Thakur and Hon'ble MoS, Shri Shripad Naik, Finally, we express our gratitude to the Blue Economy Team at MoPSW for their remarkable efforts in working relentlessly towards shaping this action plan.

I thank all the members for their support and contribution and hope that this document would pave the way for future successes.

(T. K. Ramachandran)

New Delhi
October 10, 2023

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EXECUTIVE SUMMARY

Amrit Kaal Vision 2047 - Quantum Leap to India's Global Maritime Leadership

The country's maritime sector comprising of 12 Major Ports and more than 200 non-major ports along the 7,500 kms of the coastal line plays a crucial role in the growth of the country's economy. The Government of India's vision of 2030 has highlighted Blue Economy as one of the 10 core dimensions of economic growth. To address challenges & improve coordination, Blue Economy Coordination Committee (BECC) constituted under chairmanship of Vice Chairman, NITI Aayog. BECC identified 6 functional clusters for leveraging Blue economy. Within these clusters, Logistics, Infrastructure and Shipping (including Transshipments) cluster is being driven by Ministry of Ports, Shipping & Waterways.

The Amrit Kaal Vision 2047 for Logistics, Infrastructure and Shipping (including Transshipments) has been prepared through more than 150 consultations with public and private sector stakeholders. These stakeholders comprised of representatives from concerned Central Government Ministries and Departments, Major Port Trusts, representatives from shipping industry, representatives from financial institutions, State Maritime Boards & other state departments, representatives from academia etc.

In addition to the consultation, the preparation of the action plan involved assessment of more than 50 international benchmarks analyzed for policies, acts and other regulatory provisions. Based on the various consultations and assessment, the Amrit Kaal Vision 2047 has identified more than 300 actionable points. These action points will leverage the recent development of the National Logistics Policy (NLP) and the PM Gati Shakti National Master Plan (PMGS-NMP).

Guiding principles

The preparation of the Amrit Kaal Vision 2047 for Logistics, Infrastructure and Shipping (including Transshipments) cluster was driven by the following key principals:

1. Assessment of the current landscape for identification of gaps and find actionable points to fill in the gaps for achieving the respective targets
2. Analysis of international best practices across infrastructure, capacity building, institutional framework and regulatory environment for developing the actionable points
3. Developing framework for improving innovation and financing in the maritime sector
4. Driving the agenda for promoting Atmanirbhar Bharat and sustainability in the maritime sector
5. Defining the timeline for the implementation of the actionable points

Key themes

The Amrit Kaal Vision 2047 Action Points have been defined across 11 key themes which are provided as below. A total of **300+ initiatives** along with their action plan have been identified across these themes.

1. Lead the World in Safe, Sustainable & Green Maritime Sector

Government of India's vision is to reduce emissions from maritime sector in line with IMO GHG reduction strategy and promote the development of zero and low-emission solutions. In addition, as per COP 26 the climate targets have been set with limiting the global warming well below 2 degrees Celsius and efforts will be made to limit temperature increase to 1.5 degree Celsius above pre-industrial levels.

The major ports in the country have taken multiple initiatives such as increasing the adoption of solar and wind energy, providing shore power to port crafts and using electricity powered port equipment. In addition, the ports in the country are introducing safety measures.

Apart from ports, the shipping sector has also witnessed increased adoption of vessels driven by alternate sources of fuels. These vessels are currently in the various stages of development and mainly use sources such as batteries, solar energy, LNG etc.

In order to promote and lead the world in safe sustainable and green maritime sector, initiatives for both ports and shipping have been identified as part of the Amrit Kaal Vision 2047 action plan. There are 22 initiatives identified under the theme, of which the key initiatives identified for 2047 for promoting sustainability in port include developing a strategy to make all the major ports carbon neutral, phased adoption of alternate fuels such as LNG, Hydrogen/Ammonia and biofuels for port vehicles. In addition to ports, key initiatives have also been identified for promoting sustainability in shipping. These initiatives include setting up De-Carbonization Cell at DG Shipping, launch of over 20 pilot projects under India's Green maritime shipping program, providing incentives foster development of low carbon vessels and retrofits in existing vessels, extend PLI scheme to support green maritime technology development in India etc.

2. Promote Ocean, Coastal & River Cruise Sector

India hasn't reached its potential when it comes to Maritime Tourism. While Cruise Industry is growing at steady rate, it is still subdued with various barriers. Ferry market on the other hand is limited to few regions only. An attractive and stable regulatory policy framework in line with international standards is most essential for attracting tourists and cruise lines in India. Further, suitable business modality shall be needed to connect Indian coastal districts through a low-cost water-based transport solution.

There are 25 initiatives identified under the theme, of which the key initiatives for promoting ocean, coastal & river cruise sector in India include infrastructure initiatives such as developing cruise terminals and marinas along the East & West Coast of the country and develop inland waterways for river cruises. Apart from infrastructure, policy initiatives are also proposed which include relaxing cabotage rules, extending e-visa facility to five ports, fiscal incentives in terms of custom duty exemption on consumables, reduction in GST on tickets etc. Other initiatives include updating the Standard Operating Procedures for cruise vessels in line with international standards, establishing a centralized fund under SDCL with capital to be provided by major ports for subsidizing the Ro Ro/Ro-PAX operations, capacity building through establishing training academies etc.

3. Enhance modal share of coastal shipping & Inland Water Transport

The coastal shipping and inland waterways sector in India are still in its nascent stage compared to other countries and other modes of transport. Despite the fact that water transportation is cost-effective, sustainable and environment friendly mode of movement, India is not able to fully utilize its 7,500 km coastline and over 14,000 km of navigable inland waterways.

There are 46 initiatives identified under the theme, of which the key initiatives for enhancing modal share of coastal shipping and inland water transport include creation of port based agglomeration centers, creation of coastal berths near coast based production/demand centers, Road/ Rail/ IWT connectivity/ expansion projects, reduction in port dues and terminal charges, fiscal incentives such as allowing input tax credit on bunker fuel and spares purchased from various states, reduction of GST for multimodal transportation etc., operationalize 50 waterways by 2047, introduction of low draft vessel design with a possible tug-barge combination etc.

4. Promote Maritime Cluster

Maritime clusters as identified for Amrit Kaal Vision 2047 Action Plan include creating industrial clusters along the ports which include DPA, VoCPA, SMPA (Haldia) and also at Andaman & Nicobar Islands. The key initiatives for creating the maritime industrial clusters include identification of models with private sector for developing the industrial clusters, identification of focus commodities for the industrial clusters, adoption of investor friendly policies etc.

In addition to industrial clusters, development of three islands namely Greater Nicobar & Port Blair at Andaman and Nicobar Island can be developed as a bunkering hub and Ship repair respectively. In addition, Kalpeni Island can be developed for Vessel Spares and Stores. There are 30 initiatives identified under the theme, of which the key initiatives for developing these islands would involve infrastructure, institutional and policy/regulatory initiatives.

5. Promote maritime professional services

India holds a strong position as a maritime hub and as the country continues to invest, the maritime industry continues to expand. This would require additional capital for implementation. In addition to the flow of credit, there is a need for fiscal incentives to be provided to the Indian maritime sector. Further, as the sector expands, more services shall be required in the sector due to multiplicity of disputes and expeditious settlement of insurance claims in the sector.

There are 28 initiatives identified under the theme 'Offer maritime professional services'. To promote ease of financing in the maritime sector, as part of initiatives it is proposed to establish a Maritime Development Fund to provide low-cost and long-term capital in the sector. In addition, the initiatives related to establishment of an international level maritime arbitration center, expeditious insurance claim settlement, and provision of fiscal incentives in terms of direct & indirect taxes in the maritime sector shall also be covered.

6. Become a global player in Shipbuilding, repair & recycling

India needs a strong ship building eco-system with adequate infrastructure and policy enablers to become a leader in the Ship building, repair and recycling industry. Policy measures pursued by other key shipbuilding nations suggest that each country has pursued a mix of fiscal & non-fiscal incentives for encouraging development & growth of shipbuilding industry. Similar incentives are to be introduced in Indian industry to keep pace with leading nations.

As part of Amrit Kaal Vision 2047 Action Plan, a total of 17 initiatives have been identified for shipbuilding and repair and ship recycling. The initiatives for shipbuilding and repair include extending the policy for shipbuilding for 5-10 years beyond the end of Financial Year 2025-26, promoting Atmanirbhar Bharat provisions (such as post 2023 only Indian Flagged Vessels to be allowed to serve PSU/ Govt. requirements), grading of shipyards based on technical capacities, simplification of custom procedures for import of vessel spares etc. In addition to shipbuilding and repair, initiatives have been identified for ship recycling which include expansion of Alang Shipyard, leveraging vehicle scrapping policy, developing new ship recycling locations at Andhra Pradesh, Odisha and West Bengal to cater to the markets in South East Asia etc.

7. Develop World Class Education, Research & Training

In the present scenario, the maritime education and research ecosystem in the country operates on standalone basis. There is non-availability of a platform to bring together the elements of maritime education and research, which involve training, faculty, etc. to drive the innovation in the maritime sector. The capabilities in the maritime sector in the country can be enhanced through developing an innovation ecosystem.

There are 39 initiatives identified as part of Amrit Kaal Vision 2047 of which, the key initiatives focus on creating an Innovation Ecosystem in the country to promote world class education, research and training in the maritime

sector. These initiatives mainly include promoting setting up of incubators and accelerators in the country for promoting startups in the maritime sector, setting up of Maritime Knowledge Clusters to promotive collaborative approach for research in maritime sector, establishing a Center of Excellence for Multimodal Logistics at IIM, Ahmedabad and IIFT, Delhi, establish partnerships with leading international maritime training institutes, standardization of port tariff structure across all the ports, reduce the time of professorship for faculties at maritime institute etc.

8. Strengthen India's global maritime presence

Building partnership and enhancing maritime cooperation is one of the important steps for India to grow its global stature as a maritime power. There are 43 initiatives identified as part of Amrit Kaal Vision 2047 Action Plan of which, the key initiatives focus on strengthening our global maritime presence which includes dedicated IMO cell in India, appointment of a permanent representative at IMO headquarters, London, implementation of BIMSTEC Master Plan, creating a robust BIMSTEC institutional structure to ensure implementation of regional projects in a coordinated & timely manner etc.

9. Develop World Class next generation ports

India has 12 major ports and over 200 notified non-major ports along its 7,500+ Km long coastline and sea islands. The ports are critical to Indian economy as they facilitate EXIM and coastal trade. The total cargo handled at Indian Ports (major and non-major) increased to 1319.97 million tonnes in 2019-20 from 1281.78 million tonnes in 2018-19 reflecting an increase of 3.0% during 2019-2020. India's major ports handled around 53.4% of the cargo handled at Indian ports.

There are 42 initiatives identified as part of Amrit Kaal Vision 2047, of which the key initiatives focus on developing world class next generation ports which include developing port clusters involving major and non-major ports with capacities more than 300 MTPA, creation of deeper drafts (18-23 m) at ports, developing transshipment hub, developing two new major ports, reduce vessel related charges, increase private sector participation through implementation of projects under PM Gati Shakti – NMP and Asset Monetization Plan etc.

10. Enhance Efficiency through Technology & Innovation

Maritime sector which carries ~90% of international cargo volume has seen technology advancement, innovation and transformation with the aim to bring in efficiency in operation, cost optimisation and ease of doing business. Covid-19 crisis has further underlined the critical role of digitalisation in functioning and operation of maritime supply chains across the world. It is therefore critical and essential that maritime sectors in India also improve their position in respect of technological innovation, advancement and integration.

As part of Amrit Kaal Vision 2047, a total of 17 initiatives are identified of which, the key initiatives includes implementing technology initiatives such as improving operational efficiency through E-gate 2.0 at all ports based on computer vision & OCR technologies, Drone based inventory management, Just-in-time systems at all ports, Automation of mobile harbor cranes, pilotage, mooring & anchorage etc., port planning & optimization initiatives such as digital twin for port and systems, advanced analytics-based yard management, automated allotment of berths using AI/ ML etc., establish digital center of excellence to do research for implementation of upcoming technologies in the maritime sector etc.

11. Enhance India's Tonnage

The growth of Indian-flag shipping tonnage has not been able to keep up with the pace of Indian trade needs. The number of ships under Indian flag has grown over the years but the share of Indian fleet as a percentage of the world's fleet remains close to 1% whereas leading nations such as China and Singapore have a share of 5% and 6.5% respectively in the world's tonnage. India needs to make certain policy changes and take steps to make the process of registration of vessel and sailing of Indian flagged vessel convenient for all the stakeholders and improve India's ranking and share in world's tonnage.

As part of Amrit Kaal Vision 2047, a total of 9 initiatives are identified of which, the key initiatives to improve India's Tonnage include initiatives providing fiscal incentives such as revisiting the applicability of TDS on wages paid to Indian seafarers, allowing the Input Tax Credit on the fuel, spares etc. procured for vessel, Indian ships should not be required to pay GST on reverse charge for MRO services consumed outside India etc., granting infrastructure status to shipping industry, allowing other sources of financing to vessel owners such as Alternate Investment Funds, removing restriction on ship leasing by insurance Companies etc.

Note:

- During implementation of initiatives, all stakeholders should ensure sustainable functioning of the coastal and ocean resources following EPA,1986, Water Act., 1974, Air Act., 1981, Noise pollution (Regulation and Control) Rules, 2000; Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008; National Ambient Air Quality Standards, 2009 CRZ, 2019, and EA,2006 and its amendments and guidelines of MoEF&CC shall be followed

- All proposed developmental activities under this action plan may have a comprehensive risk management plan to avoid pollution in coastal and ocean environments

Strategic Aspirations for Amrit Kaal Vision 2047

The following provides the strategic aspirations for Amrit Kaal Vision 2047:

Parameter	Unit	Where we are	Aspiration 2047
Lead the World in Safe, Sustainable & Green Maritime Sector			
Major Ports with LNG bunkering facilities	Number	1	8
No. of hydrogen/ammonia hubs	Number	-	14[1]
Major Ports with shore to ship power facility	Number	2	14[2]
Carbon neutral ports	Number	-	14
Promote Ocean, Coastal & River Cruise Sector			
India's rank of passenger volume in Asia Pacific	Rank	4th	1st
No. of Indian ports amongst top 20 ports for cruise services in Asia Pacific	Number	1	4
Number of cruise terminals	Number	6	25
Enhance modal share of coastal shipping & Inland Waterway Transport			
No. of operational waterways	Number	22	50+
Cargo volume handled by waterways	MMTPA	109	>500
Become a Global player in Shipbuilding, repair & recycling			
Global rank in ship recycling	Rank	2nd	1st
Global rank in ship building	Rank	22nd	Top 5
Develop World class next generation ports			

[1] In line with Draft National Green Hydrogen Mission Document Section 3.2 (f) stating that All Major Ports to have Green Hydrogen/Ammonia storage & bunkering facility.
[2] 14 refers to all major ports by 2047

Parameter	Unit	Where we are	Aspiration 2047
Overall Port handling capacity	MMTPA	2,500+	10,000+
% of cargo handled at PPP berths of Major Ports	Percentage	51%	100%
Number of transhipment hub	Number	1	3
Number of new Major Ports	Number	-	2
Ports with 18-23 m draft	Number	5[3]	13
Enhance efficiency through technology & innovation			
Ports with just-in-time arrival	Percentage	-	100%
Smart Ports	Number	-	5

[3] 5 ports include 1 Major Port (VPA) and 4 Non- Major Ports (Mundra, Krishnapatnam, Gangavaram & Dhamra)

Promoting blue economy in India

India's vast maritime interests have a vital relationship with the nation's economic system. The country is immensely reliant on the ocean. The Government of India's vision of New India by 2030 enunciated in February 2019 highlighted the Blue Economy as one of the 10 core dimensions of economic growth.

