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Turning the Tide: Ship Recycling as a Source of Green Steel in India

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Foreword

To meet India's national ambition to be net zero by 2070, the focus on decarbonising the steel industry is pivotal. The steel industry in India is both a cornerstone of economic growth and a significant contributor to greenhouse gas emissions. Recognising this dual reality, Climate Group is committed to supporting initiatives that advance the transition to a net zero steel industry.

This report, "***Turning the Tide: Ship Recycling as a Source of Green Steel in India***", turns to India's leadership in the ship recycling industry to be a potential source of high-quality scrap steel. Using scrap steel in steel production is an established method which conserves critical resources, reduces reliance on virgin materials, and avoids significant carbon emissions.

Given that majority of a ship is made up of steel, using decommissioned ships to salvage scrap and upcycle steel into new products promotes circularity and complements the sustainable initiatives of the steel industry.

India hosts the largest ship breaking and recycling yard in the world at Alang. Through this report, we look at the potential of the ship recycling industry to increase domestic scrap availability as well as the industry's potential in promoting circularity and realising its fullest potential.

We're grateful to Climate Catalyst for their support and guidance that enabled this research study. Our sincere thanks also go to PwC, our technical partners, for their invaluable support. We remain committed to advancing the transition to low emission steel, collaborating closely with businesses and governments to drive changes in markets and policies.

Atul Mudaliar
Director of Systems,
Climate Group (India)

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List of abbreviations

BAU	Business-as-usual
BF-BOF	Blast Furnace - Basic Oxygen Furnace
BIS	Bureau of Indian Standards
CCUS	Carbon Capture, Utilisation and Storage
CO_2	Carbon Dioxide
DRI-EAF	Direct Reduced Iron - Electric Arc Furnace
DWT	Dead Weight Tonnage
EAF	Electric Arc Furnace
EU SRR	European Union Ship Recycling Regulation
FY	Fiscal year
GHG	Green House Gas
GMS	Global Maritime Services
GT	Gross Tonnage
HBCDD	Hexabromocyclododecane
HCFC-22	Hydrochlorofluorocarbon
H_2	Hydrogen
HKC	Hong Kong International Convention
HSE	Health Safety and Environment
IHM	Inventory of Hazardous Materials
IF	Induction Furnace
ILO	International Labour Organisation
IMO	International Maritime Organisation
KPI	Key Performance Indicator
LDT	Light Displacement Tonnage
MoS	Ministry of Steel
MSME	Ministry of Micro, Small & Medium Enterprises
MT	Million Tonnes
NDC	Nationally Determined Contributions
OECD	Organisation for Economic Cooperation and Development
PAT	Perform Achieve and Trade
RE	Renewable Energy
SSI	Sustainable Shipping Initiative
t-CO_2	Tonnes of Carbon Dioxide
tcs	Tonne of crude steel
TMT	Thermo Mechanically Treated
Y-o-Y	Year-on-Year

Acknowledgment

Several stakeholders from across the ship recycling and steel industry were interviewed during the preparation of this report. While they broadly endorse the arguments presented, they should not be seen as agreeing with every finding or recommendation contained herein. We would like to thank experts from the following organisations for providing their inputs and helpful comments. These include:

Ship breakers: Triveni Ship Breakers LLP, Baijnath Melaram, Aggarwal Group, Rudra Global.

Secondary steel producers: Triveni Iron and Steel Industries Pvt. Ltd., Hans Industries, Laxmi Steel Industries.

Primary steel producers and shipping companies: JSW Steel, Tata Steel, SAIL, ArcelorMittal, Kalyani Steel, Maersk.

Associations: Ship Recycling Industries Association (India), Bhavnagar Induction Furnace Association, All India Induction Furnaces Association, Silhor Steel Rerolling Mills Association

Civil society organisations and academia: Smart Freight Centre, Sustainable Shipping Initiative, National Institute of Secondary Steel Technology, Lloyd's Register.

A special thanks to Ministry of Ports, Shipping, and Waterways for their helpful inputs. We're grateful to Climate Catalyst for their support and guidance that enabled this research study.

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About Climate Group

Climate Group is an international non-profit founded in 2003, and officially launched in 2004, with offices in London, Amsterdam, Beijing, New Delhi, and New York. Our mission is to drive climate action, fast. Our goal is a world of net zero carbon emissions by 2050, with greater prosperity for all. We do this by forming powerful networks of business and government, unlocking the power of collective action to move whole systems such as energy, transport, the built environment, industry, and food to a cleaner future. Together, we're helping to shift global markets and policies towards faster reductions in carbon emissions.

Over the last 20 years, we've grown our network to include over 500 multinational businesses in 175 markets worldwide. We also work closely with governments at all levels. The Under2 Coalition, for which we're the Secretariat, is made up of 167 state and regional governments and has been named one of the international cooperative initiatives with the highest potential for emissions reductions.

About Climate Catalyst

Climate Catalyst strengthens collaboration and mobilises new actors to address pivotal climate challenges, compelling political leaders to act at the speed and scale required to tackle the climate crisis. This is achieved through:

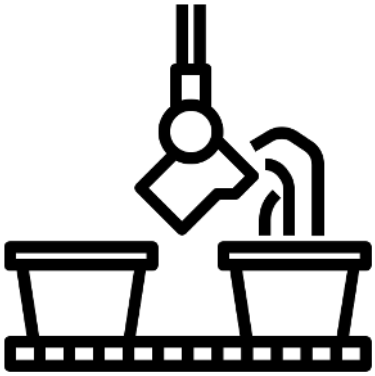
- Collaborating behind the scenes with diverse stakeholders across Europe and Asia to identify critical climate issues where action to date has been limited and the potential for impactful collaboration is high.
- Convening experts and fresh voices to share ideas and develop creative campaigns that drive substantial changes in national and regional policy, achieving sectoral tipping points and securing significant emissions reductions.
- Providing strategic advice, grants, and expertise in communications, advocacy, and business to build momentum across the climate community and catalyse impactful action.

Climate Catalyst envisions a just, thriving world where global temperature rise is limited to 1.5°C.

For more information, visit www.climatecatalyst.org, or connect on LinkedIn, Twitter, or via email at info@climatecatalyst.org.

Executive summary

Given India's commitment to achieve net-zero emissions by 2070, reducing carbon emissions of the steel industry is both essential and urgent considering its anticipated exponential growth.



The Indian steel industry, a major economic driver and critical infrastructure sector, also represents a significant source of greenhouse gas (GHG) emissions, accounting for approximately 12% of India's total emissions—a figure considerably higher than the global industry average of 7%. India's steel emissions intensity, recorded at 2.54 tonnes of CO_2 equivalent per tonne of crude steel (t-CO_2e/tcs), surpasses the global average of 1.91 t-CO_2e/tcs. This intensity is primarily due to a production model heavily reliant on coal-based pathways. Given India's commitment to achieve net-zero emissions by 2070, reducing the carbon footprint of the steel industry is both essential and urgent considering the anticipated increase in demand over the coming decades. Under the National Steel Policy (2017), the Indian government aims to raise steel production capacity to 300 million tonnes by 2030, from the current capacity of around 160 million tonnes, necessitating innovative and sustainable approaches to mitigate associated emissions.

This report presents an analysis of how India's ship recycling sector can facilitate and expedite steel decarbonisation and assesses whether the sector can adequately

supplement domestic scrap supply and promote circular economy principles. The report's objectives are:

- Assessing the volume of high-quality scrap steel generated through ship recycling, with a focus on how it can support the steel industry's sustainability goals.
- Evaluating the extent to which ship recycling can facilitate circular economy practices, especially through upcycling of steel recovered from decommissioned vessels into high-value products.
- Providing a scenario-based projection of India's position in the global ship recycling market and recommending policy and capacity enhancements based on stakeholder consultations.

Ship recycling as a source of scrap steel *

Increasing the use of scrap (recycled) steel is a viable decarbonisation pathway for the steel industry, with substantial environmental benefits. Recycling one tonne of scrap conserves 1.4 tonnes of iron ore, 0.8 tonnes of coal, and 0.3 tonnes of limestone, reducing CO_2 emissions by 1.67 tonnes[1]. Although scrap-based production technology is well-established in India, only about 21% of the 144 million tonnes of crude steel produced in 2023-24 utilised scrap due to limited domestic availability. The 40-year average lifespan of steel products delays their availability for recycling, necessitating the import of around 9 million tonnes of scrap in 2023-24. The National Steel Policy (2017) recognises the importance of scrap, aiming to increase domestic scrap availability to 70 million tonnes by 2030. Given the supply limitations, the assumption has been that ship recycling can offer a supplementary source of high-quality scrap steel as is the case in Turkey. With steel constituting 75–85% of the average ship's weight, decommissioned vessels could offer a significant source of scrap.

India's ship recycling industry, primarily based at Alang in Gujarat, processes approximately one-third of the world's scrapped ships. By salvaging and repurposing steel from these ships, the industry not only contributes to the steel supply chain but also advances circular economy principles by transforming steel into products for direct use. This report assesses the potential for ship recycling to serve as a steady source of scrap and as an engine for sustainable steel production through circular practices.

Types of steel outputs recovered from ship recycling

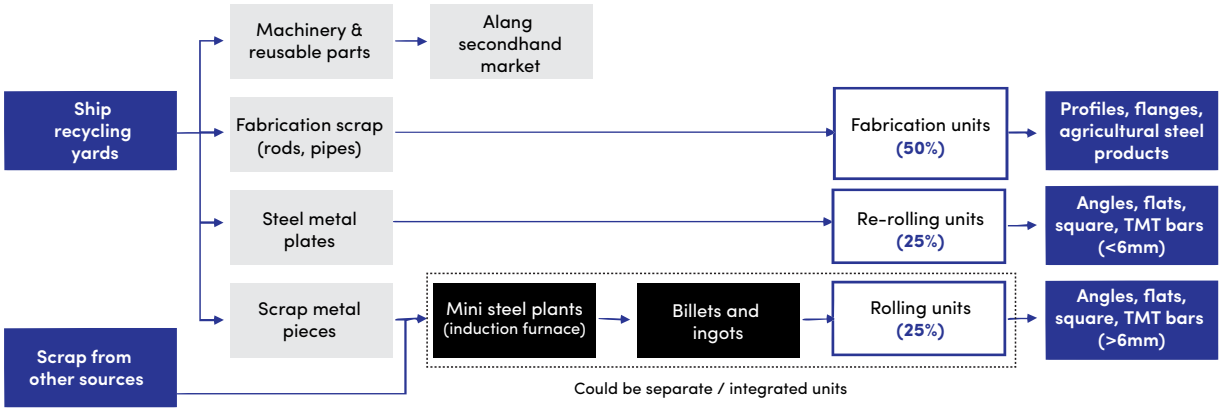
Based on an in-depth assessment of the ship recycling ecosystem in Alang, and inputs from several industry stakeholders, the report identifies different types of steel outputs that result from the dismantling of ships. These steel outputs fall in one of the following three broad categories:

- About 50% of the steel recovered from a ship is used by **fabrication units**. These units reuse pipes and rods for fabrication, along with steel plates salvaged from ships, transforming them into new finished steel products.
- About 25% of the ship steel is used in **steel rerolling units**, which primarily produce TMT bars (of less than 6 mm size), and other products such as flat bars, square bars, angles, etc.

1 The Value of Recycling Metals. Stena Recycling. Available at: https://www.stenarecycling.com/news-insights/insights-inspiration/guides-articles/the-value-of-recycling-metals/.
* For the purpose of our report, scrap steel refers to steel recovered from ships that have reached the end of their useful lives, which is then melted down and used as a raw material in crude steel production.

- The remaining 25% of the ship's steel is classified as **melting scrap** and is processed by mini-steel plants using induction furnaces. These plants blend scrap steel from international markets and other sources with scrap from ships in precise proportions to produce billets and ingots, which are then rolled into various steel products, primarily TMT bars over 6 mm.

Due to factors such as the availability of cheaper imported scrap and higher profit margins from producing and selling other types of scrap, ship recycling cannot reliably serve as a predictable or consistent source of melting scrap for use in Electric Arc Furnaces and Induction Furnaces in India. This is one of the primary findings of this study.



India has the world's largest installed capacity for ship recycling, with a possibility of manifold increase given India's vast coastline and favourable geographical conditions. Alang Sosiya Ship Recycling Yards, situated on the western coast of India in the Gujarat contributes over **98%** of total ship recycling in India with a capacity of 4.5 million Tonne LDT (Light Displacement Tonnage). India's ship recycling sector approximately accounts for one-third of the world's scrapped tonnage, with competition from Bangladesh, Pakistan and Turkey.

The ship recycling ecosystem in Alang largely depends on global volumes of ships coming in for recycling after the end of their useful lives. However, the interaction between shipping, ship building, and ship recycling is cyclical in nature. **When the shipping freight market is at its peak, fewer ships are available for recycling. A fall in the freight market, on the other hand, results in a larger supply of ships for recycling**. Currently, the global ship recycling market is going through a particularly intense period of slowdown. This can be attributed to the following reasons:

- Heightened geopolitical tensions among Red Sea-bordering nations, frequent re-routes due to Panama Canal diversions, and blockages at the Suez Canal are significantly disrupting global shipping activity. This has led to longer shipping routes and delays in ship retirement.
- Changes in global trade patterns and a stronger freight market post COVID-19 lockdown years have also incentivised owners to keep ships operational for longer periods. This has further reduced the number of ships available for recycling.

However, the current downturn in the ship recycling market is expected to improve once global conditions become more favourable for the shipping industry to modernise its assets. The report provides a framework to navigate these cyclical trends and ensure that India's ship recycling sector can meet the increasing demands of the steel industry for consistent scrap supply.