In pursuance of the Hon'ble Prime Minister thrust on Blue Economy, there have been 4 major initiatives that included comprehensive deliberation on the issues and challenges in the Maritime sector.

- Maritime India Vision 2030 by Ministry of Ports, Shipping and Waterways
- Draft Maritime Policy by NITI Aayog
- India's Blue Economy- a draft Policy Framework by EAC-PM
- ADB Report on Promotion of Coastal Shipping in India

It was observed that there was no single national agency for coordination and integration of maritime activities that fall under diverse domain - maritime ocean and costal economy, infrastructure, environment, energy, diplomacy, safety and security, ocean technology and resources, shipping, international law, culture and tourism, island development etc. These issues are presently dealt with by several ministries, authorities, agencies and departments individually. Further, reports have suggested for cohesive maritime/ocean governance framework to ensure communication, coordination and clarity between multiple stakeholders and multiple level of administrative authorities and coastal communities, for achieving better outcomes. This will avoid work in silos and duplication of efforts.

On the behest of NITI Aayog, Ministry of Ports, Shipping and Waterways (MoPSW) prepared Amrit Kaal Vision 2047. To devise the above vision and action plan, MoPSW had constituted 13 Working Groups for deliberations & preparing a roadmap with specific implementation plan on the work area designated to each Group. Under this assignment reports and presentations have been prepared in consultation with 13 working groups.

A brief skeleton of the 13 groups is given below with the Working Group Coordinator, who were identified based on the topics covered under each working group:

WG #	Working Groups	Coordinator
WG #1	Bridging the gap between the functioning of Indian Maritime Administration and the priorities of International Maritime Organization (IMO)	DG Shipping
WG #2	Building partnerships and enhancing maritime cooperation with India Ocean Rim Association (IORA) member States and Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC)	VC, IMU
WG #3	Strengthening connectivity (ferry, cruise and cargo) with neighboring countries such as Bangladesh, Sri Lanka, Maldives, and Thailand. Developing cruise tourism domestically and circuits across neighboring countries	Chairman, CoPA
WG #4a	Strengthening the India's capabilities in the domain of port logistics	Chairman, VoCPA
WG #4b	Strengthening the India's capabilities in the domain of maritime finance and insurance	Chairman, JNPA
WG #4c	Strengthening the India's capabilities in the domain of maritime law & developing leadership in maritime arbitration	MD, IPA
WG #4d	Strengthening the India's capabilities in the domain of technology in maritime sector	CMD, KPL

WG #	Working Groups	Coordinator
WG #5	Building partnerships, collaborations and international cooperation for promoting maritime domain. Promotion of world class education research and training facilities	VC, IMU
WG #6	Promoting marine clusters taking into consideration the best practices to promote blue economy related industries	Chairman, SMPK
WG #7	To develop policy measures to facilitate Indian shipping tonnage, ship building and marine structures capacities with a thrust on Make in India and Atmanirbhar Bharat	CMD, CSL
WG #8	Addressing UN SDG goals in key environment, safety and health areas for Indian ports and maritime bodies. Formulation of plan to introduce best practices and addressing the marine pollution, and promotion of the green shipping	Chairman, DPA
WG #9	Development of Islands as Maritime Cities	Chairman, ChPA
WG #10	Promote Coastal Shipping and urban water transport	Chairman, MbPA

Theme 1

Lead the World in Safe, Sustainable & Green Maritime Sector

GREEN PORTS

CURRENT LANDSCAPE

Ports, during construction and operation phase, pose environmental impact on land side as well as on waterfront side. They are the major sources of air, water, soil, and noise pollution.

Pollution caused during construction phase

On the land side, construction of a port/ terminal/ berth impacts habitat of animals due to cutting of trees and clearing vegetation. Further, construction activities degrade air quality due to dust suspension, increased vehicular movement. There is also generation of waste material from construction which pollutes land or coastal waters if not properly disposed or reused.

On the waterfront side, dredging results in silt material which is a threat to marine ecology if there is no proper channel for disposal of dredged material. Further, construction of port infrastructure changes the marine ecosystem in the area which harm the marine environment and species existing there.

Pollution caused during operation phase

There are environmental impacts after the start of operations as well. Pollution of air is caused by SO_2, NO_x and PM emissions from engines of ships, tugs, boats running in the port, Diesel Generators, welding, cutting etc. during maintenance activities, and due to vehicles used in various port operations. Use of heavy machinery in port premises cause noise pollution & also contribute to emissions. Spillage of chemicals, oil from bulk handling devices cause soil pollution. Waste generated from port activities also contribute to pollution of soil in the area.

There are negative impacts on water quality due to operations at the shore. Loading/ unloading of cargo may result in spillage of cargo into the surrounding waters when not carefully planned and executed. Pigging lines are used to transports liquid products through the port. Pigging lines are cleaned using water. Discharge of this water into the water body would result in water pollution at a high scale. There is also wastewater generation from other port activities such as cleaning of liquid waste cargo spillages, domestic wastewater generation from residences within port area, discharge of untreated sewage into surrounding water body that lead to great damage to ecosystem. Ships use their ballast water system to balance the vessel while completion of operations at the port. Ballast water is discharged into the water body after completion of the operations. This causes impact on marine biodiversity as invasive species are transferred through ballast water. Oil spills from ships is another major contributor of marine pollution damaging the ecosystem. Metals can contaminate the water during ship maintenance operations. It also poses the risk of entering the food chain through aquatic animals. A United Nations Environment Programme (UNEP) report, 2015 pointed out the following as state of severity of pollution in Indian seas.

- India dumps 0.6 MMT plastics in the oceans every year, the quantities are rising
- India ranked among 12 in top 20 countries responsible for marine pollution
- Plastic debris to sea are contributed by river systems – Three of ten rivers that contribute 90% to plastic debris to oceans are in the India subcontinent – Indus, Ganga, and Brahmaputra (Environmental Science and Technology, 2017)

Safety is a concern in ports as they are prone to natural disasters and accidents

Port safety is one of the main aspects to be looked at in the modern ports. Ports need to be safe in addition to being efficient in their operations. Ports need to provide a safe environment for its workers. Since ports are in coastal area, they are prone to natural disasters such as cyclones, tsunamis, floods, etc. Such disasters can wreak havoc on port operations if effective safety and recovery process are not put in place. Ports also need to have safety and rescue plan for vessels and cargo. Accidents are another deterrent in safety of ports. Vessel

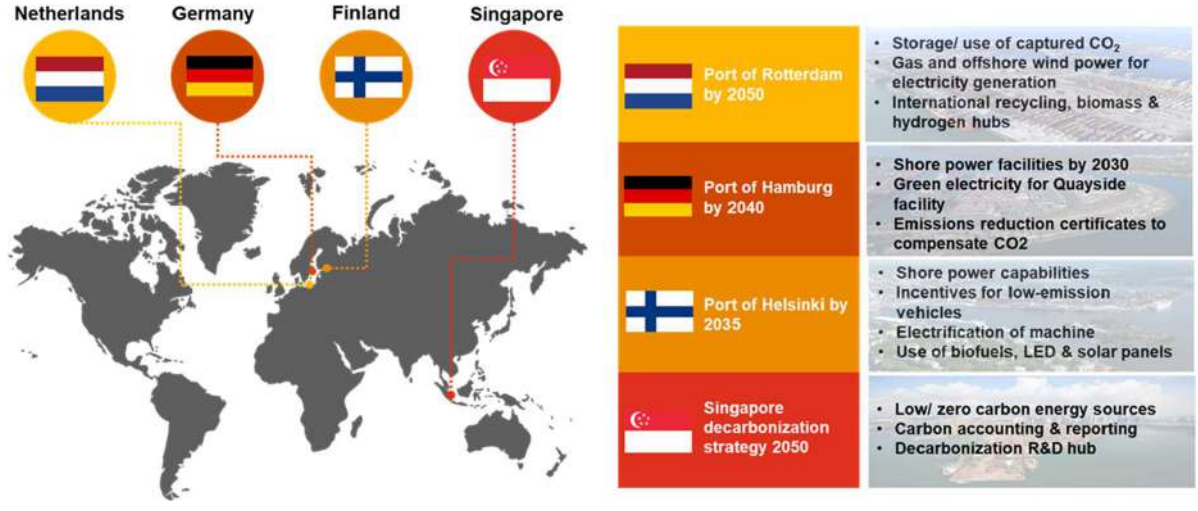
collisions, accidents related to equipment, safety in relation to hazardous materials need to be looked at for safer port operations.

GLOBAL PORTS AIMING TO BECOME CARBON NEUTRAL BY 2050

Restricting the rise of the average temperature of the earth through cutting carbon dioxide emissions is the shared global goal of humanity. Ports and maritime sector would also need to reduce its share of carbon emission and become carbon neutral in the years to come. There are several ports around the globe which are making strategies and targets to become carbon neutral in future. For instance:

- Port of Rotterdam is aiming to be carbon neutral by 2050. In this regard, they have started making steps towards following areas – supply and reuse of surplus energy through steam exchange and heat network, storage/use of captured CO_2 in greenhouses, replacement of coal with gas and offshore wind power for generation of electricity, development of international recycling hub, biomass hub and hydrogen hub
- The Hamburg Port Authority (HPA) is guided by the city of Hamburg's objective to become a carbon neutral port by 2040. The port aims that all the major terminals to be equipped with on shore power facilities by 2030. The Hamburg quayside facility is now primarily powered by green electricity (electricity from renewable sources). Further, the port compensates for CO_2 emissions that are still being generated from port-based activities through emissions reduction certificates supporting projects such as wind farms in India, low-friction anti-fouling paint for ship hulls and reforestation of rainforests in Panama
- Port of Helsinki is set to become carbon neutral by 2035.To achieve the goal, port is taking various initiatives such as shore power capabilities for nine berths, introducing incentives to use low-emission vehicles, enabling the electrification of work machine infrastructure, encouraging the use of biofuels, minimizing the Port's energy consumption by installing LED lighting, and increasing the use of solar panels.
- Maritime Port Authority of Singapore has developed a decarbonization roadmap for transition to low/ zero carbon energy sources by 2050. Further, a dedicated R&D hub is developed for decarbonization technology development.

Figure 1 Global ports aiming to become carbon neutral by 2050



KEY INITIATIVES

As mentioned below, initiatives towards greener ports have been divided into two key areas.

Infrastructure initiatives – It focus on initiatives which are environment friendly and helps in reducing pollution generated from marine operations and conserving marine ecosystem. Following are the initiatives identified under this area:

- Development of carbon neutral ports in India in next 25 years 'Amrit Kaal' and reduce GHG emissions through sustainable solutions such as usage of green fuels, electrified/ renewable energy-based yard equipment, vehicles & vessels, shore to ship power supply arrangement etc.
- Creation of port infrastructure ready for future like Hydrogen hubs

Policy and regulatory initiatives – Any new initiative would require policy push from the government for faster adoption by ports. In this regard, following initiatives have been proposed:

- Implementation framework to adopt green initiatives in terminal operations
- Incentive mechanism for discounts in port dues for vessels with lower emission
- Creation of Disaster management plans for all ports to minimize the losses in terms of human lives, assets and environmental damage and resumes working condition as soon as possible
- Creation of maritime disaster centers (2-3 each on east and west coast)
- Development of dredging
- monitoring toolkit to monitor emissions and resource consumption at ports

INFRASTRUCTURE INITIATIVES

DEVELOP CARBON NEUTRAL PORTS AND REDUCE OTHER GHG EMISSIONS

Carbon dioxide emissions are caused by vessels, work machines, heavy traffic, and the port's own operations. Based on the sources of emission, following strategic areas have been identified and their implementation timeline have been mapped to achieve carbon neutrality at ports.

Figure 2 Strategic areas to achieve carbon neutrality

Strategic Areas	Already implemented	Short term				Medium term	Long term		
	Upto 2021	2022	2023	2024	2025	(2026-2030)	2030-35	2035-40	2040-47
Clean fuel – land based		Battery operated vehicles MHC electrification		Pilot Adoption of alternate fuels such as LNG, blended biofuel-based vehicles		All the port equipments including cranes electrified	Adoption of alternate fuels such as LNG, hydrogen –based fuel cell biofuel by all ports		
Clean fuel – water based	Ports crafts provided with shore electricity at many ports		License for supply of shore power to vessels Truck to ship LNG bunkering		Shore electricity to Coastal vessels	Shore electricity to EXIM vessels Ship to Ship/ Shore to Ship Bunkering	Complete use of shore power for all vessels on ports		
Renewable/ clean energy	20 MW wind energy generation			Converting the port buildings into IGBC Platinum buildings	Hybrid energy Generation	Transfer of hybrid energy to other ports/ industries Develop Hydrogen hubs at port	Complete Hydrogen supply system for port including energy generation	Develop systems to capture Carbon Dioxide	Zero Vehicular Carbon Footprint at ports
Recycling/ Greening	Green belt at many ports	Mechanized truck for fogging & road sweeping Green belt at vacant areas	Decarbonization cell	Solid waste management and Sewage treatment		Use of dredged material for construction activities	Achieve target of 33% green cover on port Implement Circular Port Strategy including for the Coastal Economic Zone		

INCREASE USAGE OF ALTERNATE FUELS (LNG, CNG ETC.) TO REDUCE AIR EMISSION

Ports are the major source of air pollution. It generates pollution from two type of activities – land-based activity and sea-based activity.

Land based activities – On the land side, ports contain a vast array of diesel-powered machinery: straddle carriers, terminal tractors, reach lifters. Diesel powered engines result in elevated emission of various pollutants. They also make a lot of noise, another form of pollution. Further, ports handle large amounts of bulk materials e.g., aggregates, foodstuffs, fertilizer, and wood products. These materials in dry and windy conditions inevitably

result in dust drifting into neighboring areas. Dust, because it can be seen and felt by affected people, can be a major nuisance.

Sea based activities – On the seaside, ship is berthed at the terminal for cargo loading and unloading activity. Shipping vessels run on heavy fuel oil. Heavy fuel oil is much cheaper than the petrol used in land transport, but it also has a high polluting impact. The SO_2 content of Heavy Fuel Oil is 2700 times higher than road fuel. In developed countries SO_2 emissions have been dropping so that now SO_2 pollution is rare in urban environments. The main SO_2 source remaining is from ships coming into port.

This pollution causing an array of environmental impacts, can seriously affect the health of workers, and contributes significantly to regional air pollution from ships and ports.

Major air pollutants generated by port activities include carbon monoxide (CO), volatile organic compounds (VOCs), nitrogen oxides (NO_x), sulfur oxides (SO_x), and particulate matter (PM). The health effects of prolonged exposure to these compounds include respiratory diseases, cardiovascular disease, lung cancer and premature death.

Clean fuels to reduce emission from land-based activities

In India, currently, diesel alone meets an estimated 72% of transportation fuel demand followed by petrol at 23% and balance by other fuels such as CNG, LPG etc.[4]. for which the demand has been steadily rising. Green fuels have been adopted at many ports across the globe to reduce the consumption of conventional fuels and cut down air pollution emission.

Figure 3 International examples for clean fuel usage at ports

Use of LNG/ CNG as a fuel source for the vehicles - While LNG & CNG fuels sources are attractive commercially, infrastructure availability and short-term incentives will drive full-fledged adoption across ports. Hence, there is a critical need to build suitable infrastructure for driving clean fuels adoption at ports.

In India, Central Govt. has also taken several steps to provide thrust for private participation in clean fuel such as:

- PNGRB declared that any eligible entity can set up LNG station anywhere in the country
- Common guidelines launched to set up dealer operated CNG stations in India (Feb'19)

[4] National Policy on Biofuels, 2018

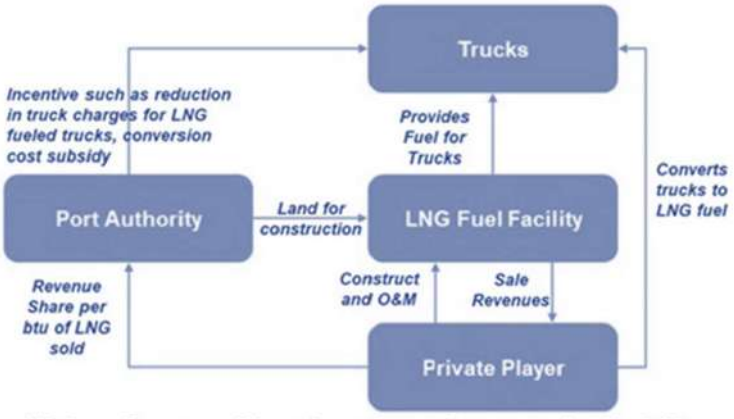
Further, some of the major ports are already on their path to adopt cleaner fuels such as LNG and CNG. For instance, Paradip port Authority is in the process of tendering the construction of LNG fuel depots. It is in discussion with Indian Oil Corporation Limited (IOCL) and Bharat Petroleum Corporation Limited (BPCL) for supply of LNG to the fuel depot.

Intervention – Port Authorities to explore PPP model for conversion of trucks and for development and O&M of LNG fuel station at ports. Pilot adoption of PPP model to be explored at JNPT, Chennai and Paradip port and further, the model to be extended to other ports

Following PPP structure (refer below figure) is proposed for faster adoption of LNG based trucks.

- Private player will provide services to install LNG engines on diesel trucks, set-up LNG station in port premises and sell LNG to truck operators
- Petroleum companies will supply LNG to LNG stations
- Port authority will provide land for setting up LNG facility. Converting diesel trucks to LNG based trucks will come at a cost, therefore, port authority will provide conversion cost subsidy. In return, port authority will receive a revenue share from private player on per btu of LNG sold. Further, in order to make faster and smooth adoption of LNG trucks, port authority will provide a fixed time period (2-3 years) beyond which it will not provide entry to diesel-based trucks

Figure 4 Structure for developing LNG fuel facility for trucks



Floating Storage Units for storing LNG fuel

LNG is a viable and environment-friendly renewable fuel. However, the transportation of LNG is a bit difficult. Any slight mishandling could result in loss of precious lives and precious fuel. Any kind of spillage in the ocean can further lead to degradation of the oceanic eco-system. Therefore, it becomes very important to safely store and transfer LNG fuel to the oceanic vessels and other LNG land- based vehicles.

Floating Storage Unit (FSU) is an offshore structure which can store LNG. In other words, any structure can be considered as FSU in any form as far as it is afloat on the sea and is capable of storing LNG. In that sense LNG carrier can be used as a FSU, and a tank lorry can be called a FSU as long as it is mounted on top of barge and released afloat. Main purpose of using FSU is to supply LNG safely to a regasification facility and occasionally to play a role as a temporary terminal in order to redistribute LNG cargo to small scale LNG carrier. Typically, LNG FSU can be used in the several cases shown in the following examples.

1. LNG FSU can be used in the environment where LNG storage tank cannot be constructed on land. Also, it can be used in the project whose scale is not profitable when LNG storage tank is installed on land considering the construction cost of the land terminal
2. LNG FSU can be used in case of utilizing an already existing and operating vessel as a replacement for FSU due to a tight construction schedule
3. LNG FSU can be used in case an additional storage facility is needed when operating a FSRU where large capacity regasification facility is mounted

As for an FSU, typically LNG carrier with more than 30 years of age is considered. Hence, to use this kind of old ship as a replacement for FSU, the performance of the main equipment and the condition of LNG cargo tank

must be considered as a priority. Additionally, evacuation sailing plans must be provided (tugboat or self-propulsion) if the area is affected by the typhoon or hurricane.

For small and medium size projects where FSU of adequate capacity cannot be readily available, even a recently constructed LNG carrier can be used as an FSU. In the given charter rate, it is more economical to construct FSU than to construct LNGC.

Internal ferry trucks based on biofuels - Pollution is increasing day by day and one of the major reasons behind this is vehicles pollutants, that come out due to the use of petrol or diesel-based vehicles. Biofuel is an alternative fuel to petrol and diesel. In conventional engines, petrol or diesel is burnt to create power but the process produces harmful carbon dioxide, nitrogen dioxide and other GHG gases. On the other hand, biofuels are made from organic material such as vegetable oil from plants and produce fewer emissions as a result.

The most common type of biofuel are bioethanol and bio diesel. Bioethanol is an alcohol which uses carbohydrates found in the sugars and starch of crops such as corn, sugarcane, or sweet sorghum. Biodiesel on the other hand, is produced by reacting vegetable oil or animal fat-based with alcohol.

Biodiesel can be used as fuel for a diesel engine, either as a direct replacement or blended with regular diesel. In most countries, biodiesel is generally available to drivers in its blended form. This is because few manufacturers have 100% approved diesel engines for biodiesel use. The same goes for bioethanol. While it can be used as fuel in its most pure form, due to compatibility issues pure bioethanol is not widely used. Altogether, most blended biofuels with a low concentration are perfectly safe to use. However, most vehicles aren't compatible with biofuels in their purest form and could therefore be damaging to the vehicle.

Government has come up with the National Policy on Biofuels 2018, which includes harnessing of biodiesel to meet the energy security of India. The goal of the policy is to enable availability of biofuels in the market thereby increasing its blending percentage. Currently, the ethanol blending percentage in petrol is around 2.0% and biodiesel blending percentage in diesel is less than 0.1%. The policy is aimed at taking forward the indicative target of achieving 20% blending of ethanol in petrol and 5% blending of biodiesel in diesel by 2030.

Additionally, on World Biofuel Day, the Food Safety and Standards Authority of India (FSSAI) launched RUCO – Repurpose Used Cooking Oil, an ecosystem that will enable the collection and conversion of used cooking oil to biodiesel. The Policy aims to increase usage of biofuels in the energy and transportation sectors of the country during the coming decade.

Intervention - In the short term, biodiesel/ bioethanol can be blended with diesel/ petrol as per the present Government guidelines (ethanol blending percentage in petrol is around 2.0% and biodiesel blending percentage in diesel is less than 0.1%.) as it does not require any significant alterations in the existing engines. Port Authorities to explore PPP model for conversion of trucks and for development and O&M of Bio-diesel retail outlets at ports. Pilot adoption of PPP model to be explored at JNPT, Chennai and Paradip port and further, the model is to be extended to other ports. The PPP structure can be similar to LNG based vehicles.

In the long run, usage of biodiesel in its purest forms to be promoted as technology and hardware becomes more accessible.

Use of battery-operated equipment - Battery or electric driven trains offer better economics than diesel engines. Hence, many global ports are opting for electrification of all equipment to reduce environmental impact and simultaneously lower operations costs. Today, most container handling cranes in Indian ports are driven by electric drives[5]. In liquid cargo terminals, 90% pumping, conveying, storage & product evacuation systems including all pumps & motors are electric driven. In Aug '21, JNPT commenced operation of 9 electric vehicles for the movement of its employees within the premises and also operationalized a dedicated charging station[6].

[5] Maritime India Vision 2030

[6] https://auto.economictimes.indiatimes.com/news/industry/jnpt-deploys-9-e-vehicles-for-movement-of-employees-in-premises/85098412

V.O. Chidambaranar Port Authority has recently deployed three e-cars for its officers[3] and three more e-cars are to be deployed in near future.

Intervention: Electrification of equipment moving cargo at port area e.g., RTGCs, reach stackers, straddle carriers, forklifts, etc.

Additionally, Ports shall mandate purchase of electrical equipment as a replacement for existing equipment to achieve full electrification over the next 10 years.

Hydrogen, Ammonia based fuel cells to power port-side equipment/ vehicles - A fuel cell uses the chemical energy of hydrogen or other fuels to cleanly and efficiently produce electricity. Fuel cells have lower, or zero emissions compared to combustion engines. Fuel cells work like batteries, but they do not run down or need recharging. They produce electricity and heat as long as fuel is supplied. If hydrogen is the fuel, the only products are electricity, water, and heat. However, on-board hydrogen storage remains a big challenge, which limits the application of hydrogen fuel cells on electric vehicles. Alternatively, hydrogen can be stored in some light chemicals such as ammonia.

Fuel cells using ammonia as the fuel is being developed to recover the energy stored in ammonia to overcome critical technical barriers to fuel cell development. Cost, performance, and durability are still key challenges in the fuel cell industry.

Intervention – MoPSW to work closely with national laboratories, universities, and industry partners to overcome critical technical barriers to fuel cell development and provide requisite support for faster adoption of hydrogen, ammonia-based fuel cells

Clean fuels to reduce emission from waterfront-based activities

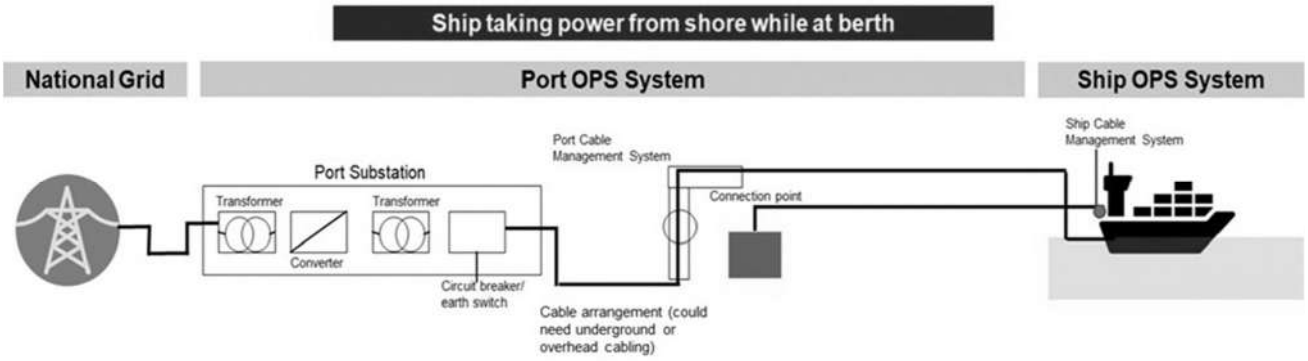
Shore to ship power supply - Ocean-going marine vessels represent one of the largest, most difficult to regulate, source of air pollution in the world and are also an essential component of the international trade and goods movement process. It is estimated that in year 2025 the on-sea trading volume in the world will be tripled compared to year 2008[7]. These vessels are similar to floating power plants in terms of power and would surely be subjected to stricter regulations if their emissions had been generated onshore.

While in port, ships use their diesel auxiliary engines to produce electricity for hoteling, unloading and loading activities. Main engines are usually switched off soon after berthing. The auxiliary engines today are running on cheap and low-quality fuel. It is known that ship's fuel contains 2700 times more Sulphur than the gasoline[8] used in cars, and together with aviation, shipping is one of the biggest emitters of pollution.

One measure to reduce emissions while at berth, is to provide electricity to the ships from the national grid instead of producing electricity by the ships own auxiliary diesel generators. To provide ships with electricity, a shore-side electricity supply arrangement is required.

[7] Batley, Plenys, Solomon, Campbell, Feuer, Masters & Tonkonogy (2004) Harbour pollution, strategy to clean up U.S. Ports. Los Angeles
[8] Schmit, H-E. (2006) SIHARBOR-Shoreside power supply for ships to reduce pollutant emissions

Figure 5 Ship taking power from shore while at berth



Onshore Power Supply (OPS) arrangement consist of two main components – Port Onshore Power Supply and Ship Onshore Power Supply. Details are as follows:

Port OPS System

- **Main Substation Building -** The main substation building represents the heart of the system and makes the centrally placed unity in the establishment. This facility contains coupling equipment such as, breakers, disconnectors, surge arrester and transformers to couple the shore-side connection infrastructure to the national grid**.** It transforms 20-100 kV electricity from national grid down to 6-25 kV.