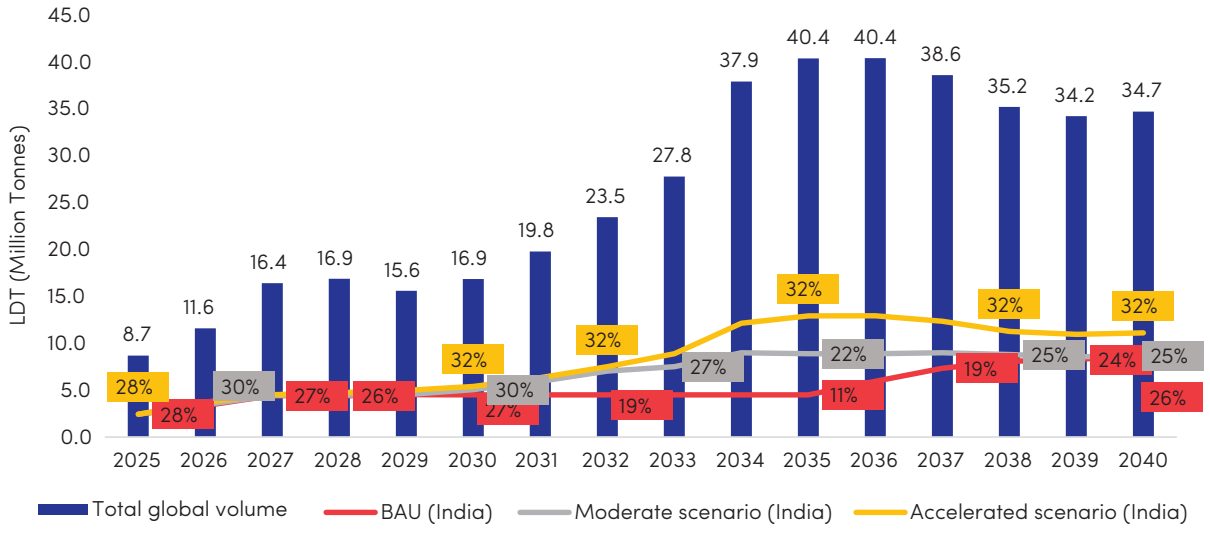
India’s ship recycling market outlook

Due to the expected uptick in global freight activities, it is estimated that around 15,000 ships (12.5% of the global fleet) will reach the end of their useful lives and be available for recycling in the coming decade. Coupled with the fact that Indian yards at Alang are increasingly likely to become compliant with global ship recycling regulatory norms, the outlook for India’s ship recycling market appears positive. Taking these factors into consideration, this study projects the total global volume of ships expected to be available for recycling by 2040. These projections were the result of extensive consultations with stakeholders from the ship recycling and steel industries, including producers, recyclers, associations, and policymakers.

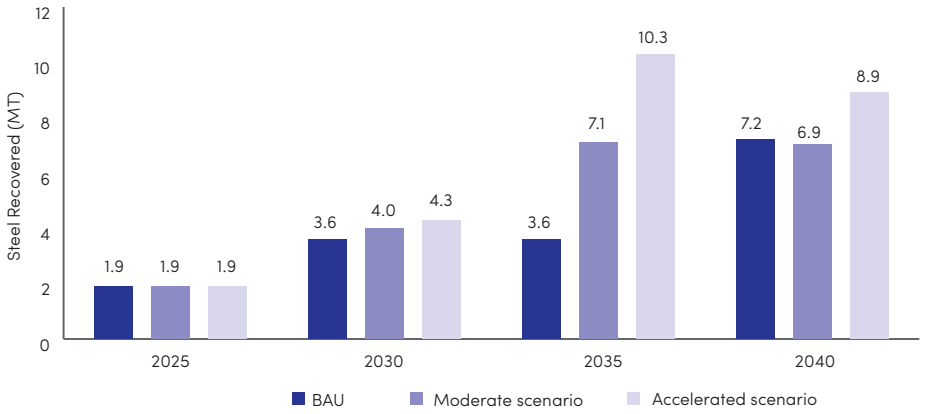
The consultations revealed the industry’s current state, challenges, and collaboration opportunities. The study also reviewed policies and reports to understand the regulatory landscape and future trends.

The study analyses India’s share in the global ship recycling market against three different industry scenarios. These scenarios are based on India’s ship recycling capacity needed to accommodate growing ship volumes, and are defined as:

- **Business as Usual (BAU):** This scenario assumes that India’s ship recycling capacity remains unchanged, and the entire capacity of 4.5 million LDT gets fully utilised by 2030.
- **Moderate:** This scenario anticipates full utilisation of the existing capacity by 2030 facilitated by a greater number of ships coming to Indian yards for recycling in upcoming years, which would be followed by a doubling of capacity in Alang by 2035, to retain the market share.
- **Accelerated:** This scenario envisages a more aggressive approach, with the existing capacity in Alang doubling by 2028, and an establishment of new ship recycling cluster on India’s Eastern Coast (West Bengal, Andhra Pradesh or Odisha, as suggested in Maritime Amrit Kaal Vision 2047) by 2035 with a similar capacity of 4.5 million LDT.



The total quantum of steel that ship recycling could generate from the projected ship volumes across the three scenarios, follows a similar pattern.



These scenarios reflect the cyclical nature of the industry and projects stabilisation with a slight decline in steel output post-2035 due to global shipping cycles. The report underscores the importance of regulatory alignment and infrastructure investment to secure India's position in the global market and expand its scrap supply.

Ship recycling's role in India's steel decarbonisation goes beyond scrap

An in-depth examination of Alang's unique ecosystem reveals that, although ship recycling currently makes only a modest contribution to scrap steel supplies for electric arc furnaces and induction furnaces, its role in India's steel decarbonisation extends far beyond this. Alang's distinct advantage is its ecosystem that contributes to advancing circular economy principles, while generating valuable raw materials and mitigating resource depletion in steel production.

Up to 75% of the total recovered steel from ships in Alang is upcycled into value-added steel products. Examples of such products include steel plates, bars, pipes and other forms of finished steel products. The steel plates also find application in the form of billets for producing finished steel products such as bars, angles, flats, etc. in the steel rerolling clusters in Gujarat and neighboring states. The upcycled steel products also fetch a higher price for the recyclers due to their perceived high quality and suitability for several applications. The remaining 25% of the recovered steel, which cannot be directly upcycled, becomes scrap steel, which is processed in induction furnaces to produce crude steel.

Due to the availability of alternative uses for recovered steel, the ship recycling sector's contribution to total scrap availability in India remains relatively low. However, by reusing and repurposing steel from decommissioned ships, India's ship recycling industry supports a closed-loop system that reduces reliance on virgin steel and avoids emissions associated with new steel production. Preliminary estimates from this study suggest that reusing steel from ships could prevent as much as 19-20 MT of carbon emissions, at the peak of ship recycling activity in India.

Considering the potential impact of the ship recycling industry on India's steel ecosystem, this study examines how maritime policies could enhance this contribution through timely capacity expansion and the development of future-ready infrastructure. The study recommends some stakeholder-driven measures to support ship recycling in India.

Key takeaways

The report outlines a roadmap for enhancing India's ship recycling sector as a central pillar in the steel industry's decarbonisation strategy. By adopting recommended policy measures and investing in capacity expansion, India can leverage ship recycling to meet domestic scrap needs, reduce emissions, and support a sustainable, circular economy within its industrial framework. This approach to ship recycling underscores its potential to drive a greener, more resilient steel ecosystem, contributing significantly to India's broader sustainability and emissions reduction targets.

To realise the potential of India's ship recycling industry as a major component of the green steel transition, this report presents the following key lessons and recommendations:

Ship recycling is not a significant contributor of scrap for steel making

The evidence suggests that only a small portion of steel recovered from a ship is utilised as scrap for steel making. Given the cyclical nature of ship recycling and availability of alternate consumption pathways, ship recycling may not be a reliable source of scrap steel as a raw material for primary and secondary steel production.

Ship recycling is advancing a circular economy by generating valuable raw materials and reducing resource depletion

Several outputs from scrappage fetch higher value in the market, and are therefore, upcycled as such. Upcycled products free-up equivalent demand on steel producers, thereby addressing natural resource conservation and proportionate reduction of emissions.

Bilateral arrangements are pivotal for increasing the flow of ships to India

Introduction of diplomatic bilateral agreements with countries for the supply of ships to Indian coasts would help create a pull for end-of-life ships to India for recycling. Building a robust global narrative on the quality of Indian yards and implementation of frameworks to monitor international compliance at existing and new yards will also be advantageous.

Timely interventions to prevent India from losing out on market share

Upcoming volumes of ship recycling will require additional capacities along both Western and Eastern coastline, failing which India risks losing out on its market share. The contribution of ship recycling to downstream steel processing industry in terms of circularity and employment generation is immense. Therefore, the existing policy targets for capacity addition should be implemented in line with prevailing global ship recycling practices.

Market enablement via financial incentives and policy schemes to boost industry

The Indian ship recycling industry can boost its competitiveness through the introduction of policy measures such as tax incentives (reduction in LDT charges, water charges, other development charges to the extent possible), access to development finance, and performance/ production-linked incentives. Additionally, efforts should be made to ensure that Indian ship recyclers can compete effectively in bidding processes, particularly against key players like Bangladesh, Pakistan, and Turkey.

Expanding capacity and streamlining downstream industry necessary for new greenfield investments

There is a need to establish a stronger downstream industry focused on higher value-added products and services, along with infrastructure development to support an integrated steel cluster. This would promote recycling activities, enhance the marketability of ship by-products, and engage a broad range of stakeholders in downstream industries, creating synergies and supporting economic viability.

Need to link industry with green steel and net zero steel discussions

The downstream steel industry has a unique opportunity to produce low-emission steel if green electricity is made available to these industrial units at a viable price. This will require business models that aggregate such demand and link it with the expected rise in demand for low-emission steel.

Building credibility and awareness

It's crucial to build a formal route of communication between the Indian ship recyclers, steel producers and global regulatory stakeholders, to credibly convey the processes followed at Indian yards. Active reporting of data and processes related to ship recycling would help in building trust and better business practices for India.

Highlights in numbers

Table 1: Report highlights

Steel sector data
India is the **second-largest producer** of crude steel with approximately **144 MT** produced in 2023-24.
Steel industry in India constitutes: • **2%** of GDP; • **20%** of industrial energy consumption; • **12%** of the country's GHG emissions; • Emission intensity of 2.54 t-CO2e/tcs.
National Steel Policy (2017) envisages boosting steel production capacity to **300 MT by 2030**.
Out of 144 MT of India's crude steel production in 2023-24, **21%** was produced through the **ferrous scrap route**.
India's total **scrap steel market** is approximately **33.3 MT**; of which 8.6 MT was imported in 2024.
National Steel Policy envisages a minimum of 70 MT of scrap steel availability by 2030.
Ship recycling data
Global annual ship recycling market **peaked at 14.7 million LDT**, then declined to approximately 3.8 million LDT by 2023.
• **India's ship recycling sector** accounts for approximately **one-third of the world's scrapped tonnage**. • **Bangladesh** leads the global ship recycling market [market share of around **38%**, 55 ship recycling yards, annual capacity of 3– 4 million MT LDT]; followed by **India** [market share approximately – **30%**, 153 yards, capacity 4.5 MT LDT]; • **Pakistan** [market share – **17.2%**, 25 yards, capacity 1.50 – 2.00 million MT LDT]; and • **Turkey** [market share – **6.3%**, 22 yards, capacity about 1.20 million MT LDT].[2]
Around **15,000 ships** (12.5% of the global fleet) will be available for recycling in the **coming decade**.
Alang has a capacity of **4.5 million LDT** with **153 ship recycling plots**, contributing to over **98% of total ship recycling in India.**
India's ship recycling market reached its **peak in 2012**, processing approximately 3.85 MT of LDT from 415 ships. In FY23, only about 1.14 MT of steel was retrieved from breaking of 131 ships. It further reduced to less than 1 MT in FY 24.
Around **75%** of the total steel recovered from ships in Alang is **upcycled** into value-added steel products. Only **25%** of the total output (0.3 MT) is sent to induction furnaces for melting.
The ship recycling sector at Alang currently contributes about **0.5%** to India's total steel production.
India's ship recycling industry could help reduce steel sector emissions by 19.8 MT of CO_2 annually by 2040.

2 Market. Wirana Shipping Corporation. Available at: https://www.wirana.com/market-pakistan.php. Accessed October 11, 2023.

Introduction

Although India has made considerable progress towards greening its electricity grid by adding renewable energy capacity, achieving its goal of a net zero economy by 2070 will require India to decarbonise its industrial sector, including steel.

India, the world's second-largest crude steel producer, stands at a critical juncture where its expanding steel industry must decarbonise. With a production capacity of 179.5 MT in 2023, the sector accounted for 2% of GDP, 20% of industrial energy consumption (iron and steel sector), and 12% of the country's GHG emissions. With a per capita steel consumption of only 97.7 kg in 2024 compared to the global average per capita consumption of 221.8 kg in 2022, India's steel sector will continue to grow. Although India has made considerable progress towards greening its electricity grid by adding renewable energy capacity, achieving its goal of a net zero economy by 2070 will require India to decarbonise its industrial sector, including steel.

Increasing the use of scrap steel as a raw material is a key lever for decarbonising steel production. However, the demand for scrap steel in India, as is the case for most growing economies, far outstrips supply. In 2024, India's scrap steel market reached an estimated 33.3 MT, of which 8.6 MT came from imports. Driven by increasing demand and supportive policies, the scrap market is expected to grow significantly in the coming years. The National Steel Policy (2017) targets a minimum of 70 MT of scrap availability by 2030, recognising the critical role of scrap in reducing dependence on raw iron ore and coking coal, lowering emissions, and promoting resource efficiency within the steel sector. However, achieving this target requires

not only increased domestic generation of scrap but also strategic policy support to bridge the anticipated shortfall.

To address this need, the Steel Scrap Recycling Policy (2019) was introduced to foster a circular economy by enhancing domestic scrap collection, processing, and recycling. The policy is designed to streamline scrap handling and support the development of scrap processing centres, enabling efficient recycling for steel production. The Vehicle Scrappage Policy (2021) which encourages the systematic phasing out of old vehicles to increase automotive scrap further supports this goal as a valuable input for steelmaking.

Yet, a gap remains between current domestic scrap availability and the ambitious targets set forth by the National Steel Policy. Meeting these targets necessitates diversifying and expanding the sources of high-quality scrap steel. Previous research in this space has indicated that India's ship recycling industry could be a potential source of high-quality scrap steel, owing to the large amount of steel in decommissioned vessels. India is already a major hub for global ship recycling, especially in Alang, Gujarat, where vessels are dismantled and processed.

The ship recycling industry offers dual benefits. Not only does it provide a significant source of recyclable steel, but it also aligns with sustainable development objectives by enabling the environmentally responsible disposal of end-of-life ships. India can capitalise on this industry by developing infrastructure and regulatory frameworks that prioritise safe and responsible recycling practices. This can supplement its steel production, enhance domestic scrap availability, and help move closer to achieving a circular economy within its steel sector.

In this context, this study explores how India's ship recycling industry can support in decarbonising the country's steel sector through the following objectives:

Goals of the Study

1. To establish how ship recycling in India can be a contributor towards scrap steel availability for steel making
2. To explore possible interactions between the ship recycling industry and steel sector in India
3. To examine the decarbonisation potential of ship recycling sector
4. To understand ship recycling's role in supplementing steel demand by upcycling steel products

Increased use of scrap steel as a decarbonisation pathway

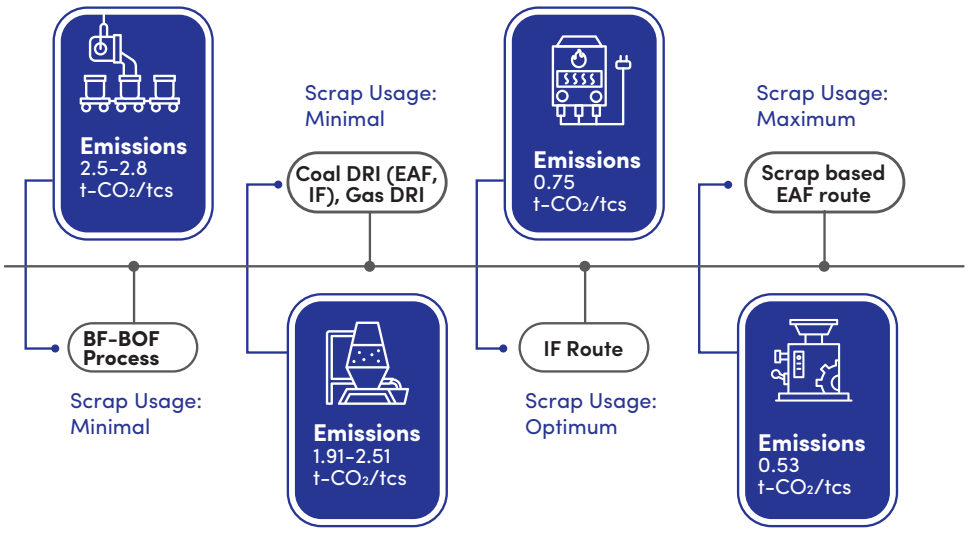
Steel is among the most recycled materials in the world, as it can be recycled infinitely while retaining its original quality and properties. Globally, over 650 MT of steel is recycled every year, with more than 30 MT recycled in India. The use of recycled steel, or scrap, results in significant energy and raw material savings since the process of converting iron ore to steel is bypassed. It is estimated that, on an average, 1370 kg of iron ore, 780 kg of coal and 270 kg of limestone are saved for every tonne of scrap steel used in steel production.

India's steel production relies primarily on three methods: the Blast Furnace-Basic Oxygen Furnace (BF-BOF), Direct Reduced Iron-Electric Arc Furnace (DRI-EAF), and Induction Furnace (IF). Both the BF-BOF and DRI methods are heavily coal-dependent, making them more carbon-intensive. In contrast, Electric Arc Furnaces (EAF) and Induction Furnaces (IF) rely on electricity to melt materials like iron pellets and scrap steel, producing crude steel with significantly lower emissions.

While scrap is typically melted in an EAF/IF, it can also be added to a BOF to help manage heat during steelmaking. Increasing scrap steel's proportion reduces the reliance on iron ore and coking coal, which are resource-intensive and have a higher environmental impact. Scrap-based steel production generates around 0.53 tCO_2 per tonne of crude steel, as compared to approximately 2.54 tCO_2 from production using iron ore. This stark difference underscores the potential of scrap as a highly effective decarbonisation pathway for the sector. The figure below illustrates the variations in scrap usage across different production routes and their impact on emissions per tonne of crude steel.

Depending on the level of renewable energy integration, an EAF production route that uses 100% scrap steel can emit 0.53 t-CO_2/tcs as compared to around 2.54 t-CO_2/tcs through production from iron ore. This suggests that scrap can be considered as a highly effective resource for decarbonisation. The variation in scrap usage across different production routes and its impact on emissions per tonne of crude steel is shown in the figure below.[3]

Figure 1: Route wise emissions from steel production



3 Decarbonising India's Transport System: Charting the Way Forward, ITF

Even though the use of scrap steel comes with significantly reduced carbon emissions and conservation of natural resources, its large-scale adoption in India is constrained by its limited availability. An important source of scrap steel are steel products which reach the end of their useful lives and are discarded (this type of scrap is known as obsolete scrap). These can range from consumer products such as refrigerators and vehicles, to infrastructure goods like buildings, ports and bridges.

Unlike major industrialised nations, India is a fast-growing economy with steel production expected to nearly double by 2030. Given India's growth trajectory and its relatively young stock of steel infrastructure, the domestic scrap supply will be insufficient to meet growing steel demand. India also imports nearly 9 MT of scrap steel, which is 25% of the total steel produced in the country through the ferrous scrap route. The problem is exacerbated by the fact that several countries have placed a ban on the export of metallic scrap, recognising the high intrinsic value of scrap steel to their domestic interests.

Given the obvious benefits of increasing the share of scrap in steel production and the need to bridge the clear gap between its demand and supply, it is important to look at industries that have traditionally not been seen as major sources of scrap steel. This study delves into one such industry in India i.e. ship recycling, to explore its potential as a reliable supplier of good quality scrap steel. Although steel from ships has always been considered a valuable resource for recycling because of its high quality, durability and resistance to corrosion, its use as melting scrap for crude steel production has been limited due to several factors.

Methodology

This study is based on outcomes from consultations with a wide range of stakeholders who provided valuable insights, opinions, and data. Their perspectives on the opportunities and challenges within the scrap steel market and ship recycling industry have informed the report's findings and recommendations.

Figure 2: Methodology

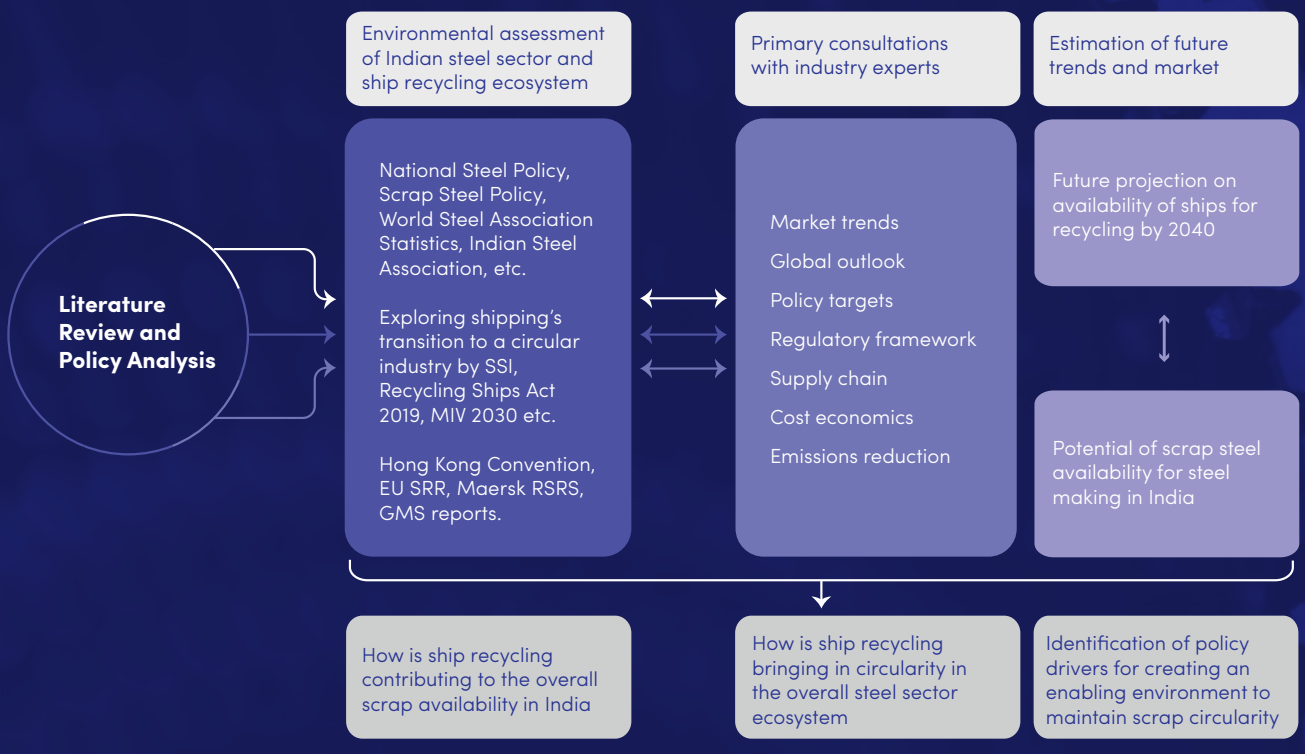
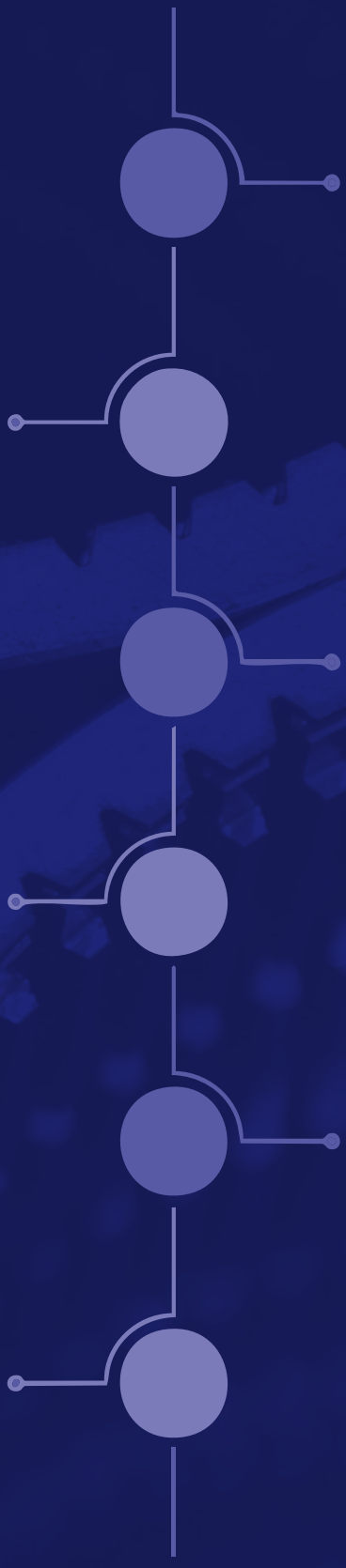


Figure 3: Stakeholder groups

Stakeholders



Civil Society Organisations:

- Smart Freight Centre
- Sustainable Shipping Initiative

Primary Steel Producers:

- SAIL
- TATA Steel
- Kalyani Steel
- ArcelorMittal Nippon Steel

Ship Breakers and Secondary Steel Producers:

- Triveni Ship Breakers
- Rudra Global Ship Recycling
- Baijnath Melaram Ship Breakers
- Hans Industries
- Laxmi Industries
- Triveni Industries

Industry Associations:

- Ship Recycling Industries Association
- All India Induction Furnace Association
- All India Steel Reroller's Association
- Steel Furnace Association of India
- Bhavnagar Induction Furnace Association

Policymakers and Academia:

- Ministry of Steel
- Ministry of Ports, Shipping, and Waterways
- Gujarat Maritime Board
- Andhra Pradesh Maritime Board
- Bureau of Indian Standards
- National Institute of Secondary Steel Technology

Private Maritime Organisations:

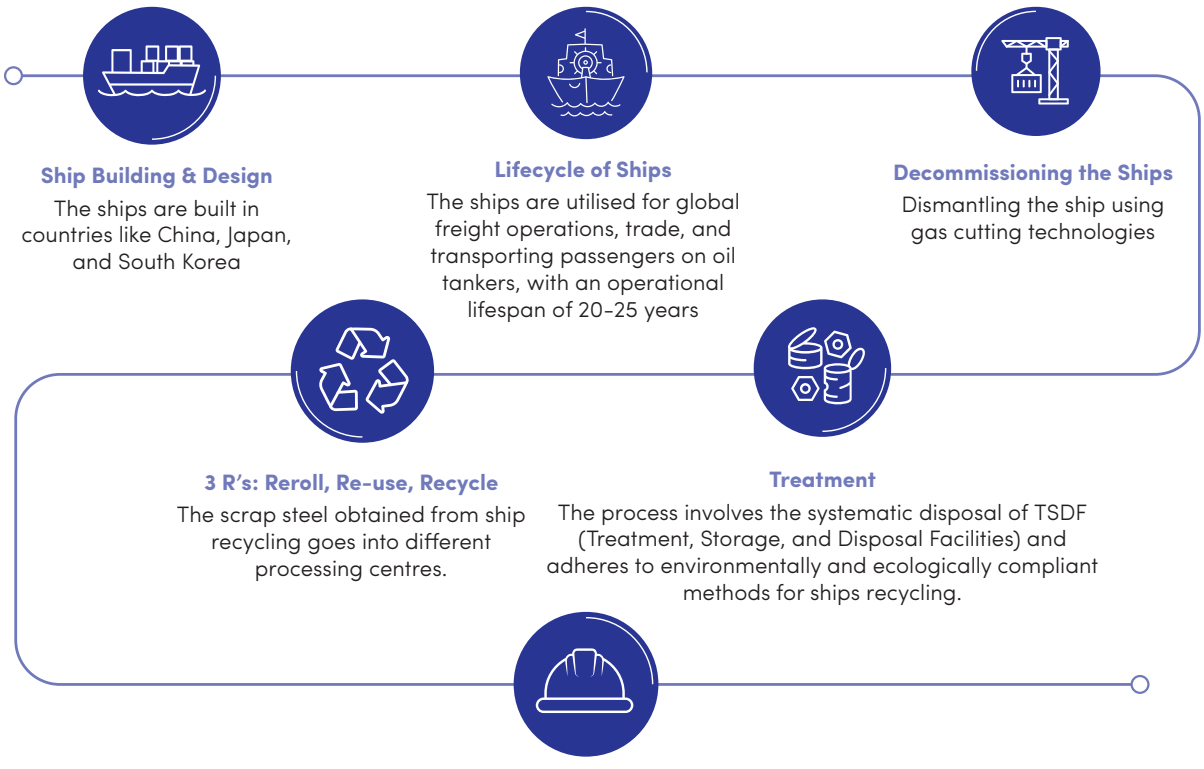
- Maersk
- Lloyd's Register

Overview of India's ship recycling industry

Scope of the ship recycling process and where steel fits in

Ship recycling involves the methodical dismantling of end-of-life vessels, recovering reusable materials, and responsibly managing waste, all in compliance with environmental and safety standards. The illustration below offers a comprehensive view of the value chain, from shipbuilding to the reuse of recovered materials within the steel industry.