  It will also have power conversion facility, where necessary. *(Electricity supply in the Community generally has a frequency of 50 Hz. A ship designed for 60 Hz electricity might be able to use 50 Hz electricity for some equipment, such as domestic lighting and heating, but not for motor driven equipment such as pumps, winches, and cranes. Therefore, a ship using 60 Hz electricity would require 50 Hz electricity to be converted to 60 Hz).*

  ***Dual-voltage transformer** is used to step down the voltage from the local power grid to 6.6 kV or 11 kV*

Figure 6 Dual-voltage transformer

- **Cable arrangement -** The cable arrangement from the main substation building out to all shore-side transformer stations will be underground cables preferably on 24 kV in order to reduce the current in the conductors as much as possible which simultaneously gives lower transfer losses**.**

Figure 7 Shore-connection

The first shore connection in Port of Goteborg, installed in 1989 at the Kiel terminal. Building in picture includes transformer & cable arrangement equipment

- **Shore side transformer station -** Every single berth that will be shore-side power supplied will be equipped with a shoreside transformer station as close to the berth as possible. The transformer station contains the transformer, which is the last link between the electric grid at shore and the electric system on the vessel. The transformer station also includes a smaller switchgear with a secondary circuit-breaker together with disconnection and earth-switch equipment of the outgoing cables. The last part of the shore-side power supply is the connection point where the vessels actual connection is made

- **Shore-side connection arrangement -** The last part of the shore-side power supply infrastructure is the connection point where the vessels actual connection is made**.** It may have cable reel system, to avoid handling of high voltage cables. This might be built on the berth supporting a cable reel, davit, and frame. The davit and frame could be used to raise and lower the cables to the vessel. The cable reel and frame could be electro-mechanically powered and controlled.

  In Fig: Cables are provided by the ship and are lowered to the connection vault

Figure 8 Cables for connection

Ship OPS System

- **Vessel connection requirement -** The vessel will be utilized with equipment to allow connection to the electric grid on shore**.** The connection cable shall in great extend as possible be provided by each vessel and beneficially be arranged with the help of a cable reel system, to avoid handling of high voltage cables. It also contains transformer to transform the high voltage electricity to 400 V.

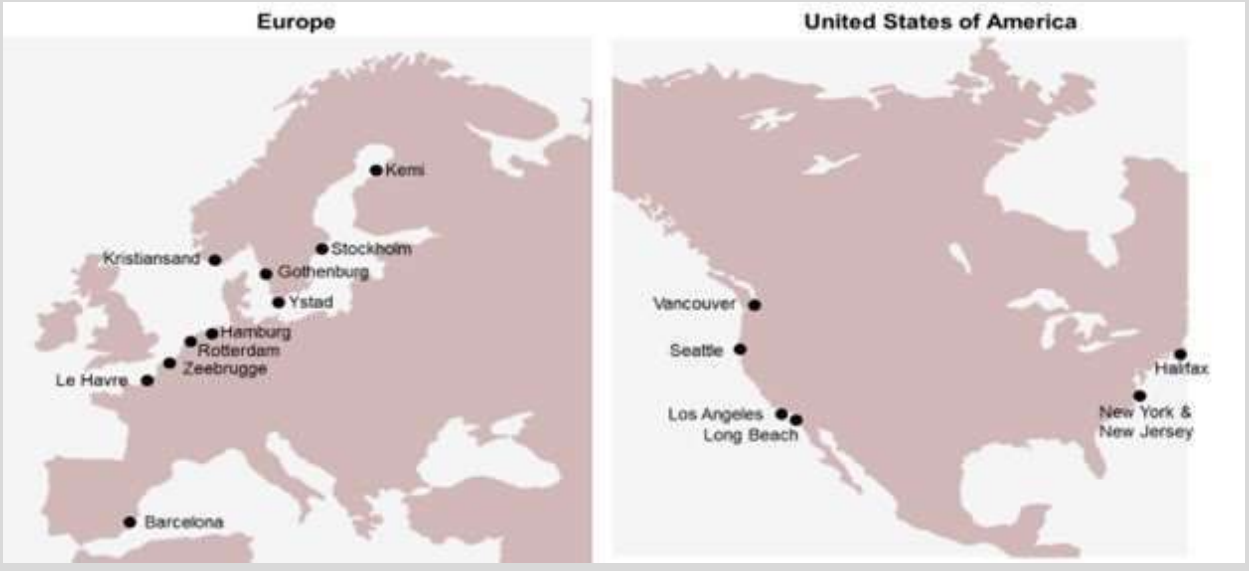
Below is a case study on shore-side power supply adopted by various ports across the globe.

Figure 9 Case Study – Shore side power supply adopted by various ports across the globe

Case Study – Shore side power supply adopted by various ports across the globe

Shore-side power supply has been used since the 80s for supplying commercial vessels with electricity. Ferries were the first vessels to be shore-side connected. The reason for this was that they always docked in the same position making it easy for connection. Today, other types of commercial ships, such as, cruise, container, and Ro/Ro vessels are connected to the electrical grid in ports around the world.

Currently ~65 ports worldwide that have applied shore-side power supply in their electrical infrastructure, and they have experienced a radical improvement of the environment at their port. This has resulted in that ports worldwide have started to investigate the possibilities with shore-side power supply. Below is the geographical location of 16 key ports.



In order to make a technical design, the onboard electric system on the vessel has to be investigated. Power demand varies depending on what type of vessel. The port must be aware of the vessels power demand, system voltage and system frequency when designing the shore-side power supply facility. Below is the table representing power capacity, system voltage and system frequency for different terminal type across different ports in the world.

Existing shore-side power supplies in the world applied for different terminal type

Terminal Type	Country/Location	Connection voltage (kV)	Frequency	Power Capacity (MW)
Container	Los Angeles, Long Beach, Vancouver	6.6	60	7.5
Cruise	LA, Vancouver, Seattle, Kristiansand, Hamburg	6.6	50-60	12
RoPax	Rotterdam, Ystad, Gothenburg, Stockholm	12.5	50-60	20
Ferries	Gothenburg, Kristiansand	6.6	50-60	0.8
Multipurpose	Zeebrugge, Kemi	11	50	3
Offshore	Kristiansand	0.4	50-60	1
Mega Yatchs	Barcelona	11	50	2.5
River Barge	Haropa	6.6	50	1.25

OPS equipment – As per the study conducted under World Ports Climate Action Program (WPCAP), following are the average number of OPS equipment required by port.

Equipment	Average per port*
Transformers	6
Circuit breakers	9
Connection points	14
Switch gears	8
Frequency convertor	1

Mobile cable reel	1

**Note: Following ports are taken into consideration for calculating average number of equipment required – Port of Rotterdam, Zeebrugge, Ystad, Vancouver, Seattle, New York and New Jersey, Long beach, Kristiansand, Hamburg, Gothenburg, Stockholm, Los Angeles*

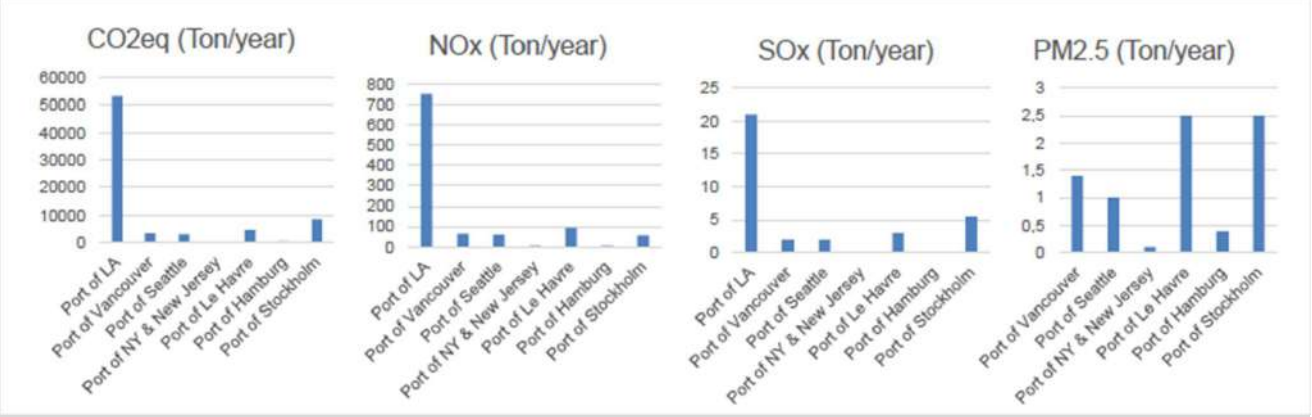
Operations – OPS system are majorly run by port authority followed by terminal operator and shipping company. However, there are also few instances where external operator runs the OPS system.

Main safety and risk preventive measures implemented in ports

- Training of staff
- Proper grounding of faults
- Opening of circuit breakers on both ship and shore when faults occur
- Efficient disconnection during emergencies for weather or excessive vessel movement relative to pier
- Efficient communications between vessel and shore personnel
- Standardized operating safety procedures shared by ship crew and shore side operators
- Indication lights show that the connection is safe to touch

Source of electricity – Majority of the ports are using national grid as a source for electricity. There are ports such as Ystad, Hamburg, Stockholm which have started using renewable energy for generating electricity.

Environment – Due to adoption of OPS system, ports have managed to significantly reduce emissions**.** As shown below, Port of Los Angeles is the front runner amongst other ports in terms of emission reduction in CO_2, NO_x, SO_x, and PM 2.5. This is mainly due to the fact the Port of Los Angeles has high number of berths equipped with OPS system (25+ berths) whereas other ports have less than 10 berths equipped with OPS system.



Discounts, Rebates and Penalties - As per the study conducted under World Ports Climate Action Program (WPCAP), cost and ROI are the key barriers faced by shipowners to adapt their vessels so they can connect to the OPS system. 16 ports namely Port of Rotterdam, Port of Zeebrugge, Port of Ystad, Port of Vancouver, Port of Seattle, Port of New York & New Jersey, Port of Long Beach, Port of Los Angeles, HAROPA Port of Le Havre, Port of Kristiansand, Port of Hamburg, Port of Halifax, Port of Gothenburg, Ports of Stockholm, Port of Barcelona, Port of Kemi were studied to understand the available discounts, rebates offered, and penalties levied by port authorities. As per the study, 60% of the ports are providing discounts, rebates to ship owners for using OPS system in port and 73% of the ports are levying penalty if the ship does not connect to the OPS system available at berth.

Shore to ship power supply could help in reducing GHG emissions at ports and save costs as well. It has various benefits such as reduced fuel consumption, reduced maintenance of vessel, reduced fuel costs, etc. Shore to ship power supply could reduce CO_2 emissions by 60 metric tons during a 10-hour at port which is equivalent to yearly emission by 150 cars travelling 50 kms a day. It would also save fuel cost of ships by Rs. 10-12 per unit.

Thus, supply of shore power will be a major step forward for reduction in carbon footprint for Indian ports.

Intervention – Prioritize port-based vessels in 1st phase to provide shore to ship electricity followed by Indian coastal/ EXIM vessels

Currently, first phase of providing shore to ship electricity to port-based vessels (tugs, port crafts) is already being implemented in some of the ports. For instance, Vishakhapatnam port is giving shore to ship power for tugs. Kamarajar port also has shore power supply for tugs and pilot boats. Chennai port gives shore power to vessels including coast guard vessel. Cochin port has infrastructure for shore power at 11 berths. Mormugao port Authority supplies shore power to cruise, tugs, and Indian coast guard vessel. Shore power supply operations for coast guard and port vessels has stated at Mumbai port Authority. JNPT is currently supplying shore power to tugs. Other ports should also follow suit and expedite the phase-1 implementation of shore to ship electricity.

Once the phase 1 is fully implemented, ports can start phase 2 implementation process wherein they can provide necessary infrastructure to Indian coastal and EXIM vessels for receiving shore to ship electricity.

Figure 10 Phase wise implementation of shore power supply at Indian ports

Key model parameters	Short Term Port crafts & ancillary vehicles	Long Term Indian coastal and EXIM
Power consumed by vessel *(Power supply readiness of State electricity board a constraint)*	Low: Lesser power consumed due to smaller vessel size	Med for shorter/coastal Navigation High for long haul transport
Residence at Port *(Degree of emissions at ports)*	High: Vessels used for internal port operations	Med for vessels moving from one Indian port to other Low for In-transit at particular Indian ports
Social economic benefit *(Cheaper options first for local Indians owning smaller vessels)*	Benefit flowing to local Indians owning/ operating the vessels	Benefit flowing to local And international trade
Vessel description	Port based tug boats	Indian Vessels carrying cargo on shorter duration and foreign vessels for export/import

Following are the aspects to be considered while implementing shore-to-ship power supply facility at the ports.

Development model - Ports shall look to assign a revenue sharing contract to an external entity which will invest in the Ship-to-Shore facility and operate the same.

Distribution license - As per Electricity Act 2003, commercial power transmission, distribution and trading is not permitted by any entity other than DISCOMs. MoPSW to align with Ministry of Power so as to allow ports for commercial power distribution.

Technical specifications - Technical standardization across ports to be aligned. Power demand varies depending on the type of vessel. The port must be aware of the vessels power demand, system voltage and system frequency while designing the shore-side power supply facility.

Figure 11 Ship to ship LNG bunkering

LNG bunkering - Different types of ships, including cruise and containers ships, are fitted with engines which can burn LNG fuel to reduce harmful emissions from the exhaust of the ship.

LNG fuel is different in properties when compared to conventional heavy fuel oil or LSFO used on ships. Due to its cryogenic temperatures where it can be stored and transferred, the procedure for transferring the fuel into the ships requires a safer approach when compared to other fuel oils.

LNG bunkering can be performed by following three methods:

Figure 12 Truck to Ship LNG bunkering

Truck to Ship - Among the various methods for in-port bunkering of LNG-fueled ships, Truck-to-Ship (TTS) transfer is currently most frequently used. With TTS, the LNG truck is connected to the ship on the quayside, generally using a flexible hose. This is today the most widely used bunkering method, because of the still limited demand in combination with the lack of infrastructure and the relatively low investment costs. For these reasons, truck-to-ship bunkering is a good provisional solution for LNG bunkering. For capacity reasons, truck-to-ship bunkering is most suitable for smaller LNG-fueled vessels with limited bunker volumes, like tugboats, inland vessels, coastguard vessels and smaller passenger vessels.

Ship to Ship - Ship-to-ship bunkering can take place at different locations: along the quayside, at anchor or at sea. The high investment cost for bunker vessels is considered the main barrier. The industry is hesitant to invest in such vessels, in part because they have only limited alternative operations when LNG bunker demand is limited. Given the high flexibility of bunkering vessels, ship-to-ship bunkering is suitable for large vessels such as RoPax/RoRo vessels, bulk carriers, and container vessels.