Figure 4: How ship recycling sector enhances recycling and re-use of steel products



Steel forms the backbone of ship construction due to its strength, durability, and cost-effectiveness, with high-tensile steel often used in hulls and other vital components. A commercial ship has an average lifespan of 25–30 years, which varies on factors like maintenance and operational conditions. Once ships reach the end of their operational life, they're decommissioned and sent to recycling yards, mainly in India, Bangladesh, Pakistan, and Turkey, where they're dismantled and processed for material recovery. Remarkably, 95–98% of a ship's weight can be recycled, with steel alone accounting for about 90% of the total mass.[4]

During recycling, steel from various parts of the ship, such as hull plates, beams, and structural components, is salvaged. This steel can be reused directly in construction or manufacturing or melted down for new products. Ship recycling directly enables circularity by recovering substantial quantities of steel, reducing reliance on virgin iron ore, and minimising the energy-intensive processes of mining and raw material transport. In fact, recycling steel requires far less energy than producing new steel from iron ore, resulting in less carbon footprint and furthering decarbonisation efforts in the steel sector.

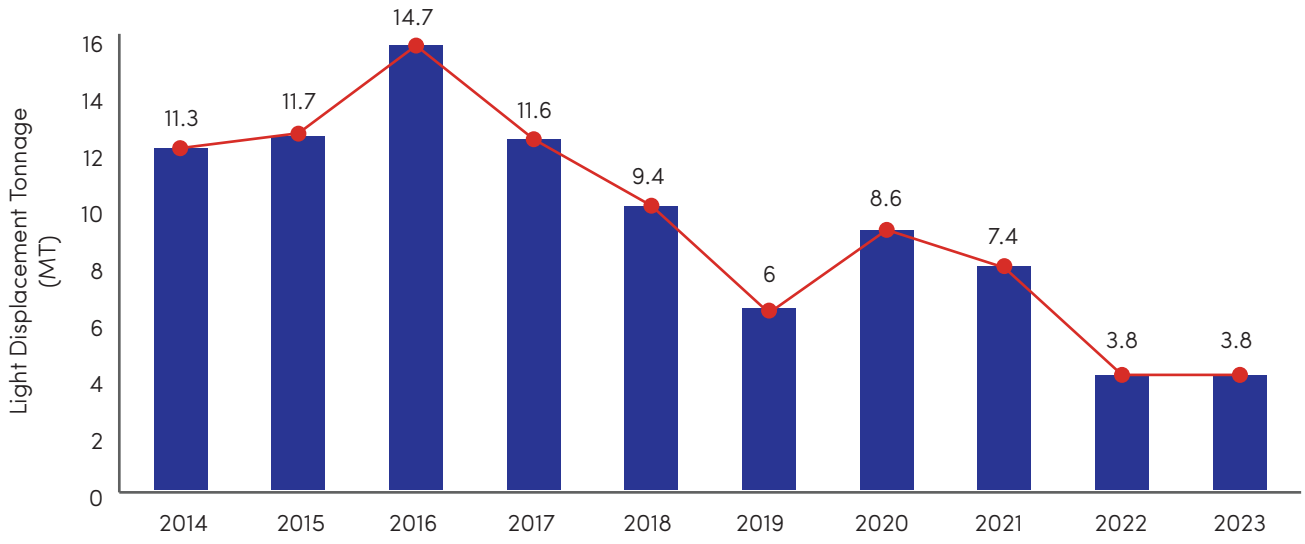
Beyond environmental benefits, ship recycling fosters economic opportunities, especially in regions with shipbreaking yards. It supplies the steel industry with high-quality scrap for efficient production methods like EAFs. This process also keeps large amounts of steel out of landfills, reducing waste.

Market assessment of the ship recycling industry and its drivers

The ship recycling market uses LDT, as a measure for a ship's weight, which includes all permanent equipment. LDT excludes cargo, fuel, water, ballast, supplies, passengers, crew, and other non-permanent elements.

The global ship recycling market has experienced notable volatility in recent years. Recent data from UNCTAD illustrates this trend: the global annual ship recycling market peaked at 14.7 million LDT over the past decade but has since fallen sharply to approximately 3.8 million LDT in 2023.

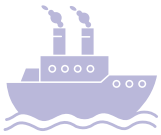
Figure 5: Global ship recycling trends (Source: UNCTAD)



4 Based on Stakeholder consultations with Ship Recycling Sector stakeholders; & IOP Conference Series: Materials Science and Engineering. 2015;95(1):012067; https://iopscience.iop.org/article/10.1088/1757-899X/95/1/012067/pdf.

Currently, the availability of ships for recycling is strikingly low, which has a direct impact on the volume of materials entering recycling yards. Several elements contribute to this downturn:

Table 2: Ship recycling market downturn drivers

Ship recycling market downturn drivers
 **Geopolitical tensions around the Red Sea** The Red Sea is a crucial maritime route for global shipping. It connects the Mediterranean Sea to the Indian Ocean. Geopolitical tensions in countries bordering the Red Sea, such as Yemen, Saudi Arabia, and Egypt, have destabilised shipping routes. Geopolitical conflicts, military confrontations, piracy etc. have made the Red Sea a high-risk zone, with vessels avoiding this route, leading to longer voyages and delays. Shipowners are hesitant to retire ships that are still operational due to the increased demand for safer, alternative routes.
 **Panama Canal water level concerns** The Panama Canal is a shortcut for maritime trade via the Atlantic and Pacific Oceans and relies on freshwater lakes for its operation. In recent years, drought conditions have lowered the water levels of the Gatun Lake, a crucial water source for the canal, leading to restrictions on the number of transits and the maximum draft of ships. Restrictions cause delays and congestion, pushing shipowners to keep vessels in operation longer to meet demand and avoid potential losses from delayed shipments.
 **Frequent vessel attacks** Maritime piracy, terrorism, and territorial disputes have led to an increase in vessel attacks, particularly in regions like the Gulf of Guinea, the Strait of Malacca, and the South China Sea. Incidents of piracy off the coast of West Africa and Southeast Asia have been reported frequently, which pose a risk to crew safety and disrupt shipping schedules. This leads to operational ships being used for an extended period to compensate for damaged ones delaying the retirement of older ships.
 **Suez Canal blockages** The Suez Canal is a vital waterway for global trade as it offers the shortest maritime route between Europe and Asia. In March 2021, the grounding of the *Ever Given* blocked the canal for six days, creating a massive backlog of ships and causing widespread disruptions to global supply chains. Such blockages result in significant delays, forcing shipowners to keep their fleets operational to manage the backlog and ensure reliability in supply chain.
 **Changes in global trade patterns** Shifts in the global economy, such as changes in manufacturing hubs, trade policies, or economic alliances, can alter shipping routes and demand for maritime transport. Global trade changes have resulted in the need for more or different types of ships, incentivising shipowners to retrofit or repurpose existing vessels rather than scrapping them.
 **Stronger Post-COVID-19 freight market** The COVID-19 pandemic initially disrupted global trade and shipping, but the subsequent economic recovery has led to a surge in demand for goods and shipping services. The post-pandemic recovery phase has seen an increased demand for container shipping as global trade rebounded, leading to higher freight rates and strong demand. This has made it financially advantageous for shipowners to keep older ships in operation longer, thus reducing the number of ships available for recycling.

The current low availability of vessels not only limits the tonnage entering recycling yards but also poses significant obstacles for yards aiming to enhance their operational capacity and maintain competitive pricing. Overall, these factors have collectively contributed to the current scarcity of ships available for recycling.

However, there is potential for a turnaround. As the global shipping industry adapts to new regulations and environmental standards, there will be opportunities for ship recycling yards to innovate and improve their practices. With increasing awareness of sustainability, yards that invest in green technologies and processes will be able to not only comply with regulations but also attract more business from environmentally conscious shipowners. Several dynamics indicate that the ship recycling market could soon witness positive developments:

- **Regulatory evolution**
  As stricter environmental regulations come into effect globally, shipowners may be compelled to recycle older vessels sooner to avoid penalties, leading to an uptick in ship availability for recycling.

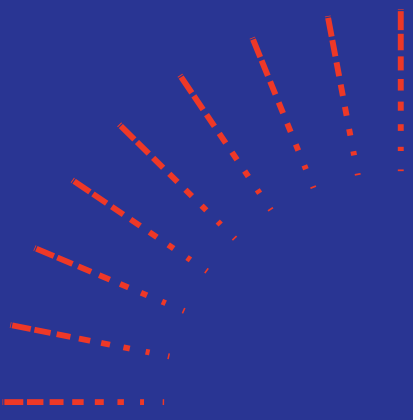
- **Industry transformation**
  The maritime sector is increasingly focusing on sustainability, with shipowners seeking to align their operations with sustainable practices. This shift could drive more vessels towards recycling yards that are compliant with international environmental standards.

- **Market cycles**
  Historically, the ship recycling market has experienced cyclical trends. As older ships age and reach the end of their operational lives, an increase in the number of vessels entering the recycling market is anticipated.

- **Technological advancements**
  Innovations in recycling processes and technologies are likely to enhance efficiency and reduce costs. This can make ship recycling more appealing to shipowners who are looking to responsibly dispose of end-of-life vessels.

- **Stakeholder collaboration**
  Increased collaboration between shipowners, recycling yards, and regulatory bodies can foster a more supportive environment for compliance and best practices. This can lead to improved industry reputation.

By embracing these factors, ship recycling yards can position themselves as integral players in the transition toward a more sustainable maritime industry. As the market evolves, those facilities that adapt to changing demands and enhance their operational capabilities are likely to thrive, setting the stage for a revitalised and resilient ship recycling sector.



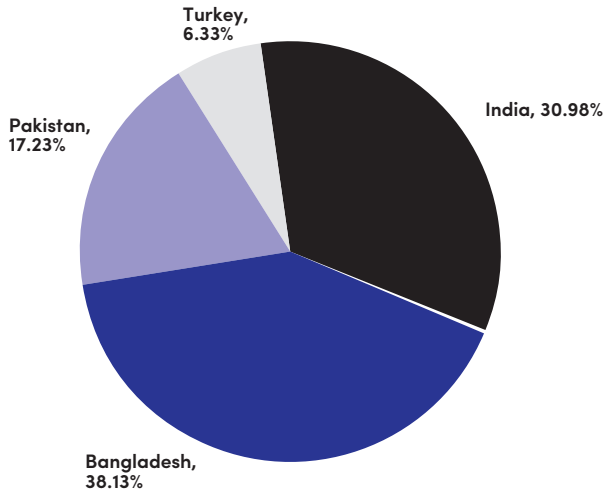
Key players

Ship recycling is shaped by a country's geographical and infrastructural viability, alongside the incentives the industry offers to the national economy. Low labour costs and the demand for scrap steel have determined geographical hotspots for ship recycling[5]. Initially, this industry was formally established and organised by industrialised countries such as the United Kingdom, United States, and Japan to dismantle damaged ships from World War II. Subsequently, it expanded to Mediterranean countries like Spain and Turkey.

In the 1970s, ship recycling operations began relocating to Asian nations, including Taiwan, China, and South Korea. It reached its zenith in the 1980s in these countries, capturing nearly three-quarters of the global shipbreaking market. However, a decline followed due to rising wages and insufficient government support for acquiring high-value vessels. This decline paved the way for the growth of the ship recycling industry in the Indian subcontinent between the 1980s and 1990s.

Today, India, Bangladesh, Pakistan, and Turkey are the primary players in the ship recycling industry, with their market shares illustrated below.

Figure 6: Country-wise share of ship recycling



India's ship recycling sector accounts for one-third of the world's scrapped tonnage, predominantly centred in Alang, which hosts the largest ship recycling yard globally. Established in 1983, Alang benefits from a significant hydrological advantage, with a tidal range of 10-11 metres and a 15-degree beach gradient that facilitates the beaching of ships. Located in the Gulf of Khambat, the yards are naturally protected during inclement weather. Overall, Alang's immense capacity, strategically advantageous location, and cost-effective operations provide it with a competitive edge over other ship recycling locations worldwide. In addition to Alang, ship recycling is also done in Mumbai (Maharashtra) and Kolkata (West Bengal). The Gujarat Maritime Board has set ambitious policy targets to double the ship recycling capacity in Alang over the next four to five years.

There are discussions to establish ship recycling facilities in Andhra Pradesh and Odisha. The Andhra Pradesh Maritime Board (APMB) is planning to develop an industrial park that integrates shipbreaking with downstream activities, such as steel processing, as part of a broader integrated steel cluster. However, these plans are still in the early stages of development.