Shore to Ship - Another bunkering method is shore-ship, whereby LNG is either bunkered directly from an (intermediary) tank or small station, or from an import or export terminal. Pipelines from the terminal to the quay are needed if the LNG terminal is not directly situated at the berth. Shore-ship bunkering is especially suitable shipping services with a high frequency, limited demand, less strict timetables, and limited vessel draft. Examples include bunkering vessels, tugs, inland shipping vessels, utility vessels and fishing boats.

Figure 13 Shore to ship LNG bunkering

IMO has set standards and guidelines which need to be followed while transferring LNG. The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC code) needs to be followed by the bunker ships which carry the fuel and transfer it to the cargo or passenger ships. Whereas International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF code) needs to be followed by the ships which receive the LNG bunker fuel.

In India, the required infrastructure for providing LNG bunkering services is limited. However, some ports are taking steps to set up the facility. For example, Syama Prasad Mookerjee Port has identified land in Haldia for LNG storage and

bunkering. Further, there is also ongoing work for setting up Floating Storage Regasification Unit (FSRU) at Mumbai port Authority for LNG bunkering.

Figure 14: Leading global ports with LNG bunkering programs

Intervention - Indian ports to increase adoption of LNG by promoting awareness of LNG based vessels & establishing LNG bunkering stations in following manner.

- **Phase 1 - Truck to Ship bunkering** – In the first phase, ports should start providing bunkering services through truck to ship bunkering method due to the following reasons:
    - LNG demand is limited and therefore, limited capacity trucks would be suitable option
    - Relatively low investment cost than other methods
    - Trucks can also be used for LNG distribution for other purposes
- **Phase 2 - LNG bunkering (Ship to Ship Bunkering or Shore to Ship Bunkering)** – As the demand picks **up** and become stable, large capacity would be required. In this case, either of the following two methods can be used:
    - **Shore to ship bunkering** - In this method, LNG is either bunkered directly from an (intermediary) tank or small station, or from an import or export terminal. In this case, ports would need to be equipped with LNG terminal. However, other type of facilities such as FSRU, fixed storage terminal can also be explored for providing bunkering services.
    - **Ship to Ship bunkering** – This method is suitable for all type of vessels due to high flexibility of bunkering vessels. Ports would need to invite private participation for building and operation of LNG bunkering barge to serve ocean carriers. The commercial model in this method would be such that Government will get revenue share for every unit of LNG sold by private player.

Currently, LNG bunkering services are being provided at Cochin Port. Further, following ports may establish LNG bunkering facility – JNPA, Mumbai, New Mangalore, VOCPA, Ennore, Kolkata and the island city at Andaman and Nicobar Islands.

ACCELERATE ADOPTION OF RENEWABLE ENERGY

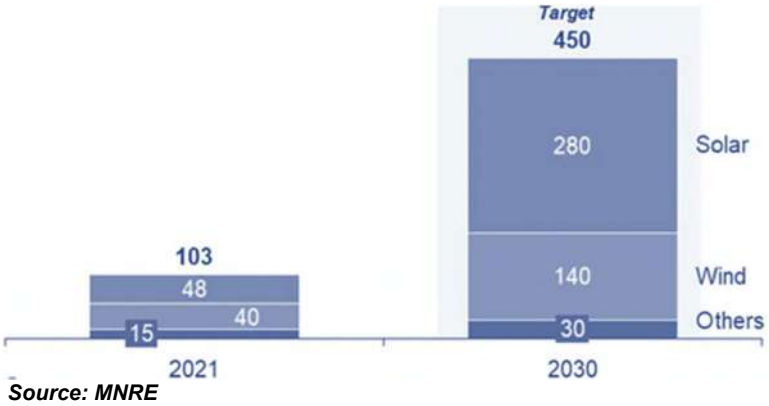
Renewable energy is energy that is collected from renewable resources which are naturally replenished. The main sources of renewable energy are solar, wind, tidal, wave, geothermal, hydropower, biomass etc., some of which are commercially viable, and some are still evolving to be economical and competitive.

Existing renewable energy capacity of India is ~103 GW as of Oct 2021(~38% of overall installed power capacity India). Solar energy is the major contributor to the renewable energy sector (48 GW). The current consumption of renewable energy at the Indian Major Ports is less than 10% of the total power demand. As per Ministry of Ports, Shipping and Waterways, India intends to increase share of renewable energy to 60% of total power demand of each of its major port.

Figure 15 Sources of renewable energy

Other sources constitutes Geothermal, Ocean thermal Biomass, Hydrogen, etc.

Figure 16 India renewable energy capacity and target



Source: MNRE

Solar Energy - In India, Solar power generation cost is lower than coal power generation cost. Most of the ports have installed solar PVs to utilize generated power in various operations.

For instance, cochin port Authority has already commissioned 250 MW of rooftop and floating PV. VoCPT has implemented 500KW rooftop solar power plant. 3.17 MW solar energy is being produced at JNPT and upcoming plant will expand this capacity by 2.5 MW in next two years.

Ports can plan long term for solar power generation and use as average lifespan of solar panel is 20-25 years. Solar power ecosystem would be a big part of renewable energy system of tropical country like India by 2030 and beyond.

Intervention - Accelerate adoption of renewable source of energy through usage of Solar PVs which can be extended to other ports for rooftop installation and for mooring and dolphin operation.

Figure 17 Rooftop Solar Panels in Port of Rotterdam

Figure 18 Solar Powered Mooring in Port of Hamburg

Wind Energy- Wind power is also evolving rapidly in India and can be installed at the breakwater and along the periphery of the port premises for energy generation. With national targets determined by the Ministry of Renewable Energy (5,000 megawatts of offshore wind by 2022, and 30,000 megawatts by 2030), ports would be optimum location for this endeavor.

Few major ports (e.g., DPT, V.O. Chidambarnar, Kamarajar Ports) have considerable installations. Deendayal has implemented 20MW wind energy plant.

Figure 19 Wind power

Intervention: It is the need of the hour that the Major Ports have a well-defined strategy to adopt emerging technology and focus on following steps:

1. Identify feasible areas for onshore wind farms across port land, shallow waters, and breakwaters
2. Explore setting up windmill farms through PPP structure
3. Leverage offshore windfarms potential at southern tip of the Indian Peninsula, offshore regions around the Port of Okha, and vast salt fields of Kutch region

INCREASING RECYCLING THROUGH CIRCULAR ECONOMY

The current global economy is a linear system: raw materials are extracted, turned into products and whatever remains is treated as waste.

The Port contains a large variety of waste flows which can be originated from port operations and industrial activity near port area. Following are the category of waste:

- Plastics and rubber: Plastics and rubbers are key materials in the global economy and exist in many types and forms. Plastics are found in almost every consumer product, packaging and industrial component. Although plastics can technically be recycled at a very high quality, many plastics flows are not captured, sorted, and recycled.
- Biomass: Biomass and organic materials flow through the economy in tremendous quantities, from the foods that we consume to the vast range of applications for products derived from wood. The extraction, processing and consumption of bio-based goods and products are also associated with large quantities of wastes that include food waste; paper, pulp, and wood wastes; and a range of organic liquids and sludges, for example, as a result of sewage treatment.
- Metals: ferrous and non-ferrous metals
- Minerals: Enormous quantities of mineral wastes are produced, including construction and demolition waste, soil, sand and gravel, glass waste and a wide range of other mineral wastes from industry near port.
- Chemicals: The Chemical industry near ports produces a wide range of chemical wastes, including diverse acids and bases, solvents and catalysts used in organic and inorganic chemical processes. Additional wastes come from other industries that manufacture paints, adhesives, and chemicals for the photo industry. Next to this, the sector produces significant amounts of chemical sludges, aqueous substances and washing liquids
- Industrial waste: Energy, agri-food and other industries are also important sectors in the port area. These industries produce a wide array of industrial wastes that include industrial oils, solid wastes and industrial sludges and liquids.

- Other waste: In the previous sections, the most prominent heterogeneous flows of waste through the port have been presented. In addition to these, waste such as manufacturing goods, components, electronic equipment etc., which are not attributable to any of the above-mentioned category, are placed here.

Globally, ports such as Port of Rotterdam are moving towards establishing themselves as circular hubs. Port of Rotterdam is strategically well-positioned to develop into a circular hub due to following reasons:

- It has a large ecosystem of companies exchanging outputs (products and waste products) among themselves. This essentially means output of one company can act as a feedstock for the other company and vice versa. Examples are the exchanges of low-temperature steam between Lyondell and Covestro in the port, residual heat of the Shell refinery for district heating in the city of Rotterdam, and CO_2 from Alco and Shell for the greenhouses in the province of Zuid-Holland.

- Further, infrastructure, utilities, and land (co-siting) are shared among companies when possible. This enhances the business and material performance of companies, having the result of limiting waste as much as possible while making the port a more attractive area to conduct business. Port of Rotterdam is currently working on collective waste treatment installations for wastewater and organic waste flows, which will deliver technical advantages, cost reductions and environmental benefits for the companies involved.

- The local industry, logistics sector and surrounding region generates a wide variety of waste flows. Valorizing and recycling these residual flows offers Rotterdam new economic opportunities and societal benefits through efficiently utilizing available resources and reducing carbon footprint. In this regard, the port is acting as a breeding ground for start-ups which work on innovative technologies to convert waste to value.

The Port Authority is actively advancing four circular pathways in collaboration with a range of partners to make the port and port-based supply chains more circular. The pathways are: Innovation Ecosystem, Sorting and Recycling, Industrial Symbiosis and Carbon Capture Utilization & Storage (CCUS). The details are presented below:

Figure 20 Case study - Port of Rotterdam transition towards circular port

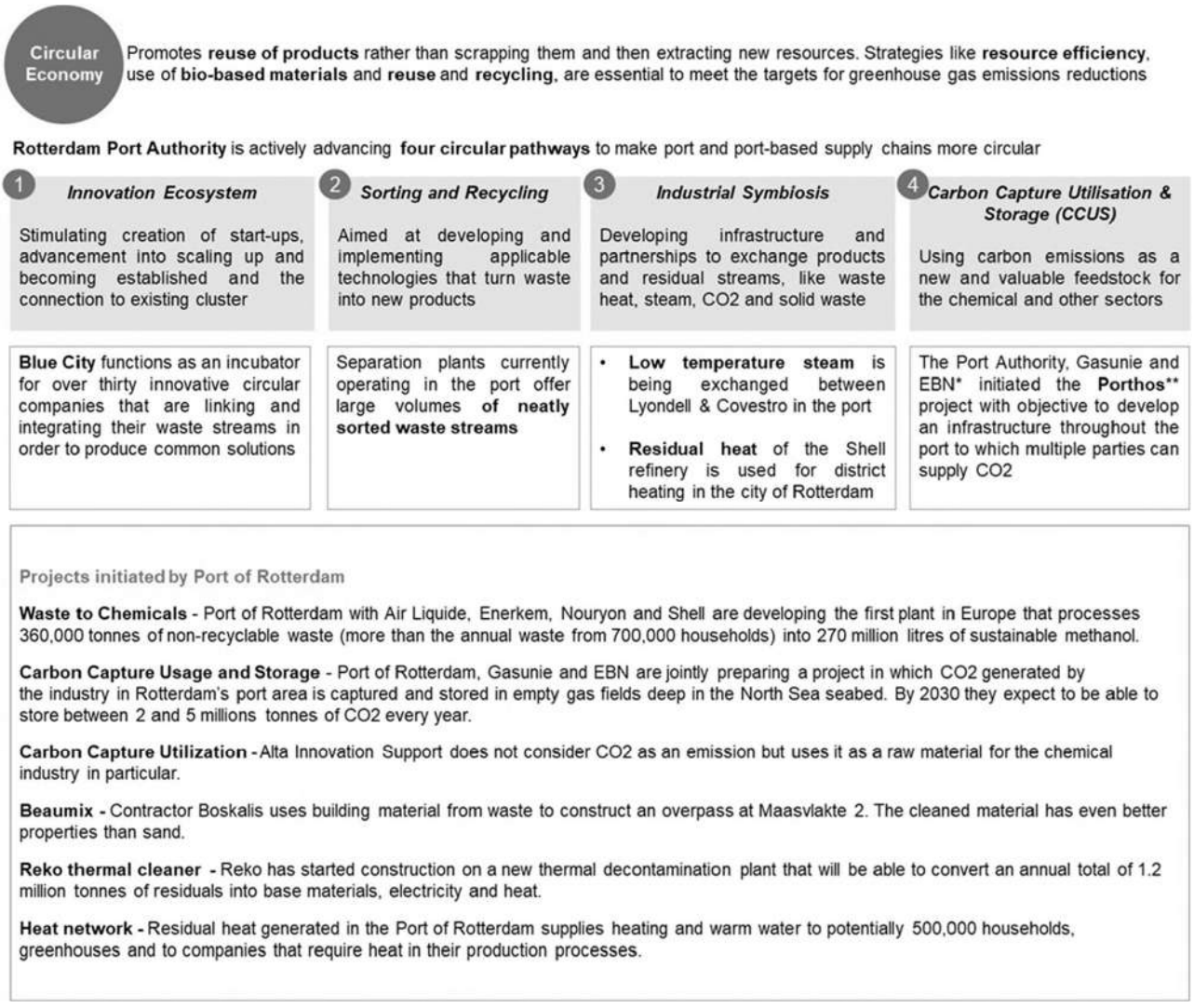


Figure 21 Key principles for circular ports

Intervention

The circular economy provides unique opportunities for the port to future-proof its activities for a decarbonized world. In India, key ports to be identified where material flows from all over the world and all stages of value chains come together, especially of industries that are huge consumers of raw materials. This essentially means that the port should be a global hub for industrial and logistics activities. This is one of the important factors if a port aims to become circular port. In case of Port of Rotterdam, the sheer size of the industrial and logistics activities in the Rotterdam region makes the concept of industrial symbiosis achievable. Further, extensive network of hinterland connections offers an excellent opportunity to aggregate circular activities.

JNPT in the west and Chennai in east can be the potential options for establishment of circular ports. Following are four circular pathways to make port and port-based industries more circular:

Figure 22 Four circular pathways

Innovative solutions from industry/ start-ups – The port authority has to focus on encouraging innovation. This mainly involves supporting industries/ start-ups that are working on innovative technologies for recycling.

Sorting and recycling – This aim at developing and implementing applicable technologies that turn waste into new product

Industrial symbiosis – The concentration of industrial and logistical activities makes it relatively easy for companies to exchange products and residual flows, and also to use shared facilities. Port authorities would need to identify and support industries that would complete the circular links. For instance, dredged spoils can be explored to be reused/ recycled as sand in construction activities, therefore, it would make sense if construction companies utilize the waste generated from dredging in construction activities and complete the circular link.

Carbon capture utilization and storage – Port is a considerable source of greenhouse gases, produced by several large point sources. In the short term, port authority should focus on the re-use of CO_2 in greenhouses as well as sub-surface storage in order to realize a reduction in CO_2 emissions to the atmosphere. On the longer term, CO_2 will be used as a feedstock for a variety of value-added products, such as chemical building blocks, synthetic fuels, or mineral building materials.

REDUCE MARINE POLLUTION

There are several sources of marine pollution. Some of key sources which are originated from ports and maritime activities are as follows:

Figure 23 Sources of marine pollution

Sewage from port operations – Sewage generated from ports and maritime activities are now treated to tertiary level which is the final stage of the multi-stage wastewater cleaning process. The tertiary level of water treatment removes inorganic compounds, bacteria, viruses, and parasites. Removing these harmful substances makes the treated water safe to reuse, recycle, or release into the environment. Majority of the ports re-uses the treated water for horticulture and dust suppression.

Some ports have established sewage treatment facility for treatment of wastewater produced in and around the port. Vishakhapatnam port has setup a 25 KLD tertiary level sewage treatment plant, which treats drains & sewage. Sewage treatment plant of 1.5 MLD has been operationalized at Deendayal port as well.

Oil spills – The Indian Coast Guard, part of the Ministry of Defense, is the designated national authority for oil spill response in Indian waters under the National Oil Spill-Disaster Contingency Plan (NOS-DCP). As per NOSDCP, ports are required to be capable of handling tier-1 level of oil spill within their jurisdiction. Tier-1[9] spills are generally small in size and response is overseen by ports itself. Some ports have developed their own Oil Spill Disaster Contingency Plan (e.g., New Mangalore port, Cochin port have their OSDCP in place) which is applied in conjunction with NOS-DCP and other applicable regional, state, district OSDCP for cleaning operation of oil spills.

[9] Spills are operational in nature occurring at or near an operator's own facilities i.e., site specific as a consequence of its own activities and includes most shore-side oil facilities with oil transfer sites, oil storage installations, offshore installations, and all related vessels, which are required to plan for and be able to provide a clearly identifiable and effective firsthand response to pollution incidents

However, in case of major oil spill of tier-2[10] and tier-3[11] nature, response for clean operation is done through regional/ national/ international coordination. The response is guided by national/ regional/ state/ district level OSDP with assistance from Indian coast guard.

Present system is adequate to handle small to large spills.

Bilge and ballast water from the vessels - India is not yet a signatory of The International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BMW convention), however DG Shipping has issued guidelines in relation to bilge and ballast water management to Indian vessels making calls to Ports where the convention is in force. These guidelines are issued to establish accountability with respect to disposal/ reuse of bilge and ballast water.

Intervention - All ports must establish guidelines for bilge and ballast water management which Indian ships and calling vessels from non-signatory countries must follow in order to berth at Indian ports.

GREEN BELT

Green belt development helps in capturing emissions and reducing noise pollution. It supports in maintenance of biological diversity and climate of the surrounding areas. The roots of trees hold the soil together and prevent erosion due to wind or water. It also contributes to maintaining water table, maintain soil moisture. Green belt near material handling area can reduce effect of dust, noise on environment and reduce pollution levels in port area. Hence all ports should aim to develop adequate green cover near material handling area.

MoEF&CC mandates greenbelt development in ports through guidance manual for Environment Management Plan (EMP) to control air and noise pollution. Currently recommendation from MoEF&CC is for greening of 33% of the port area. Green belt in Indian ports varies from 3% to 36%.

Indian ports except ports with vast land area are facing challenge to meet the recommended greening area due to inadequate land.

Intervention- Ports shall enter into discussion with MoEF&CC to allow mangrove plantation in alternative land and develop mangrove under 33% greenbelt cover.

DEVELOP KEY INDIAN PORTS AS INTERNATIONAL HUBS FOR HYDROGEN PRODUCTION, APPLICATION, AND EXIM TRADE

Hydrogen is being seen as an alternate fuel to power vehicles, equipment, and heat buildings. Hydrogen is a clean fuel which when burn in the presence of oxygen produces water and energy. There are three main types of hydrogen based on their production process.

Green hydrogen - Green hydrogen is made by using clean electricity from surplus renewable energy sources, such as solar or wind power, to electrolyze water. Electrolysers use an electrochemical reaction to split water into its components of hydrogen and oxygen, emitting zero-carbon dioxide in the process. Green hydrogen currently makes up a small percentage of the overall hydrogen because production is expensive.

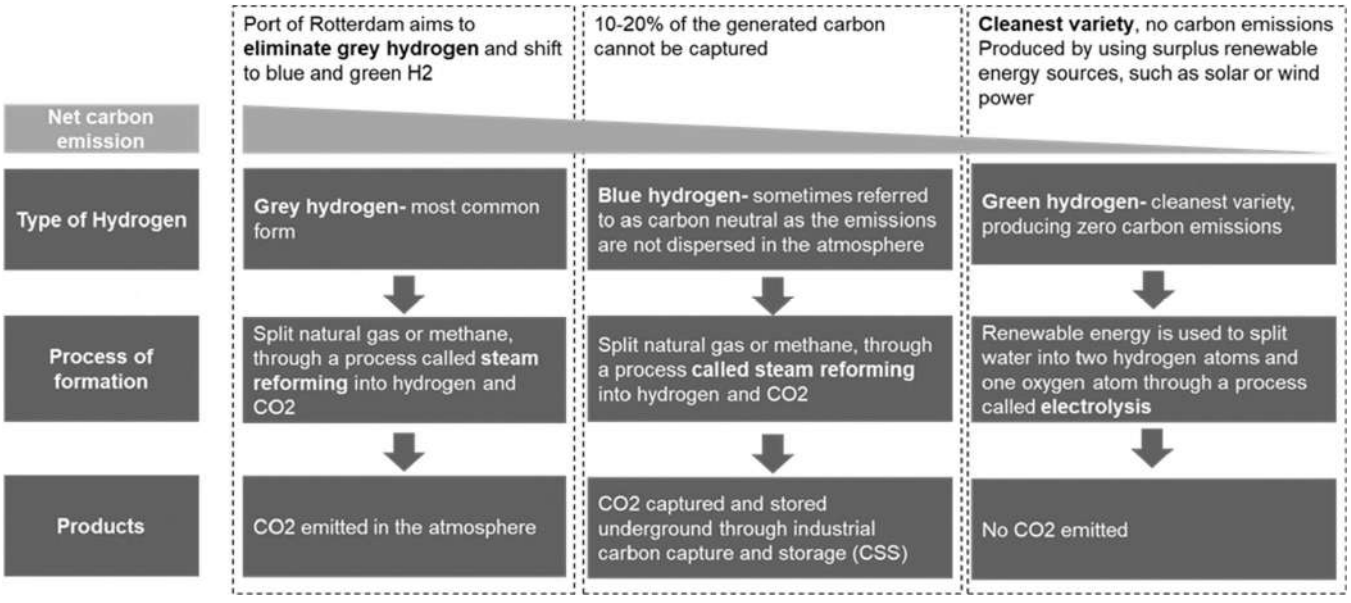
Grey hydrogen – This the most common form of hydrogen. Grey hydrogen is created from natural gas, or methane, using steam methane reformation but without capturing the greenhouse gases made in the process.

[10] Spills are most likely to extend outside the remit of the Tier 1 response area and possibly be larger in size, where additional resources are needed from a variety of potential sources and a broader range of stakeholders may be involved in the response. State Governments are expected to plan for and respond to such oil spills within the Territorial Sea (up to 12 nautical miles), along with the Indian Coast Guard (Western Region) where the spills exceed the clean-up capability of Tier 1, or for which no responsible party can be identified

[11] Spills are those that, due to their scale and likelihood to cause major impacts, call for substantial further resources from a range of national and international sources. The Indian Coast Guard, which manages the National Oil Spill Disaster Contingency Plan (NOS-DCP), is responsible for, spills within a region which are beyond the resources of the region, or which occur within the EEZ or outside regional boundaries likely to impact the Indian coastline

Blue hydrogen - Blue hydrogen uses the same process as grey, except this time the carbon is captured and stored. This makes it much more environmentally friendly but comes with added technical challenges and a big increase in cost.

Figure 24 Types of Hydrogen



However, there are certain constraints in adopting green hydrogen as an alternate source of energy.

Technology – Huge quantity of green hydrogen is needed to replace conventional fuels such as natural gas, oil, and coal. To generated green hydrogen in huge quantity, it would need electrolysers to be built on a large scale

Electricity - Creating green hydrogen needs a huge amount of electricity, which means a considerable increase in the amount of wind and solar power is required.

Transportation and Storage – Transportation of hydrogen is expensive. Unlike, for example, oil that is liquid at 'normal' temperatures, hydrogen has to be cooled down considerably (to -253 degrees Celsius) to make it liquid. An alternative is to 'pack' (and unpack) hydrogen into another molecule, such as ammonia (NH3), methanol or a Liquid Organic Hydrogen Carrier (LOHC) which requires energy.

Globally, countries have realized the potential of hydrogen as a clean fuel and have started using hydrogen for powering vehicles, equipment, and heating buildings. Ports around the world are playing catalytic role in harnessing hydrogen and catering to the demand of nearby regions. Ports like Rotterdam in Netherland, Antwerp, Zeebrugge in Belgium, and Newcastle in Australia developing hydrogen hubs to speed up green hydrogen development. Following is a case study of Port of Rotterdam which has started building infrastructure.

Figure 25 Case Study | Port of Rotterdam is aiming to become an international hub for hydrogen production, import, application, and transport to countries

- Port of Rotterdam aims to eliminate grey hydrogen and shift to blue and green hydrogen
- Port of Rotterdam will have a hydrogen system that combines production and use, particularly in industry, but also imports and transit flows of hydrogen to other parts of the Netherlands and Northwest Europe
- Port Authority and Gasunie, natural gas infrastructure and transportation company, are working on an initiative to have a backbone for hydrogen running through the port as early as 2023
- Main transport pipeline will supply companies with hydrogen produced at conversion parks in the port
- Backbone will be connected to Gasunie's national infrastructure throughout the Netherlands and to corridors leading to industrial areas in Chemelot in Limburg, and North Rhine-Westphalia.
- In time, there are also plans for a terminal to facilitate imports of hydrogen

Port of Rotterdam has several proposed projects to make it a hydrogen hub

Project	Description	Timeline
Backbone	The backbone connects production and import (tankers) with clients in the port area	2023
Conversion Park	2GW conversion park (industrial estate) for the production of green hydrogen	2023
Electrolyser upscaling	Shell is planning a 150-200 MW electrolyser for the conversion park Nouryan, BP and port of Rotterdam authority have teamed up in H2-fifty on development of 250 MW electrolyser	2023 2025
Transport	A consortium is being developed with the aim of operating 500 trucks on hydrogen. Eventually hydrogen can also be used to heat greenhouses and buildings	2025
Blue Hydrogen	H-vision for blue hydrogen production. The released CO2 is stored in depleted gas fields under the North Sea	2026
Import Terminals	Large scale import of hydrogen compounds at import terminals to cater to northwestern Europe demand for sustainable energy	2030

Further, ports like **Antwerp, Zeebrugge** in Belgium and **Newcastle** in Australia developing hydrogen hubs to speed up green hydrogen development

India has already started taking steps towards reducing their dependence on importing fossil fuels and developing an ecosystem to cater to hydrogen. India has announced a National Hydrogen Energy Mission (NHM) that will draw up a road map for using hydrogen as an energy source. India's ambitious goal of 175 GW by 2022 got an impetus in the 2021-22 budget which allocated Rs. 1500 crore for renewable energy development and NHM realizing hydrogen as future source of energy. Further, Reliance Industries intends to invest $10 billion over the coming three years in a 20km^2 green energy giga-complex at Jamnagar. The complex would be dedicated to electrolysis to produce green hydrogen and fuel cells for converting hydrogen into mobile and stationary power. Another project is ongoing at Indian Oil's Gujarat refinery, wherein the focus is on creation of blue hydrogen with carbon capture technology.

Intervention:

Indian ports can play a major role in meeting the targets set under NHM and catering to the future need of hydrogen by various industries. Kandla, JNPA, New Mangalore, Cochin, Visakhapatnam port as well as island city of Andaman and Nicobar Islands can be set up as international hubs for hydrogen production, storage, bunkering and EXIM trade.

Following are the key strategic areas which need to be covered by the ports identified ass international hubs for hydrogen production, application, and EXIM trade.

Figure 26 Key strategic areas to become hydrogen hubs

Power generation from renewable/ clean energy – Production of green hydrogen is generated from electrolysis process which breaks water into hydrogen and oxygen through power generated from renewable sources. With growing need of hydrogen as a source of energy by different industries which are currently using conventional source of energy, huge capacity of renewable energy plants would be required. Port authority would need to accordingly conduct the study to estimate the future demand of hydrogen which can be catered by the port and accordingly plan installation of renewable energy plants.

Steam Methane Reforming (SMR) for blue hydrogen and Carbon Capture and Storage (CCS)–SMR mixes natural gas with very hot steam, in the presence of a catalyst, where a chemical reaction creates hydrogen and carbon monoxide. Additional water is added to the mixture converting the carbon monoxide to carbon dioxide and creating more hydrogen. The CO2 generated from the process is removed, transported, and permanently stored through CCS technology. Port authority would need to partner with entities working on this technology for setting up SMR process and CCS technology.

Electrolysers – As indicated above, green hydrogen production will require electrolysers upscaling if the future requirement of industries is to be met. Port authority would need to partner with entities working on this technology.

Transport network – The transportation of hydrogen will be a crucial step for ports. Similar to LNG, Hydrogen requires cryogenic set-up for transportation. Ports which are planning to set up LNG terminal or have existing LNG terminal can be used for conducting EXIM trade of hydrogen. For transporting hydrogen on land, port authority would require pipeline set up (if hydrogen is to be transferred in gaseous form) or trucks with cryogenic facility (if hydrogen are to be transferred in liquid form). The former option is the cheaper mode of transportation; however, it would involve considerable capital expenditure for developing new pipelines.