5 Kagkarakis, N. D., Merikas, A. G., & Merika, A. (2016). Modelling and forecasting the demolition market in shipping. Maritime Policy & Management, 43(8), 1021–1035. https://doi.org/10.1080/03088839.2016.1185181

Chittagong houses **Bangladesh's** primary shipbreaking yards and offers advantages similar to Alang, including low operational costs and strategic coastal access. The domestic steel industry in Bangladesh heavily relies on shipbreaking, creating a continuous demand for end-of-life vessels. A study by the Bangladesh Shipbreakers and Ship Recyclers Association found that 60-70% of the steel used in the country's re-rolling mills is sourced from the shipbreaking industry[6]. This reliance has led to strong government support, including incentives and assistance to help the shipbreaking industry procure ships at competitive prices. This has also enhanced its attractiveness to shipowners and reinforced Bangladesh's footprint in global ship recycling.

Pakistan's shipbreaking industry, centred in Gadani, shares many competitive advantages with Alang and Chittagong, including low labour costs and significant domestic demand for recycled steel. Like Bangladesh, this industry is crucial for Pakistan's steel sector, which depends heavily on recycled materials from ship dismantling. The sector faces challenges related to safety and environmental practices. However, ongoing efforts to improve regulatory compliance and modernise operations are positioning Gadani as a competitive player in global ship recycling.

Turkey has established itself as a key ship recycling destination, particularly in the Aliaga region. Despite its significantly smaller capacity compared to Alang and Chittagong, Turkey's shipbreaking yards are distinguished by their adherence to EU environmental and safety standards, making them highly appealing to shipowners concerned about regulatory compliance. Additionally, Turkey's strategic location at the crossroads of Europe and Asia provides easy access to global shipping routes, often making it a preferred destination for EU nations for geopolitical reasons.

These countries employ two primary methods of ship breaking: beaching and landing. In beaching—used predominantly in India, Pakistan, and Bangladesh—the ship is dragged onto the beach at high tide, secured with ropes and winches, and dismantled directly on the shore. Turkish shipyards, by contrast, use the landing method, where ships are pulled partway onto a concrete platform with the rear portion still in the water. Although the landing method is generally considered less harmful to the environment than beaching, it does not match the environmental safeguards of dry docking, where dismantling occurs within an enclosed concrete area, preventing toxic waste from contaminating the beach. Ship recycling yards approved by the EU currently practice either dry docking or landing.

In recent years, many Indian shipyards have taken significant strides toward cleaner ship recycling practices. These yards are periodically reviewed by the European Commission for inclusion on the list of yards eligible to dismantle EU-flagged vessels.

Experts have also advocated for a nuanced view of ship recycling beyond the traditional methods of beaching and landing. The hybrid "intertidal landing" approach has emerged in India, particularly in Alang, where ships are partially beached for dismantling but kept accessible for safer handling. However, an issue has arisen with the term "intertidal landing," as some Indian yards have adopted it without significant upgrades to their facilities, sometimes claiming little difference from traditional beaching.[7] The term originally referred to improved practices pioneered by a specific yard, but many others have applied it indiscriminately.

This evolving terminology highlights the importance of standardisation, especially as some Indian shipyards pursue compliance with EU environmental and safety standards. The European Commission's inspections at Alang may influence whether "intertidal landing" becomes a formally recognised and standardised method. The following sections explore the implications of these developments on the Indian ship recycling industry.

6 Rahman, S. M., Handler, R. M., & Mayer, A. L. (2016). Life cycle assessment of steel in the ship recycling industry in Bangladesh. Journal of Cleaner Production, 135, 963-971.

7 Marprof Environmental Ltd. (n.d.). Landing vs. beaching vs. intertidal landing. Retrieved November 6, 2024, from https://marprof.net/marprof-environmental-ltd/blog/landing-vs-beaching-vs-intertidal-landing/

Figure 7: Key stakeholders of the ecosystem and their role

Maritime organisations	➔ Regulating freight market, end-of-life ships' traffic ➔ Research and innovation on ship recycling, best practices and their effective implementation
Policy makers	➔ Establishing safe and environmentally sound recycling practices ➔ Designing incentive schemes for green recycling technologies ➔ Supporting in construction of sustainable facilities and capacities
Ship breakers	➔ Ship dismantling operations, recovery of metals and other outputs ➔ Environmental compliance ➔ Employment generation
Industry associations	➔ Advocacy for favourable policies and regulations. Provide inputs in developing industry standards and best practices for ship recycling and steel making Research and Innovation for technologies to reduce emission intensity
Steel producers	➔ Market utilisation of recycling scrap as input, contributing to price stability and availability ➔ Cost efficiency to match the scrap economies ➔ Supplementing their raw material needs with high- quality scrap metal

Global regulations driving the industry markets and operations

Since ship recycling requires careful management of environmentally sensitive materials in ecologically fragile areas. The implementation of Occupational Health and Safety (OHS) principles, and Environmental, Social, and Governance (ESG) guidelines are essential. To address the industry's sustainability challenges, various international maritime organisations and shipping companies have established a range of regulations and guidelines. These regulations serve as legal frameworks designed to safeguard both human health and the environment at recycling yards. The section below discusses some of the key regulations shaping the sector.

Basel Convention

The Basel Convention, which was signed in 1989 and enforced in 1992 by the United Nations Environment Programme (UNEP), regulates the export of hazardous waste from OECD to non-OECD countries. As of June 2024, it had 191 parties and 53 signatories. The Convention classifies obsolete ships as hazardous waste unless they have been pre-cleaned. This significantly impacts Asia's ship recycling industry, including operations in Alang, where waste management regulations are less stringent. While the Convention aims to enhance environmental safety, it has also increased compliance costs and slowed down operations.

In 2019, EU implemented a ban on the transfer of hazardous waste, including ships, from OECD to non-OECD countries. This ban adversely affected South Asian recyclers. However, the European Parliament and the European Council reached a political agreement in November 2023, allowing EU ships to come to India by April 2024. This

was contingent upon Indian shipyards obtaining EU certification. Currently, Europe can only recycle less than 10% of its ships domestically, necessitating the recycling of 90% of its fleet in India and other Asian countries. Given that ships typically have a lifespan of 25-30 years, many vessels will soon reach this critical age.

Shipyards in Alang are viewing this situation as a market opportunity, with several prominent facilities making significant progress towards compliance. These initiatives include the installation of advanced waste treatment systems, establishment of proper disposal mechanisms for toxic materials, and workforce training to ensure adherence to best practices and regulatory changes. Many yards are upgrading their machinery and obtaining the necessary certifications to demonstrate compliance through audits, inspections, and administrative processes.

The Ministry of Environment, Forest and Climate Change (MoEFCC) and the Gujarat Maritime Board (GMB) have strengthened their regulatory frameworks for better alignment with the Basel Convention. The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, have been enforced rigorously. This has established standards for the handling, treatment, and disposal of hazardous waste. Additionally, institutions such as the Indian Maritime University and the National Institute of Oceanography have been actively involved in research and development to support compliance efforts, offering technical expertise and capacity-building programmes. Indian yards are also benefiting from international technical assistance, funding, and capacity-building initiatives provided under the Basel Convention trust funds, which are helping to enhance practices and technologies within the ship recycling industry.[8]

EU Ship Recycling Regulation

The European Union Ship Recycling Regulation (EU SRR) establishes rigorous standards for the environmentally safe and responsible dismantling of ships. It covers both EU-flagged vessels and non-EU ships entering European ports. In 2013, in preparation for the enforcement of the Hong Kong Convention, the EU introduced the EU Regulation on Ship Recycling (EU SRR), which took effect on 30 December 2013. From 31 December 2018, ships with EU flags exceeding 500 gross tonnage (GT) and ships visiting EU ports must be recycled in safe and environmentally friendly facilities, as stipulated in the Regulation.

The EU SRR imposes stricter standards than other regulations, including a check on the beaching method, the safe handling of hazardous waste, and the protection of worker rights. Article 19 outlines a proposed financial mechanism designed to prevent ships from being diverted to non-approved recycling facilities. It aims to ensure they are recycled only at those facilities listed as certified by European standards. Article 8 requires that new ships with contracts signed post-31 December 2018 must have an inventory of hazardous materials, and ships with EU flags or visiting EU ports must have a certified inventory by 31 December 2020. According to Article 16 of the EU SRR, the European Commission updates a list of approved recycling facilities in EU and beyond.[9]

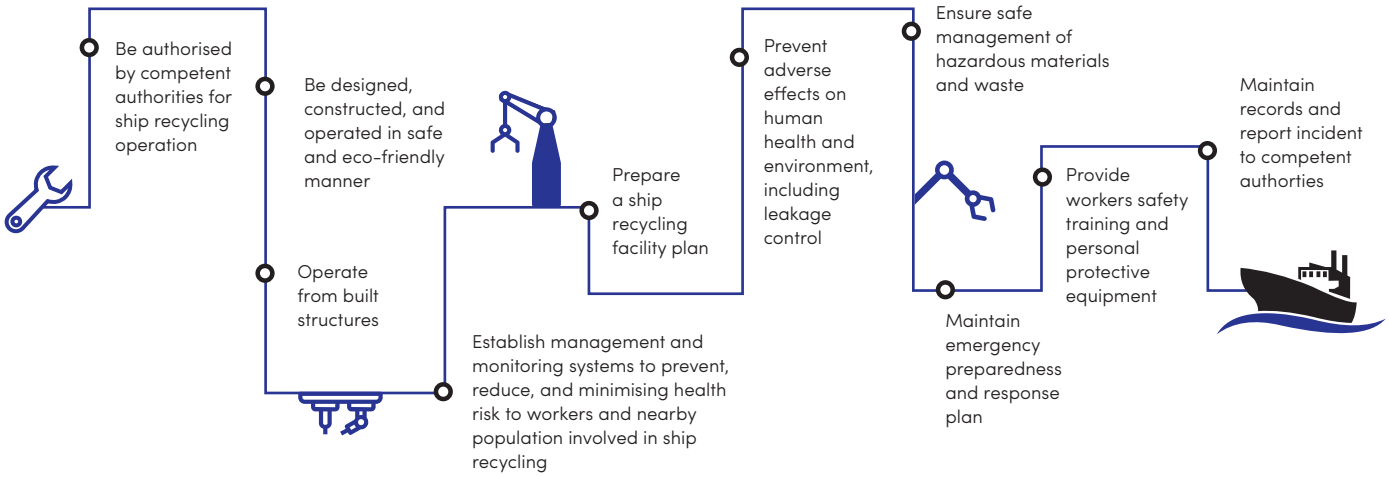
The Regulation's primary goal is to reduce the environmental and human health risks posed by ship recycling. It mandates the inclusion of certified facilities, detailed ship recycling plans, and strict worker safety and waste management protocols. Compliance requires shipyards to develop comprehensive Ship Recycling Facility Plans (SRFPs) that adhere to stringent environmental and safety guidelines throughout the dismantling process.[10]

8 Trust Fund for the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (BC): Contributions Status 2024. Basel Convention. https://www.basel.int/TheConvention/FinanceBudget/TrustFund(BC)/ContributionsStatus/2024/tabid/9815/Default.aspx.

9 Francesco Tola & Enrico Maria Mosconi & Marco Marconi & Mattia Gianvincenzi, 2023; Perspectives for the Development of a Circular Economy Model to Promote Ship Recycling Practices in the European Context: A Systemic Literature Review: https://ideas.repec.org/a/gam/jsusta/v15y2023i7p5919-d1110397.html

10 European Commission DG Environment. (2019). Inspection of a Ship Recycling Facility: Site Inspection Report Application 023 (Report No. 2019-0743, Rev. 1). DNV GL AS Maritime Environment Advisory.; European Commission Directorate-General for the Environment. (2020). Inspection of a Ship Recycling Facility in India: Site Inspection Report Application 006 (Report No. 2019-0050, Rev. 2). DNV GL AS Maritime Environment Advisory.

To be included in the European List, a ship recycling facility needs to:



Since 2016, 27 Indian shipyards, including those in Alang, have sought inclusion on the EU's List of Approved Recycling Facilities. Despite considerable investments in upgrading their facilities, none have been added to the list.[11] A key barrier highlighted by EU inspections has been inconsistencies in the SRFPs submitted by Indian shipyards. These plans, which are intended to provide operational clarity, were often found lacking in the specific procedural detail necessary to ensure safe dismantling, according to EU inspectors.[12] This disconnect between policy and practical execution has raised concerns about the shipyards' ability to manage complex dismantling operations safely.

Another significant challenge for Indian shipyards is leakage control in intertidal zones, where most shipbreaking occurs through the beaching method. EU inspections flagged inadequate control over hazardous materials, particularly in the cleaning of ship components such as double-bottom tanks. The cleaning processes, which often involved materials like sawdust or sand, were deemed insufficient to prevent the spread of oily residues, especially during high tides. This raised concerns about environmental safety and the yards' ability to meet EU environmental protection standards.

Although the EU SRR does not explicitly ban the beaching method, it has become a critical point of contention. Ship recyclers in Alang believe that beaching is perceived by EU regulators as environmentally risky, despite its widespread use in countries like India.[13] While the EU maintains its stance on the method, there are concerns that the regulatory framework may create a de facto barrier for countries relying on beaching. This can inadvertently benefit yards using alternative methods, such as dry-docking and landing, which are more common in Europe and Turkey. Some observers argue that the selective application of standards is somewhat protectionist, as it places certain countries at a disadvantage despite their technological advancements.[14]

In addition to operational and environmental challenges, the lack of adequate medical infrastructure has also been an issue for Indian shipyards. Alang's yards, for example, lack nearby trauma centres or hospitals capable of handling serious injuries. Workers in critical condition often face delays in receiving urgent care, with the closest hospitals are over an hour away. Although the Gujarat Maritime Board has approved a $1 million grant to build a trauma centre, the absence of this infrastructure has been a significant factor in the rejection of Indian yards from the EU's approved list.[15]

11 Marprof Environmental Ltd. (2022). Report on the European List of Ship Recycling Facilities: 3rd Edition (October 2022). BIMCO.
12 European Commission. (2024). Site inspection report: Application 024. Retrieved November 6, 2024, from https://ec.europa.eu/environment/pdf/waste/ships/Site%20Inspection%20Report%20Application%20024.pdf
13 Ahmad, M. (2022). Ship recycling in India-environmental stock taking. Indian Law Review, 6(3), 465-478.
14 EU Ship Recycling Rules Look Like Protectionism: Analysis. BIMCO. April 8, 2019. Available at: https://www.bimco.org/news/priority-news/20190408-eu-ship-recycling-rules-are-protectionism.
15 Ayushi Srivastava and Commodore Debesh Lahiri, 2024. SUSTAINABLE SHIP RECYCLING IN INDIA – SOCIAL, TECHNOLOGICAL AND ENVIRONMENTAL ANALYSIS: https://maritimeindia.org/sustainable-ship-recycling-in-india-social-technological-and-environmental-analysis/

Despite these hurdles, some Indian shipyards have made substantial investments in improving their operations. These upgrades include impermeable flooring, large offshore cranes for safer dismantling of ships, and enhanced accommodation for workers. These efforts reflect a broader shift towards compliance with international regulations such as the EU SRR and the Hong Kong International Convention (HKC). Some Indian yards have also adopted more sustainable practices, such as combining beaching with the alongside method and using cranes to better control leakages in intertidal zones.[16]

Nevertheless, the beaching method continues to be viewed unfavourably by EU regulators. Indian ship recyclers argue that they have made significant technological and safety advancements, but without multilateral discussions or a shift in the EU's position on beaching, inclusion on the EU list appears challenging. Shipyards in India have stressed on a more balanced regulatory approach, calling for recognition of the progress they have made rather than focusing solely on the method of shipbreaking.

The EU SRR has driven improvements in Indian shipyards, fostering innovation and increased investment in environmental protection and worker safety. However, the EU's current regulatory framework may inadvertently act as a barrier to entry for markets that rely on beaching. A bilateral agreement between the EU and India could be a way forward, enabling Indian shipyards to demonstrate their compliance with global safety standards while addressing the unique challenges they face.[17] Until such an agreement is reached, Indian shipyards will continue striving for recognition, despite the significant regulatory hurdles they must overcome.

Hong Kong Convention

The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships was adopted in May 2009 by the International Maritime Organization (IMO). The Convention aims to eliminate risks to the environment, human health, and safety during ship recycling. It was conceived in response to global concerns over unsafe recycling practices. According to the IMO, the Hong Kong Convention (HKC) adopts a comprehensive 'cradle to grave' approach, covering all environmental and safety aspects of ship recycling. This includes the ship's design, construction, operation, and eventual recycling, while mandating compliance through certification and reporting requirements. The Convention also ensures the responsible management and disposal of waste streams in a safe and environmentally friendly manner. It assigns duties and responsibilities to shipowners, shipbuilding yards, ship recycling facilities, flag states, port states, and recycling states.

Ships destined for recycling must have an onboard Inventory of Hazardous Materials. Authorised ship recycling facilities will need to create a specific Ship Recycling Plan for each vessel. Governments must ensure that the recycling facilities within their jurisdictions adhere to the Convention's standards.[18]

The Convention will come into effect on 26 June 2025. It currently has 22 Contracting States, including India, Bangladesh, and Turkey, representing 45.81% of the world's merchant shipping tonnage. In Alang, 111 of 153 ship recycling yards comply with the Convention's standards.[19] As early adopters, this gives Indian yards a competitive edge over other yards.

HKC mandates that shipowners secure an International Ready for Recycling Certificate (IRRC) for a ship's final journey to a recycling destination. This certificate is intended to ensure that the recycling process is safe and environmentally friendly. However, it also

16 Marprof Environmental Ltd. (2022). Report on the European List of Ship Recycling Facilities: 3rd Edition (October 2022). BIMCO.

17 EU Ship Recycling Regulation: An Inhibitor or Catalyst for Greening Ship Recycling Yards https://www.gmsinc.net/article/greening-ship-recycling-yards-eu-regulation

18 What Will Happen When Hong Kong Convention on Green Ship Recycling Comes into Force? Economic Times. Available at: https://infra.economictimes.indiatimes.com/news/ports-shipping/what-will-happen-when-hong-kong-convention-on-green-ship-recycling-comes-into-force/112100023.

19 Sustainable Ship Recycling in India: Legal, Economic, and Political Analysis. National Maritime Foundation. Available at: https://maritimeindia.org/sustainable-ship-recycling-in-india-legal-economic-and-political-analysis/.

classifies the ship as hazardous waste under the Basel Convention, leading to potential legal ambiguities. Additionally, shipowners are required to supply a report detailing the inventory of hazardous materials to the recycling facilities before the recycling process begins. The Basel Convention, unlike the HKC, does not consider the flag state but instead places responsibility on the state of export (from which the ship begins its final voyage), any transit state, and the state of import (the recycling state). The overlapping requirements create uncertainties that need to be addressed.

Local experts in Indian ship recycling yards view the Convention as a positive development for safety and environmental practices, though they also acknowledge the financial burden of compliance, particularly for smaller yards. Overall, it is seen as a vital step toward aligning with global best practices for sustainable ship recycling. More than 75% of Indian ship recycling yards have met the requirements for HKC compliance, creating a first-mover advantage for Indian yards in the global market. With fewer compliant yards in Bangladesh, Pakistan, and Turkey, it is anticipated that a substantial number of end-of-life vessels will be directed to Alang for recycling in the coming years. However, economic implications, such as the prices that yards are willing to pay for ships, will continue to influence decisions. For companies committed to safe and sustainable ship recycling, Alang may become a more favourable option. As compliant yards increase their competitive offers, they can potentially attract a greater share of the end-of-life vessel market.

Compliance requirements by private companies:

Case 1: Maersk's Responsible Ship Recycling Standard (RSRS)

Maersk, a leading global shipping company, established the Responsible Ship Recycling Standard (RSRS) to enforce stringent environmental, safety, and ethical practices in ship recycling. Based on the HKC, it exceeds HKC's guidelines on several parameters. RSRS covers critical areas such as downstream waste management, labour and human rights, and anti-corruption measures. RSRS compliance is enforced for Maersk-owned vessels through assessments led by Maersk's Quality, Health, Safety, and Environment (QHSE) teams and supplemented by external auditors.

Alang has been identified as a viable site for Maersk RSRS-compliant recycling. To enable responsible recycling practices in Alang, Maersk has invested in logistics infrastructure, including warehousing, rail services, and land transport to support the handling of ship parts and hazardous waste. However, significant challenges remain. Worker safety and welfare infrastructure are limited, with shortages of medical and hygiene facilities. Maersk has sought to address some of these needs by funding a mobile health unit and providing hygiene and awareness training.[20]

From 2017 to 2023, Maersk recycled 16 vessels across seven Alang yards, employing over 1,100 workers.[21] Yet competition among yards, often driven by price, sometimes hampers consistent adherence to high safety and environmental standards. Maersk's QHSE superintendents and consultants monitor these yards closely, but the safety of workers and effective waste management remain challenging goals.

In the coming years, as more vessels reach the end of their operational life, Maersk expects to increase its ship recycling activities. It aims to invest in shipbreaking yards that are already certified under the HKC and are also committed to adhering to Maersk's RSRS standards.[22] This engagement reflects the complex balance between meeting stringent environmental standards and navigating the practical limitations of shipbreaking facilities in regions with limited infrastructure.

20 A.P. Moller – Maersk. Sustainability at A.P. Moller – Maersk. Available at: https://www.maersk.com/sustainability/reports-and-resources.

21 Responsible Ship Recycling. Maersk. Available at: https://www.maersk.com/sustainability/our-esg-priorities/responsible-ship-recycling

22 Maersk to Scrap Eight Panamax Ships in India and China. gCaptain. Available at: https://gcaptain.com/maersk-to-scrap-eight-panamax-ships-in-india-and-china/.

Case 2: Mediterranean Shipping Company (MSC) Ship Recycling Policy

Mediterranean Shipping Company (MSC) has developed a Ship Recycling Policy that adheres to international standards on environmental, health, safety, and labour practices, and aligns with the HKC. MSC prioritises the selection of certified recycling facilities, conducts site visits, and appoints auditors when necessary to ensure strict compliance with environmental and safety protocols. The company's policy mandates working exclusively with facilities certified by reputable bodies, including the IMO and the EU, for all ship recycling activities.

MSC aims to uphold workers' rights and safety at these facilities and regularly reports on compliance and progress to maintain transparency. The company has focused its recycling activities on a small number of vetted yards in Alang that meet HKC standards and practice advanced green recycling. MSC limits ship sales to this carefully selected group.

To further support the local recycling sector, MSC collaborates with stakeholders to address ongoing challenges at shipyards, including efforts to improve infrastructure and worker safety. MSC has also participated in EU delegation visits to Alang. Recently, MSC sent two container ships—the 1,893-TEU MSC Gabriella (built in 1985) and the 1,524-TEU MSC Agata II (built in 1994)—to Alang for recycling operations.[23]

Table 4: Comparison - Global regulations

Parameters	Hong Kong Convention	EU SRR
Scope & Application	Applies to all ships over 500 gross tonnes globally, except naval auxiliary and warships.	Applies globally to all ships over 500 gross tonnes, except naval auxiliary, warships. Particularly applicable to EU-flagged ships or those that call at ports or anchorages of EU member states.
Implementation	Requires ratification by countries and will come into force on 26 June 2025.	Enforced by all EU member countries on 31 December 2018.
Requirements	**IHM:** Requires inventory of hazardous materials (IHM),[24] hazardous materials listed in the Hong Kong Convention document. **Ship Recycling Plan:** Each ship has to prepare a ship recycling plan listed as per the document. **Duration of the certificate:** The certificate will be provided for a duration of 5 years (hazardous materials certificate).	**IHM:** Inventory of 15 hazardous materials listed in Annexure 1 of the EU SRR document is required, and so are Ship Recycling Plans. The difference is of two additional chemicals banned: HCFC 22 & HBCDD. **Ship Recycling Plan:** Each ship must prepare a plan listed as per the document. **Duration of the certificate:** The certificate will be provided for a duration of 5 years. **Health care**: Trauma centres at the ship recycling facilities are required.

23 MSC Responsible for a Quarter of Boxship Recycling Deals as Two More Are Scrapped. TradeWinds. Available at: https://www.tradewindsnews.com/containers/msc-responsible-for-a-quarter-of-boxship-recycling-deals-as-two-more-are-scrapped/2-1-1713539.

24 Hong Kong Convention vs EU Ship Recycling Regulation: Where We Stand. SAFETY4SEA. Available at: https://safety4sea.com/cm-hong-kong-convention-vs-eu-ship-recycling-regulation-where-we-stand/.

Parameters	Hong Kong Convention	EU SRR
	Health care: Health care facilities should be developed for workers. **Recycling method:** The method of ship recycling need not be mentioned. **Waste management:** Management of hazardous materials is there but no mention of impermeable floors.	**Recycling method:** The EU list needs to mention the method of ship recycling and the type of ship and size to be recycled. **Waste management:** Waste generated during the ship recycling process should be done only on **impermeable floors** with effective drainage systems. The document mandates the mention of type of waste management process applied and the evidence that the applied process will be carried out without endangering human health and in an environmentally sound manner.
Certification	Requires "Ready for Recycling" certificate for ships.	Requires **Statement of Compliance (SoC) and Certificate of Compliance (CoC) for ships.**

More than 75% of Indian ship recycling yards have achieved compliance with HKC standards. In contrast, only four out of 50 operational yards in Bangladesh are certified as green ship recycling facilities.[25] Turkey demonstrates a more robust performance, with nearly all its 22 operating yards having received Statement of Compliance for HKC compliant recycling of ships[26]. Meanwhile, ship recycling yards in Gadani, Pakistan, are undergoing enhancements in safety and environmental practices, reflecting a broader regional trend towards improved industry standards.

According to an assessment by a Rajya Sabha Committee and experts from the Gujarat Maritime Board, several initiatives have been undertaken to align the Indian ship recycling industry with international standards[27]. These initiatives include developing and implementing facility management plans, drafting ship-specific dismantling strategies, establishing oily waste reception facilities, and managing hazardous materials such as paint chips and asbestos. Additionally, significant efforts are being made to enhance healthcare infrastructure at Alang, including the establishment of advanced medical facilities equipped with MRI, CT scan, ICU, X-ray, operation theatres and laboratories.

There is a strong emphasis on the scientific treatment of effluents, mandatory use of personal protective equipment (PPE), and minimising of workplace fatalities. Yard owners are also investing in firefighting equipment, emergency breathing apparatus, and comprehensive training for new workers.

As a result of these initiatives, several ship recycling yard owners are increasingly committed to obtaining Statements of Compliance for HKC standards and ensuring, in principle, adherence to the EU SRR. As per an industry expert from Maersk, post-Panamax ships are largely unapproved by most EU-regulated ship recycling yards. This presents a significant opportunity for Alang. Alang is well-equipped to handle these larger vessels as their numbers are expected to rise in the coming years. By continuing to enhance safety, health, and environmental compliance, Indian ship recycling yards are poised not only to retain their prominence in the industry but also to compete effectively with facilities in Bangladesh, Pakistan, and Turkey. Increasing the number of certified green ship recycling yards in India will be essential for their competitive advantage.

25 Mehtaj N, Golam Zakaria NM, Ibn Awal Z, Dipto SS, Hannan MA, Dev AK, Ali MT. Ship recycling process in Bangladesh and a survey-based risk assessment with mitigation proposal. Heliyon. 2022;8(1):e02400. Available at: https://www.sciencedirect.com/science/article/pii/S2405844024153753.