POLICY AND REGULATORY INITIATIVES

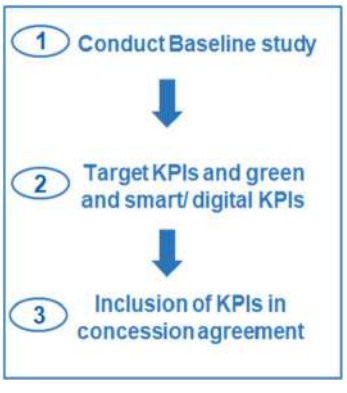
IMPLEMENTATION FRAMEWORK TO ADOPT GREEN INITIATIVES IN TERMINAL OPERATIONS

Implementation framework for green initiatives have been tailor-made according to the type of terminal (new or existing).

Figure 27 Implementation framework for new terminals

New Terminals – There are three key steps to be followed for implementing green initiatives in new terminals which are as follows:

Initially, project authorities would need to conduct baseline study on select operational terminals across parameters such as usage of clean fuel in various port operations, area under green belt, share of renewable energy, vessel turnaround time on the basis of last 3-year performance of the terminals.



- Post base line study, project authorities would need to define/ revise target KPIs (existing/ new) and introduce green KPIs across all the parameters
- Finally, the identified KPIs and green KPIs would need to be accordingly included in concession agreement

Bidders would include the cost incurred in adopting green initiatives in the quotation. Further, port authority would provide incentives to operators for going beyond 15% on green KPI in any year.

Existing terminals – There are five key steps to be followed for implementing green initiatives in existing terminals which are as follows

- Step 1 - Project Authorities would need to conduct baseline study basis last 3-year performance of the terminal and minimum standards in concession agreement across the key parameters. If Base lining study is prepared by PPP project operator, then it shall be vetted and approved by an independent third party

Figure 28 Implementation framework for existing terminals

- Step 2 - Based on base lining study, project authority would need to define/ revise target KPIs (existing/ new) and introduce green KPIs across all the parameters
- Step 3 - PPP Port Operators/ Project Authority would need to submit an action plan proposing multiple green projects/intervention to the MoPSW/ State Maritime Boards for approval
- Step 4 - PPP Port operators/ Project Authorities would need to prepare an impact assessment report, estimating upfront capital cost, technical changes, improvement in efficiency, increase in operating cost for terminal, impact on environment and efficiency in port operations.
- Step 5 - MOPSW/ State Maritime Boards may employ independent agencies to vet and approve the funding requirement, targeted outcomes of the proposed projects/interventions

Port/ terminal operators to calculate additional capital expenditure and operating and maintenance cost required to implement green initiatives/ projects and define the total amount required to attain cost neutrality to project authority. Post defining the amount, port authority/ MoPSW may cover 50% of the said amount in the form of discount on revenue share. The remaining 50% would need to be borne by port/ terminal operator. However, on achievement of target green KPIs, remaining 50% of the amount will be reimbursed to port/ terminal operators. Further, port authority would provide incentives to operators for going beyond 15% on green KPI in any year.

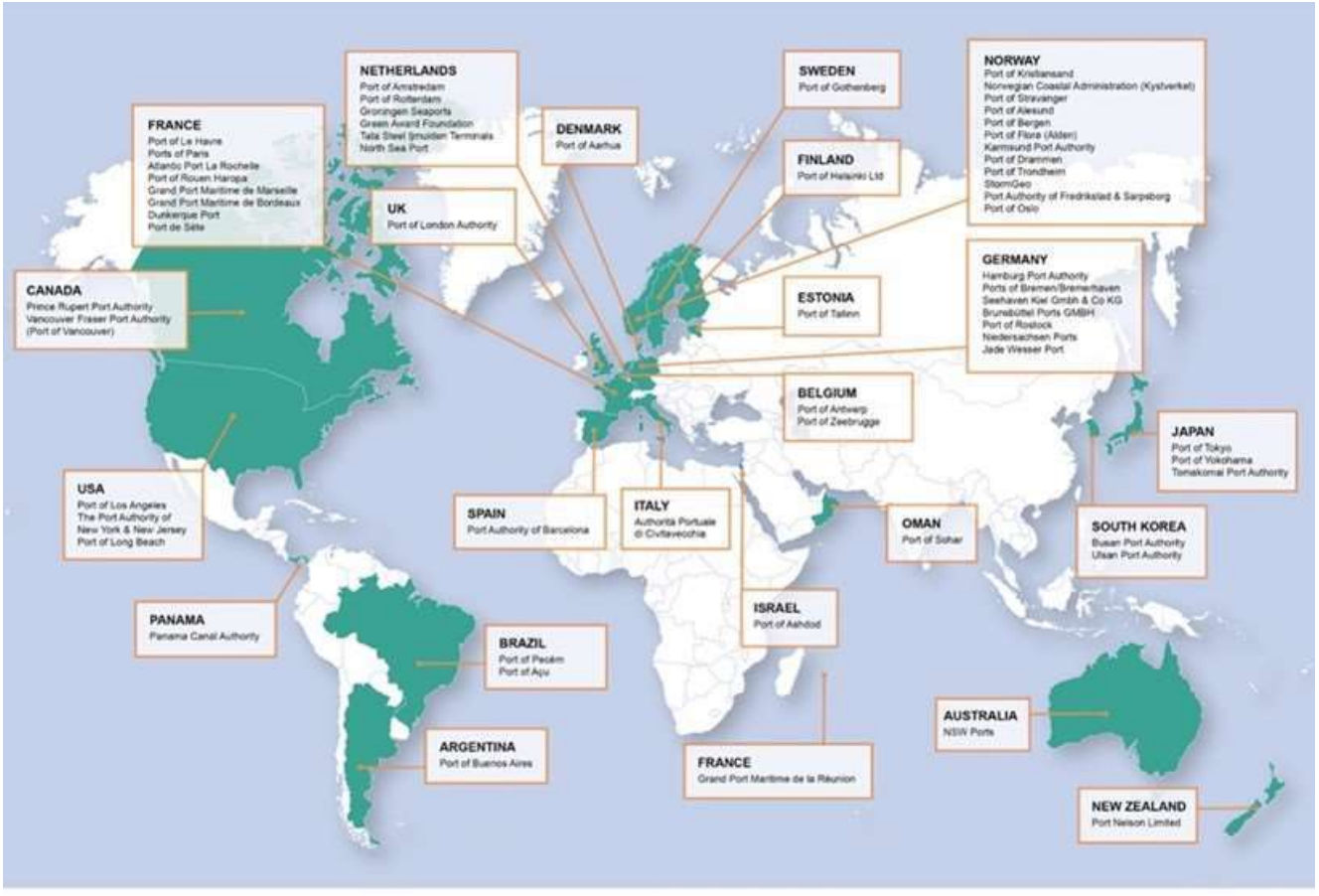
INCENTIVE MECHANISM FOR FASTER ADOPTION OF CLEAN FUEL AND CLEAN/ EFFICIENT TECHNOLOGY IN VESSEL OPERATIONS

To increase the number of vessels eligible for discounts and therewith encourage uptake of cleaner fuels and clean/efficient technologies, some ports offer incentives to ships that perform as per the set standards under different ratings/ index programs. Following are the key widely recognized rating/ index programs in the world.

RightShip GHG Emissions Rating - RightShip's GHG Emissions Rating provides a transparent method to assess the relative efficiency of vessels and compare a ship's theoretical CO_2 emissions relative to peer vessels of a similar size and type using the easy to interpret A – G scale. In this scale, A is the most efficient rating and G is the least efficient rating. Pioneering ports such as Canada's Port of Vancouver and Prince Rupert Port Authority now use RightShip's GHG Rating to offer incentives for more efficient ships, reducing CO_2 emissions and other criteria pollutants in port.

Environment Shipping Index – The ESI indicate the relative emission levels of air pollutants (NO_x, SO_x, and CO_2), taking into account all engines onboard and all fuel types. The emission level of a sea ship is set against the IMO regulations that apply to current ship operation. The baselines will be lowered in the future, following IMO regulations. The overall ESI score varies between 0 (meeting IMO regulations) and 100 (no emissions). Additionally, it also rewards ships that can use onshore power supply while at berth. Following are the countries which are utilizing ESI to provide incentives to shippers who uses clean energy and/ or are efficient in its operations.

Figure 29 Participating incentives provider countries



Green Award - A Green Award certificate, which can be obtained by ships that go above and beyond the industry standards in terms of safety, quality and environmental performance, acts as a quality mark and brings benefits to its holders. The following countries recognize this certificate program to offer incentives to shippers -Argentina, Belgium, Canada, Germany, Gibraltar, Japan, Latvia, Lithuania, New Zealand, Oman, Portugal, South Africa & the Netherlands.

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Clean Shipping Index - The basis of the Clean Shipping Index is a digital questionnaire covering vessels' environmental performance. The questions cover general information about the shipping company as well as vessel-specific information. Vessels are scored on the following parameters – SO_x, CO_x, NO_x, chemicals, water and waste and particular matter. Final scores for vessels are based on the outcome of the questionnaire. A total of 150 points can be obtained, 30 points for each of the 5 different parameters. The final score results in CSI Class 1-5 according to the below scheme:

- CSI Class 5: 125-150 points
- CSI Class 4: 100-124 points
- CSI Class 3: 75-99 points
- CSI Class 2: 38-74 points
- CSI Class 1: 0-37 points

Green Marine - Green Marine is an environmental certification program for the North American marine industry. It is a voluntary, transparent, and inclusive initiative that addresses key environmental issues through its 14 performance indicators - Aquatic invasive species, Cargo residues, Community impacts, Community relations,

Dry bulk handling and storage, Environmental leadership, Greenhouse gas emissions, Oily discharge, Pollutant air emissions NOx, Pollutant air emissions SOx & PM Spill prevention and stormwater management, Ship recycling, Underwater noise, Waste management

Energy Efficiency Design Index (EEDI) - EEDI is the measure of the amount of CO2 emitted by the ship (in grams) per tonne-mile of work. IMO sets the Required EEDI which is the maximum value of EEDI required for the ship. Over the period of time, IMO wants to reduce the required EEDI value for the ships so that in future the ship's engines are even more energy efficient. The actual value of EEDI attained by the ship would be different from required EEDI. The actual value would depend on factors such as specific fuel consumption of engines, type of fuel used, the speed of the ship, deadweight of ship, efficient technology used. If the above-mentioned factors are leading to efficiency in engine working and reduction of CO2 emission, then actual EEDI may be less than required EEDI. Incentive provider countries look at the actual EEDI of ships as against the required EEDI set by IMO and provide incentives to ships which perform better than required EEDI.

Figure 30 Case study – Incentive schemes adopted by Port of Vancouver

Case study – Incentive schemes adopted by Port of Vancouver

Port of Vancouver's EcoAction program recognizes a variety of cleaner fuels and technologies, as well as different incentive/rating schemes for reducing ambient air and carbon emissions, providing vessels with 3 different levels of discounts on port dues. Ships may qualify for gold, silver or bronze levels, which qualify them for a 23%, 35% or a minimum 47% discount. The EcoAction program provides discounts through one of the following five qualifying incentive schemes

INITIATIVE	CRITERIA FOR SHIPS TO QUALIFY FOR DIFFERENT LEVELS OF DISCOUNT ON PEORT DUES		
	Bronze (23% discount)	Silver (35% discount)	Gold (47% discount)
RightShip GHG Emissions Rating and Quality index (Qi) Rating	GHG C & Environmental 3+ stars	GHG B & Environmental 3+ stars	GHG A & Environmental 3+ stars
Environment Shipping Index (ESI)	20 ≤ Score < 31	31 ≤ Score < 40	Score ≥ 40
Green Award Certified vessels	Award certificate		
Clean Shipping Index (CSI)	Score of 3	Score of 4	Score of 5
Green Marine-environnemental performance certification	Level 3 GHG & min. Level 2 others	Level 4 GHG & min. Level 2 others	Level 5 GHG & min. Level 2 others
Energy Efficiency Design Index (EEDI)	Attained EEDI 5% better than required EEDI	Attained EEDI 10% better than required EEDI	Attained EEDI 15% better than required EEDI

Intervention – Indian port authority should also recognize any of the above-mentioned rating/ certification programs to offer discounts on port dues or any other form of incentives to promote operations of clean fuelled vessels at ports. This will boost usage of clean marine fuel in the country and promote sustainability at ports.

CREATION OF DISASTER MANAGEMENT PLAN

Of India's 7,516 km coastline almost 5,700 kilometers are highly vulnerable to the impacts of tropical cyclones and related hydro-meteorological hazards. This results in recurrent loss of life and properties. Natural disaster losses equate to up to 2% of India's Gross Domestic Product (GDP) and up to 12% of Central government revenue. Indian subcontinent is the worst affected region of the world which is exposed to nearly 10% of the world's tropical Cyclones.

An effective Disaster Management Plan (DMP) helps to minimize the losses in terms of human lives, assets and environmental damage and resumes working condition as soon as possible.

Ports are mandated to maintain DMP in order to comply with different rules and regulations and to receive EC and CRZ Clearances.

Figure 31 Disaster impact

National Disaster Management Plan (NDMP) are already formulated which provide guidelines covering all phases of disaster management: **mitigation, prevention, response, and recovery**.

Figure 32 MRCC Areas

- **Mitigation** involves steps to reduce vulnerability to disaster impacts such as injuries and loss of life and property. This involves proactive measures taken before a disaster occurs. For e.g., strengthening of infrastructure.
- Disaster **prevention** refers to measures taken to eliminate the root- causes that make people vulnerable to disaster. Examples include dams or embankments that eliminate flood risks, land-use regulations that do not permit any settlement in high-risk zones, and seismic engineering designs that ensure the survival and function of a critical building in any likely earthquake
- **Response** addresses immediate threats presented by the disaster, including saving lives, meeting humanitarian needs (food, shelter, clothing, public health, and safety), cleanup, damage assessment, and the start of resource distribution
- **Recovery** is the fourth phase of disaster and is the restoration of all aspects of the disaster's impact on a community and the return of the local economy to some sense of normalcy

Ports and other maritime entities have formulated their activities and location specific DMPs which has led to quick response and better coordination in the last decade to extreme coastal climatic events. Ports like Cochin port have developed a very robust DMP. For other ports, there is a scope of improvement in DMP.

Aspects of DMPs towards extreme coastal climatic events and general areas of strengthening are discussed below:

- **Standard Operating Procedure-** Fill gap(s) in the DMPs by cross port audits and adopting best practices of other ports. Further, ports can standardize their DMP format for better implementation and quick familiarization.
- **Early warning systems-** Establish early warning system for Tsunami preparedness. Additionally, put in place hotline between ports to India Meteorological Department (IMD) and District DM for pre-event and post event coordination. Further, usage of harmonized system codes should be encouraged for emergency communication and coordination through walkie talkies.