26 Wirana Markets Data: Turkey. Wirana Shipping Corporation. Available at: https://www.wirana.com/market-turkey.php.

27 Rajya Sabha Report 2023. Status of Ship Building, Ship Repair, and Ship Breaking Industries in the Country. https://sansad.in/getFile/rsnew/Committee_site/Committee_File/Press_ReleaseFile/20/193/712P_2024_2_15.pdf?source=rajyasabha

India's policy drivers for the ship recycling industry

The Government of India and several state governments have implemented various policies and programmes for the maritime sector. These focus on improving infrastructure, efficiency, services, and ship recycling capacity. The ship recycling industry operates within a framework designed to address environmental, social, and safety concerns. Key policies and regulations include:

Table 5: India's policy drivers in ship recycling

Policy/ Regulation	Impact on ship recycling
Maritime Amrit Kaal Vision 2047	The Maritime Amrit Kaal Vision 2047 (MAKV) is a comprehensive initiative by the Indian government. It aims to transform the country's maritime sector by becoming globally competitive, sustainable, and technologically advanced by the year 2047. This vision aligns with India's broader goals of economic growth, environmental sustainability, and enhanced global maritime presence. The vision is to enhance the efficiency and capacity of Indian ports, thereby boosting trade and contributing to economic growth. MAKV aims to secure Coastal Regulation Zone (CRZ) authorisation, reduce taxes and customs, and expand the Alang-Sosiya yard. The policy seeks to encourage EU and OECD countries to directly transfer ships to Alang and to allow high-quality steel from ship recycling to be used in construction. Key highlights include: • Establishing six mega ports to significantly enhance India's international trade capacity. • Relaxing taxes and import duties, collaborating with EU nations to send vessels to India at subsidised rates. Developing 70 scrapping centres to create a robust demand-supply ecosystem. • Long-term plans to build one new facility by 2030 and **two additional facilities by 2047 along the eastern coast** (West Bengal, Andhra Pradesh, Odisha) to capture Bangladesh's market., The goal is to elevate India's global ship recycling ranking from number 2 to number1 by 2030. • Prioritising sustainable practices, advancing technologies like autonomous ships and AI, improving port infrastructure, and integrating coastal communities into sector growth. • Establishment of a Maritime Development Fund aimed at providing accessible working capital and long-term financing to the maritime industry. • Establishing maritime training institutes and programmes to develop a skilled workforce for the industry. • Streamlining regulatory processes to make them more efficient and transparent, encouraging investment in the maritime sector.[28]
Maritime India Vision 2030	The Maritime India Vision 2030 (MIV 2030) is an ambitious blueprint laid out by the Indian government to revolutionise the country's maritime sector by the year 2030. To make India a leading maritime nation, it is essential to modernise port infrastructure, improve operational efficiency, and adopt global best practices. With growing concerns about environmental sustainability, the vision emphasises green and sustainable practices in the maritime sector. Developed by the Ministry of Ports, Shipping, and Waterways, MIV 2030 aims to double its current ship recycling capacity. It plans to expand annual capacity by 4 MT and increase the number of yards from 153 to 198 by 2030. This expansion is expected to achieve a total capacity of 9.5 MMTA, positioning India to meet growing global demand. It focuses on securing India's position in the global maritime landscape and achieving self-reliance in shipbuilding, repair, and recycling. Key objectives include:

28 Amrit Kaal 2047. Ministry of Ports, Shipping and Waterways, Government of India. Available at: https://shipmin.gov.in/content/amrit-kaal-2047.

Policy/ Regulation	Impact on ship recycling
	❯ Raising India's global ranking in ship recycling to number 1 by 2030 and enhancing shipbuilding and cargo/passenger movement through inland waterways. ❯ The SAGARMALA project aims to boost ship recycling capacity and promote the 'Waste to Wealth' concept. This will be achieved by reforming regulations and developing infrastructure in collaboration with the Bureau of Indian Standards (BIS). ❯ Strategic interventions include relaxing BIS guidelines for recycled steel pricing, redeveloping Alang-Sosiya plots, establishing a ship-repair cluster on the east coast, developing an ISO 17025 testing lab, and showcasing India's ship recycling capabilities through trade events. ❯ Ongoing engagement with the European Commission aims to attract EU-flagged ships to the Alang shipbreaking yard. ❯ Improving connectivity with global markets, streamlining logistics, and fostering international maritime partnerships. ❯ Streamlining regulatory processes, reducing bureaucratic hurdles, and encouraging private and foreign investment in the maritime sector.[29]
Recycling of Ships Act, 2019	The Recycling of Ships Act, 2019 is a landmark legislation in India aimed at regulating the recycling of ships in an environmentally sound and safe manner. This Act aligns with international conventions and standards, particularly the HKC. It is implemented by the Ministry of Ports, Shipping, and Waterways. Key provisions include: ❯ Immediate restrictions on hazardous materials for new ships. Existing ships have five years to comply. ❯ Exemptions for government-operated warships and non-commercial vessels. ❯ Ship recycling facilities must be authorised. Recycling must follow a ship-specific recycling plan, with a "Ready for Recycling" certificate required as per the HKC. ❯ Regular monitoring and reporting are mandated to ensure compliance.[30]
Ship Breaking Code	Enacted in 2013, the Ship Breaking Code aligns with the HKC and focuses on eco-friendly ship dismantling. Key elements include: ❯ **Safe recycling**: Mandates procedures for worker safety and minimal environmental impact. ❯ **Ship-Specific Recycling Plan (SSRP)**: Details the ship's inventory of hazardous materials and outlines proper dismantling processes. ❯ **Scrap steel as a resource**: Recognises scrap steel as a valuable recyclable resource, aiming for maximum recovery while minimising contamination.[31]
Gujarat Maritime Board Ship Recycling Regulations 2015	The Gujarat Maritime Board Ship Recycling Regulations 2015 set guidelines for ship recycling in Gujarat, requiring: ❯ Advance notification to the Gujarat Maritime Board, preparation of a hazardous materials inventory, and submission of a Ship Recycling Plan for approval. ❯ Emphasis on environmental protection, worker safety, waste management, and regular monitoring. The regulations cover permissions, renewals, development and resizing of plots, and beaching regulations.[32]

29 Maritime India Vision 2030 Report. Ministry of Ports, Shipping and Waterways, Government of India. Available at: https://sagarmala.gov.in/sites/default/files/MIV%202030%20Report.pdf.

30 Recycling of Ships Act, 2019. Ministry of Ports, Shipping and Waterways, Government of India. Available at: https://sagarmala.gov.in/sites/default/files/Recycling%20of%20Ships%20ACT%2C%202019%20%282%29.pdf.

31 CB Code Revised 2013. Ministry of Ports, Shipping and Waterways, Government of India. Available at: https://shipmin.gov.in/sites/default/files/1157392371CBCODErevised201310022017_0.pdf.

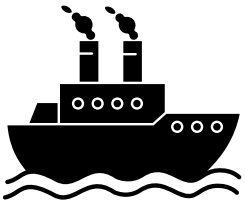
32 Ship Recycling Regulation 2015. Available at: https://maritimecluster.org/wp-content/uploads/2021/12/Ship-Recy-Regula-2015.pdf.

Indian maritime acts and initiatives aim to transform the country's maritime sector into a globally competitive, sustainable, and technologically advanced industry, while ensuring safe and responsible recycling practices. A key component of this transformation is the Sagarmala project, which falls under the Maritime Amrit Kaal Vision 2047. This ambitious initiative emphasises the development of green ports, the implementation of digital solutions, skill development programmes, and comprehensive regulatory reforms. To ensure compliance and safety, regular security audits are conducted at shipbreaking yards.

Various initiatives are being launched with a planned investment of ₹ 9,000 to 10,000 crores. These include reductions in taxes and duties, such as the import duty of 2.5% and GST of 18%, aligned with the costs of imported scrap. Additionally, there is a push for collaboration with OECD countries to facilitate the direct transfer of their vessels to Alang, and offer a subsidised selling price like in the case of Turkey. There are also plans to establish new scrapping centres along the coastline. With funding mechanisms being developed under the Maritime Amrit Kaal Vision, shipyards are investing between ₹ 5-10 crore each to meet international standards.

Continued infrastructure development and capacity enhancements are essential components of these initiatives, positioning Indian ship recycling yards to accommodate an increased influx of vessels for recycling in the coming years.

Alang-the nucleus of India's ship recycling industry



According to an estimate, on an average, Alang caters to
98%
of India's, and
32%
of global ship recycling volumes.

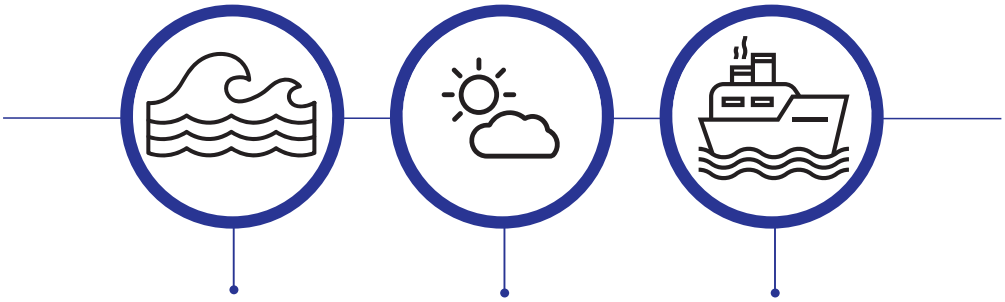
Established in 1983 in Gujarat on the western coast of India, the Alang Sosiya Ship Recycling Yard (ASSRY) has emerged as the largest and one of the most preferred ship recycling destinations in the world. According to an estimate, on an average, it caters to 98% of India's, and 32% of global ship recycling volumes. It is a cluster of 153 individual ship breaking yard plots, stretching along a coastline of 14 kms, with an estimated ship recycling capacity of **4.5 million LDT.**

Alang's distinctive geographic and strategic advantages drove its emergence as a leading global hub for ship recycling. Its location along India's western coastline provides ideal conditions for shipbreaking, with a tidal range and seabed suitable for beaching large vessels. Alang's proximity to major shipping routes, a robust downstream market for recycled materials, and supportive regulatory frameworks contribute to its dominance in the industry.

Figure 8: Alang Sosiya Ship Recycling Yard (Google Earth View)

Alang significantly influences the industrial landscape in the region and has spurred the growth of end-use industries like steel re-rolling mills and steel melting facilities.

Table 6: Alang geographical advantages



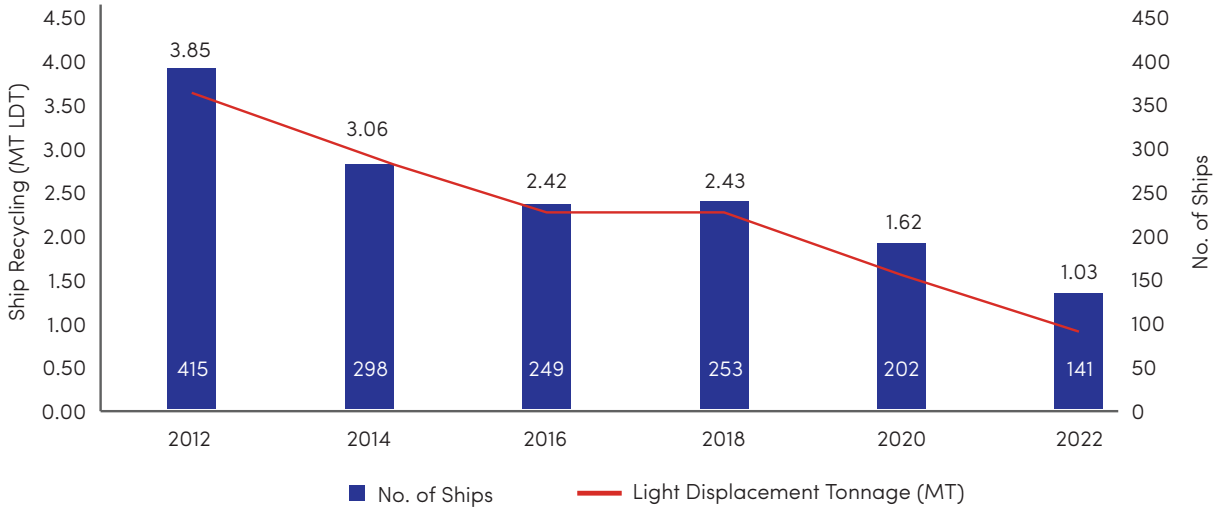
Strategic positioning within the high tide zone and ideal weather conditions, supporting continuous ship breaking operations

Quick drying capability of the seabed, even during monsoons, which helps in handling various materials and equipment involved in the ship breaking process.

Sloping coast of Alang, along with a long dry area, facilitating the uninterrupted beaching of vessels

In 2012, India's ship recycling industry reached new heights, processing nearly 3.85 MT LDT from 415 vessels. However, since then, the sector has experienced a steady decline.

Figure 9: Ship recycling market trend for India (Source: SRIA)



As previously noted, the ship breaking industry is inherently cyclical, and it is currently going through a phase when there is a scarcity of ships available for dismantling. Additionally, Alang's ship recycling sector finds itself at a disadvantage as it is unable to match the higher bids from Bangladesh and Pakistan for ships that are available. Consequently, India, once a dominant force with a 40% market share, has been eclipsed by Bangladesh, and its share has dwindled to around 30%.

The following sections delve into the multifaceted reasons behind this downturn, examining the intricate economic, national, and international dynamics that influence the industry's health.

Increased global freight activity: The availability of ships for recycling is intricately linked to global freight rates and trends, driven by worldwide trade and economic conditions. This relationship is well-understood within the maritime community. During the pandemic, the freight industry witnessed a surge in demand, prompting ship owners to extend the operational life of vessels to capitalise on profits. This extension has delayed decommissioning, resulting in fewer ships being available for recycling.

Higher ship valuations in Bangladesh and Pakistan: Bangladesh and Pakistan generally offer higher prices than India for acquiring ships for recycling. This is influenced by local demand and economic factors affecting steel prices. Bangladesh, in particular, has a high demand for scrap steel due to rapid growth in construction and steel production. This leads buyers to frequently pay a premium for end-of-life ships, with bids often exceeding $400 per LDT. Similarly, Pakistan's infrastructure projects drive high demand for steel, pushing it to match or exceed Indian bids, thereby putting India at a competitive disadvantage.

The 2019 Basel Ban Amendment and preference for Turkey: The Basel Ban Amendment restricts the export of hazardous waste, including end-of-life ships, from OECD to non-OECD countries. This has significantly impacted India's ship recycling industry by limiting access to compliant vessels. This restriction reduces the supply of recyclable ships, often laden with hazardous materials like asbestos and Printed Circuit Boards (PCBs), thus limiting the number of ships India can legally dismantle. Consequently, India faces increased competition from OECD-compliant recycling facilities, such as those in Turkey, which further constrains its output and revenue potential.