- **Post event immediate relief-** Recovery activities to be conducted within a week post disaster like debris removal**,** corpse management, medical facilities, medical relief, food (community kitchens), supply of clean water, etc. Delegation of Authority should be put in place for spending of CSR funds for post event relief activities.
- **Mock Drills-** Disaster specific mock drill should be conducted to check the effectiveness and to identify gaps in existing DMP
- **Climate change response and adaptation-** Ingrain resilience to extreme climatic events in port operations and maintenance activity. Rebuilding of damaged infrastructure should be taken up based on "Build Back Better" principle which aims at reducing the risk to the people of nations and communities in the wake of future disasters and shocks.

DEVELOP SUSTAINABILITY MONITORING TOOLKIT TO MONITOR EMISSIONS AND RESOURCE CONSUMPTION AT PORTS

Integrating sustainability into core business practices is considered essential to futureproof the port industry. A sustainability tool kit may be developed to monitor performance of ports across following 13 areas.

Figure 33 13 areas for sustainable strategy

Land use planning – Developing sound land and water area use is the first step towards becoming a Green Port. This is both for new port developments (Greenfield) and upgrading existing developments. Port authority to determine if the chosen location allows for a viable long-term operability of the port when considering the overall social (workforce, hinterland), ecological (nature areas) and environmental (sedimentation/erosion, wave/flooding, river discharges, etc.) situation. Further, it to make a long-term plan in which land and water areas are assigned to the different functions in the port in such a way that the port operations work effectively, (hinterland) transport modes are enhanced, the natural environment can flourish and the people enjoy the area

Modalities and connectivity – An increase in world trade would lead to increase in sea transport. To be able to cope with increase in marine trade, quality and capacity of hinterland connectivity should be adequate. Development of hinterland connectivity should keep sustainability into consideration such that modal shift to more environment friendly mode of transport is promoted.

Air quality – Under this area, port authority should ensure that further development of port operations does not impact the air quality in the area while continuing measures to meet emissions reduction targets.

Surface water and sediment quality – Port authority should prevent port operations from degrading the surrounding water quality or even take measures to improve the water quality in the port which is suited for the ecosystem and has potential for ecological habitats to be developed in the port area. Additionally, there should be a system that monitors the water and sediment quality in and around the port area.

Soil and groundwater quality – Port authorities to ensure to facilitate further economic developments by managing historic legacies of soil and groundwater pollution in such a way that environmental, health and safety risks are controlled

Dredging impact – Monitor dredging activities to test and demonstrate best management practices (BMP) effectiveness aimed to prevent/minimize impacts from dredging. Additionally, search for opportunities for beneficial re-use of dredged material by identifying and appointing areas for development of port infrastructure and natural ecosystems

Sound/Noise Impacts - Port activities and related transport produce sound that can be perceived as a serious environmental nuisance. This can be above or underwater sound. Sound may not only reduce the quality of life but may also provide a health hazard and may have ecological impacts. In order to mitigate noise pollution, port authority should develop acceptable sound contours in and around the port based on measurements taken during different seasons/meteorological conditions. Subsequently, port authority should do zoning of the port with different permitted noise levels for the various zones. Noisy industry can be moved to areas with a higher permitted noise level.

Energy and Climate Change Mitigation - Greenhouse gas (GHG) pollutants such as carbon dioxide (CO2) are linked to global warming. Marine industry is a significant contributor of GHG pollutants. Port authority should ensure that further development of port operations does not impact the air quality in the area while continuing measures to meet emissions reduction targets. Port authority should focus on reducing energy consumption and energy costs through increase of efficiency and modernizing (industrial) processes.

Climate adaptation - Ports must prepare for sea level rise, including increased storm surges, due to climate change. Sea level rise has already impacted port operations in some areas of the world. Port authorities need to ensure that port infrastructure and land transport corridors to the port are developed taking into account climate change impacts.

Habitat and Species Management Health - Ports and their (maritime) accesses are often located in or near valuable natural habitats, in certain cases designated as protected areas. Port authority needs to incorporate eco-structures in new developments that allow for development of ecological systems, e.g., aquaculture. Further, port authority should ensure it integrate habitat creation in port master and development plans. Port authority should also support monitoring and research in development of habitats in port areas.

Landscape Management and Quality of Life - Landscape is an area whose character is the result of the action and interaction of natural and/or human factors and it is a key issue in an individual's social well-being and people's quality of life. Port authority should conduct a visual impact assessment for existing and new facilities. Visual impact results from the combination of visual modification (contrast between the development and the existing visual environment) and visual sensitivity (a measure of how critically a change to the existing landscape will be viewed from various use areas). Once visual impact assessment is completed, port should propose a mitigation plan. Mitigation actions fall under one of the following strategies: avoidance, reduction, remediation, and compensation. Examples of mitigation measures are: Sensitive location and siting, Site layout, Choice of site level, Appropriate form, materials and design of built structures, Lighting, Ground modelling, Planting, Use of color schemes, camouflage, or disguise.

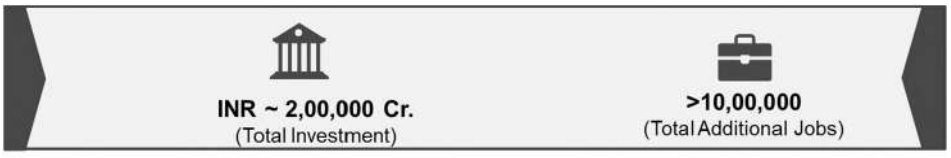
Ship related waste management – The protection of the marine environment can be enhanced by eliminating discharges into the sea of ship-generated waste and cargo residues. This can be achieved by improving the availability and use of reception facilities. Port authority should srxfcnsure maximum delivery of ship-generated waste and cargo residues through availability of adequate port reception facilities and the establishment of (financial) incentive schemes in order to avoid waste being discharged at sea.

Sustainable Resource Management - Within ports, significant material flows are generated, by economic activities or by infrastructural developments on land or in water. By closing material loops, significant waste flows can be avoided. Closing material loops requires cooperation between companies to detect (waste) material

streams they can exchange. Therefore, companies must have some kind of forum to exchange information, experiences, and good practice examples.

The above areas to be regularly monitored by a Program Management Unit Cell. The monitoring exercise to be repeated at regular intervals (6-12 months) or after every significant intervention to assess the impact.

Total investment required and potential job opportunities



GREEN SHIPPING

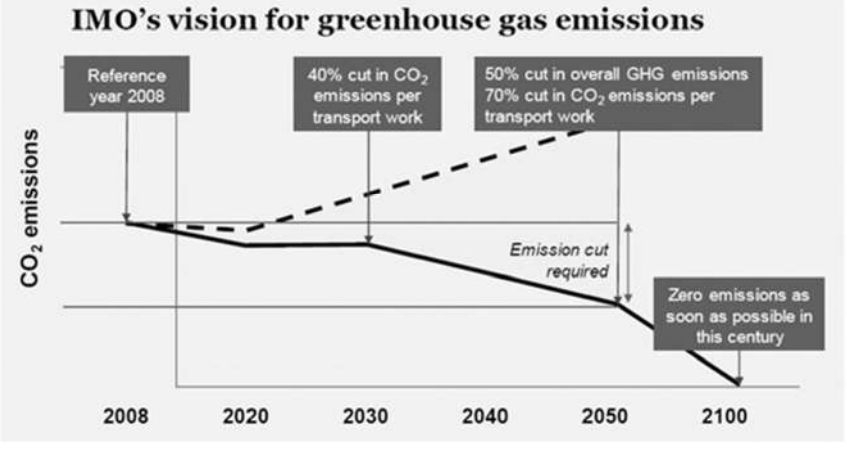
CURRENT LANDSCAPE

Urgent action is necessary to accelerate the pace of the energy transformation and decarbonization of the economy, including the shipping sector, a strategic sector of the global economy. At present, about 99% of the energy demand from coastal shipping sector is met by fossil fuels, with fuel oil and marine gas oil (MGO). If no actions are taken, IMO has flagged that GHG emissions associated with the shipping sector could grow between 50% and 250% by 2050 in comparison to 2008 emission levels. Clearly this broad range of projected GHG emissions flags a level of uncertainty in terms of how the sector will evolve over the next 30 years. Nonetheless, even the lower-level band of GHG emissions increase is an area of great concern in terms of global warming.

To address these concerns, there is a need to map out a path to a decarbonized maritime shipping sector. Its primary focus is the analysis of a pathway to a mitigation structure that will limit global temperature rise to 1.5 degrees Celsius (°C) and bring CO2 emissions closer to net zero by mid-century.

In April 2018, IMO adopted a strategy for reducing greenhouse gas emissions from international shipping, which sets the level of ambition of reducing emissions by at least 50 % by 2050 compared with the level in 2008. The overall vision is to phase out greenhouse gas emissions from the industry as soon as possible in this century. In addition, the IMO strategy includes ambitions to improve the energy efficiency of each ship and to reduce the carbon intensity of the whole sector by reducing emissions per unit of transport work done by at least 40 % by 2030 and further towards 70 % by 2050.

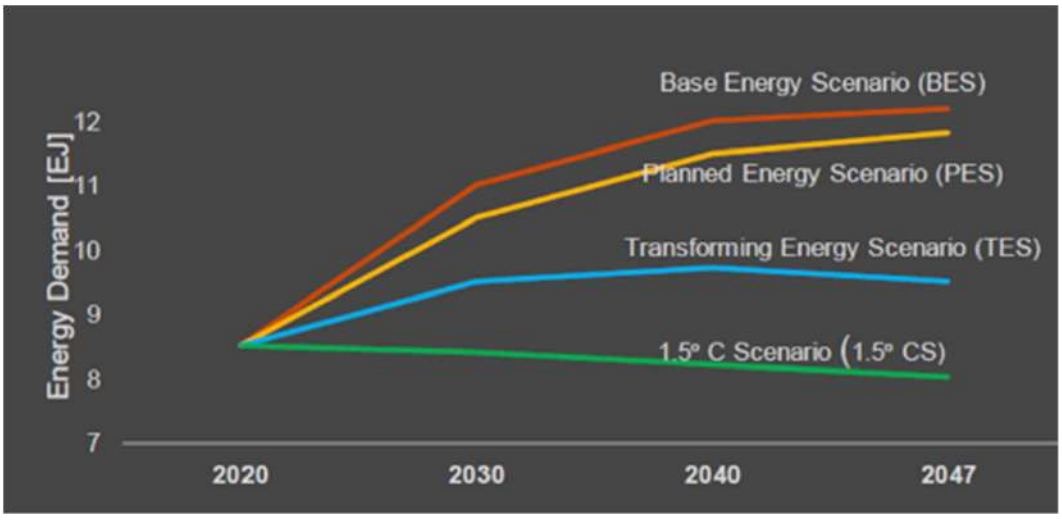
Figure 34: IMO & CoP 26 Green emission targets



The dotted black line shows the projected emission trend under a business- as-usual scenario
The solid black line shows an emission trajectory in line with IMO's strategy

To achieve the above target, four scenarios have been analyzed - Base Energy Scenario (BES), Planned Energy Scenario (PES), Transforming Energy Scenario (TES) and 1.5-degree Celsius Scenario (1.5 CS)

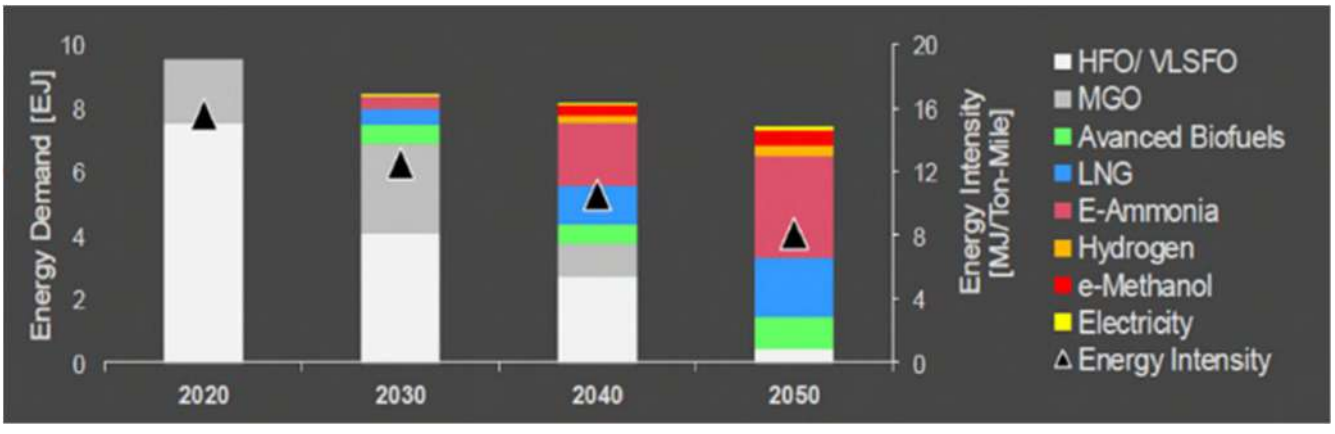
Figure 35: Energy demand in different scenarios (Source: IMO/ IRENA)



Business-as-usual behavior represented under the BES would imply an overall growth of 30% in energy demand by 2050. Similarly, for the PES, final energy demand would increase by 24%. In contrast, for the TES and 1.5°C Scenario, final energy demand could decrease by 3% and 17%, respectively.

While the BES scenario implies that the inclusion of renewable fuels by 2050 is practically null with fuel oil and MGO being dominant, the PES scenario explores a pathway in which LNG becomes the fuel of choice by 2050. In parallel, TES considers a more balanced picture where the inclusion of renewable fuels represents about 40% of the share by 2050. In contrast, the 1.5°C Scenario pathway presents a total renewable fuel share of 70% and limited participation of LNG. In the latter scenario, green H2-based fuel is expected to play a major role, particularly green ammonia. The overall transition from 2018 to 2050 from a carbon-intensive sector, currently predominantly based on the use of fuel oil and MGO, to a decarbonized sector in 2050 with a high inclusion of renewable fuels is illustrated below:

Figure 36: Fuel mix to achieve 1.5-degree Celsius scenario (Source IMO/ IRENA)



KEY INITIATIVES

POLICY AND REGULATORY INITIATIVES

IMPLEMENT GREEN MARITIME SHIPPING PROGRAMME