Domestic regulations: The BIS regulation (IS 1786:2008) restricts the re-rolling of steel from ships into TMT bars greater than 6mm in diameter. This limits the market segments that the industry can cater to. The regulation has impacted the downstream activity in ship recycling significantly. Alang's industry can generally benefit from a higher degree of support and enabling environment. Incentives, trade fairs, exhibitions and bilateral agreements to promote the Indian ship breaking and recycling industry could be useful.

Insights from Alang

Yard owners described the current condition aptly: "When the ship freight market is in boom, the ship recycling market is in doom." This 'doom' in Alang has been exacerbated by the inability of the ship owners to compete with the prices offered by Bangladesh. Bangladesh can offer an extra $50-$60 per LDT.

This is due to a greater reliance of its domestic steel industry on steel being salvaged from ships; as well as incentives being provided by the Bangladeshi government.

Despite these challenges, the ship recycling industry is on the cusp of a revival.

Freight trends indicate that over the next decade, approximately 15,000 ships—representing 12.5% of the global fleet—are expected to be recycled. This is double the number of the previous 10 years, highlighting increased demand for sustainable ship recycling.

Additionally, over half of the world's ships are more than 15 years old. The average fleet age was 22.2 years as of early 2023, while the typical ship lifespan is around 25 years. Each year, between 600 and 800 ships reach the end of their operational life, positioning India for substantial growth in its ship recycling market.

Insights from Alang

Globally, growth in freight activity is expected to slow down to 2.1%-2.4% in the period till 2027, pushing a sizeable number of container vessels for recycling during the 2025-2026 period. Additionally, due to lower recycling rates in recent years, more ships that have reached the end of their operational life will be sent for recycling soon. This will lead to a metamorphosis of the ship recycling market. We understand from our visit to Alang that India has an advantage to absorb a lot of the upcoming decommissioned ships because of their current adaptation exercise to be EUSRR and HKC compliant. This is a significant financial investment from Alang's businessmen as business is currently low and the investments represent a farsighted approach. Bangladesh's yards, accordingly, have started late on their journey to make their yards green and will therefore not be completely prepared (from sustainability regulations point of view) to absorb as many ships when the spurt occurs.

Since 2016, many ship recycling yards in Alang have taken steps to comply with international standards to improve safety and environmental practices. Currently, out of 153 yards at Alang, 111 are in compliance with HKC, set to come into force from July 2025. This is expected to help India gain a larger share of the global ship recycling market, since its main competitors Bangladesh and Pakistan currently have only 6 and 1 HKC compliant yards respectively.

Quality Control Order – Ministry of Steel

Background:

The ship recycling industry in India, particularly in Alang, was established in the 1980s. This industry provided significant raw material to steel re-rolling mills in the form of metal sheets. These sheets were re-heated and rolled into various steel products such as TMT bars, rods, plates, sheets, wire rods, billets, and ingots, which were mainly used in the construction industry. Numerous re-rolling factories sprang up in Bhavnagar and Sihor to process this steel.

Impact of IS 1786:2008: High strength deformed steel bars and wires for concrete reinforcement — specification

IS 1786:2008 is the standard notified by BIS which governs the production of TMT bars from ship scrap material and restricts the use of recycled scrap steel for manufacturing re-rollable bars.

In 2013, the Quality Control Order (QCO) was issued, prohibiting the use of recycled metal sheets without a material composition history for making reinforcement bars or TMT bars above 6mm in diameter. This required ship breakers to provide the metallurgical history of the steel, examining its physical and chemical properties, before re-rolling the raw material.

Consequences:

The introduction of these new regulations significantly altered the industrial ecosystem in Bhavnagar and Sihor:

- Industries in Bhavnagar and Sihor shifted to manufacturing high-value fabrication products using ship scrappage, which find application in agricultural equipment, general engineering and fabrication.
- Conversely, the number of Induction Furnace based steel plants increased from 20 to 90, with 75 of them being active.
- Around 60 new induction furnace units were set up in Sihor to produce ingots and billets for re-rolling mills.

- In the areas around Alang, the number of Steel Re-rolling Mills (SRRM) reduced from 120 to 65, of which only 55 are currently active, However, a number of other factors such as consolidation of production capacities, shift in markets, energy prices, etc. may have also played a role.

Way Forward:

An interministerial committee has been formed to review the impact of the Quality Control Order (QCO) on the steel re-rolling industry in Bhavnagar and nearby areas. This committee, which includes representatives from relevant national standards and regulatory bodies, is working on creating a Standard Operating Procedure (SOP) for using ship plates through material composition testing.

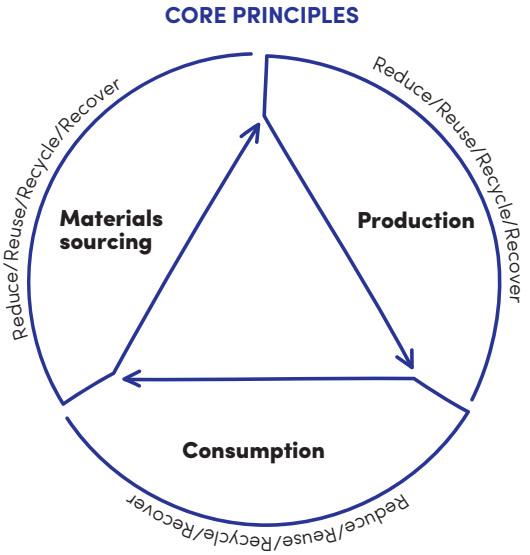
Stakeholders are actively engaging with the committee to address the issue of material composition in steel plates. A sampling plan has been proposed for steel recovered from different parts of ships post-breaking. These samples will be tested for their material composition, including elements like Iron, Manganese, Carbon, Sulphur, and Phosphorous, in NABL (National Accreditation Board for Testing and Calibration Laboratories) accredited laboratories to meet the raw material traceability requirements of IS 1786. This proposal is currently under discussion within the committee.

Alang: Circular economy in action

The Ellen MacArthur Foundation defines a circular economy as a system where "products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting." This approach aims to address global challenges such as biodiversity loss, waste, and pollution by decoupling economic activity from the consumption of finite resources. In practice, it involves keeping materials in use as long as possible, whether as whole products, components, or raw materials, thus preserving their intrinsic value.

A prominent model illustrating the principles of a circular economy is the 4R Framework - Reduce, Reuse, Recycle, and Recover. In this framework, circularity is achieved through a "closed loop" system, where outputs from one process feed directly back as inputs for another, keeping materials in use for as long as possible. This contrasts sharply with the traditional linear model, in which resources flow in a one-way path—from extraction to production, consumption, and ultimately, waste disposal.

Figure 10: Principles of circular economy



The Sustainable Shipping Initiative describes two approaches to a closed-loop system:

- **Closing the physical loop:** All steel recovered from end-of-life ships are used in building new vessels, creating a direct material flow between shipbuilding and ship recycling. Although ideal in theory, physical looping faces practical challenges. Ship recycling is concentrated in countries like India, Bangladesh, Pakistan, and Turkey, while shipbuilding hubs are primarily in China, Japan, and South Korea. Transporting steel between these regions adds significant costs and emissions, making a physical loop difficult to achieve sustainably.
- **Closing the net loop:** A more viable approach involves directing steel recovered from ships to different industries outside shipping, in alignment with domestic market demands. This approach underpins Alang's model, where nearly every material from dismantled ships finds downstream applications across various sectors.

Though Alang is often synonymous with ship recycling, over the last four decades, it has also built up a comprehensive ecosystem centred around shipbreaking, with strong markets for nearly all materials derived from ships.

Table 7: Items typically recovered from ships (Source: GMS)

Furniture and fixtures	**Steel**	Wardrobes, cupboards, chairs, tables, mirrors and mirror cabinets, tables, benches, doors
	Wood and plywood	
	Kitchen items	Dishes, dish washers, electric heater, refrigerator, washing machines, deep refrigerators, water coolers,
	Bathroom fixtures	Urinals, bathtubs, wash basins, commodes, plastic buckets
On-board machinery	**Electrical and mechanical appliances**	Transformers, heat exchangers, condensers, generators, alternators, compressors, boilers, marine engines, water pumps, cranes, gas cutters, shaft bearings, propeller
	Garage and stores	Bolts, nuts, screws, ship logs, polypropylene ropes, steel wire ropes, net, tarpaulin, brushes, paint cleaning scrapper, spare gaskets, tools like hammer and chisel, lathe machines, pipes, oil spill mitigation units, chemicals and paints
Miscellaneous items	**Office equipment**	Computers, printers and scanners, fax machines, wall clock, binoculars, record players, vacuum cleaners, calculators, projectors
	Lifesaving equipment	Life buoys, lifeboats, life jackets, life raft, mooring boats, foam tanks, fire extinguishers, boiler suits, helmet, cables, masks, safety harness belts
	Communication/ signalling devices	Intercom & telephones, GPS systems, periscopes, loudspeakers, megaphones, foghorn, thermometers, barometers, marine compass

Alang has the capacity to generate approximately 3.5 MT of steel and steel products in a year from decommissioned ships. This can significantly reduce the need for virgin steel production and minimise environmental impacts associated with resource extraction.

The steel output from ship recycling (Figure 10) can be categorised into the following key types:

- **Upcyclable/reusable steel products** including steel bars, pipes, engines, and other finished steel items that are almost immediately reusable.
- **Steel plates** or versatile outputs that can be either upcycled in fabrication industries or used as raw materials in steel rerolling mills. These can be used as a substitute to ingots and billets, to produce finished products such as bars, angles and flats.
- **Steel scrap** or steel with no direct upcycling potential, which is melted in induction furnaces for crude steel production.

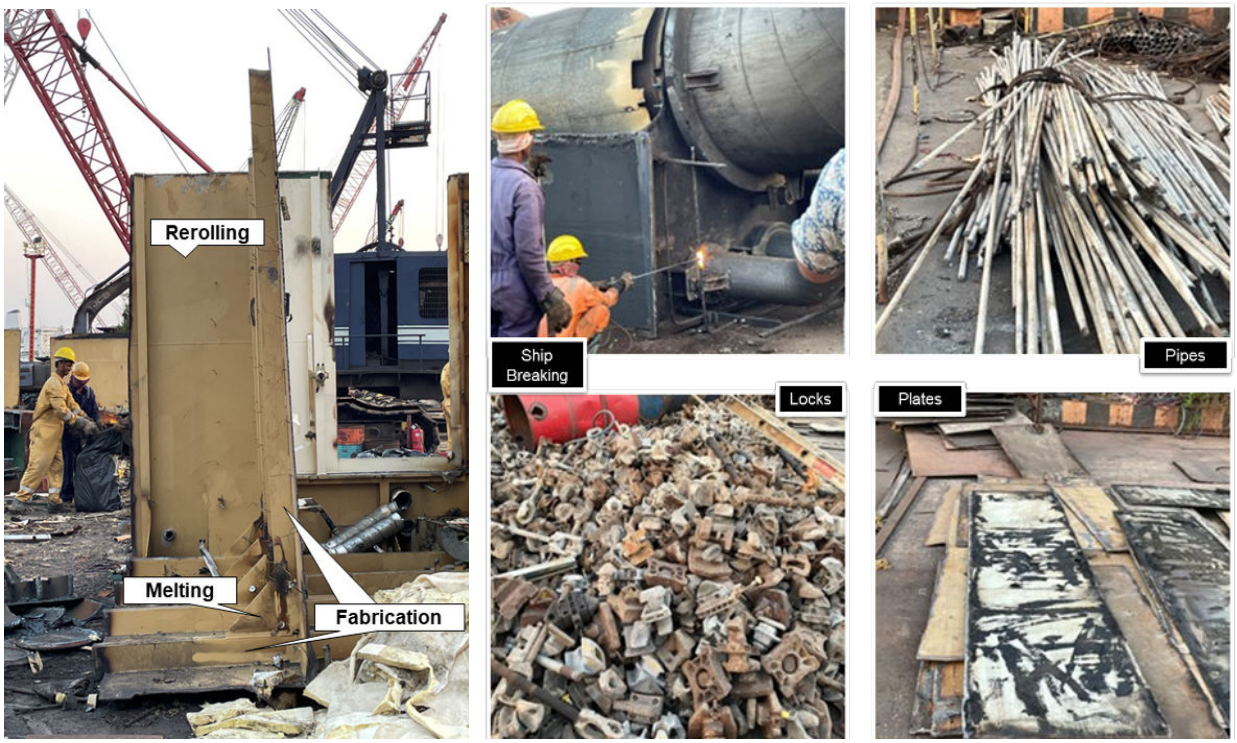
A cluster of steel re-rolling mills and induction furnaces around Alang actively process the steel recovered from dismantled ships, contributing significantly to a self-sustaining closed loop local economy. Beyond steel, many other goods are salvaged from incoming vessels, including furniture, paint, electrical equipment, lubricants, and oil, which supply numerous local industries as discussed. Many of these items are sold directly to the public through a network of retail and wholesale shops. With a robust downstream market for the materials derived from ship recycling, the Alang ecosystem serves as a strong example of circular economy principles in action.

Insights from Alang

99.5% of a ship can be reused or recycled and the yard owners believe that their industry is inherently sustainable as they salvage and save what would originally have been written off as waste. Ship recycling allows for the recovery of various materials and components that can be reused, repurposed, or recycled. The primary material recovered is steel, as ships are largely constructed from it, along with other non-ferrous metals such as aluminium, copper, and brass. Mechanical components like engines, auxiliary machinery, valves, and fittings are also salvaged. As discussed in detail below, these steel components broadly follow one of three pathways – fabrication units, rerolling mills or scrap melting units in induction furnaces. Each of these pathways offers a different profit margin to the recycler. For instance, metal plates fetch a higher price if sold to fabrication units and re-rolling mills than if they are sold to scrap melting units, due to high quality of the material, better durability and tensile strength.

The following images show how parts of a vessel reaching Alang can be reused, based on a consultation with ship recycling experts Some parts of the ship can be sent to fabrication, rerolling and melting units, while other parts find direct application in various industries.

Figure 11: Steel items recovered from ships (captured in site visits)

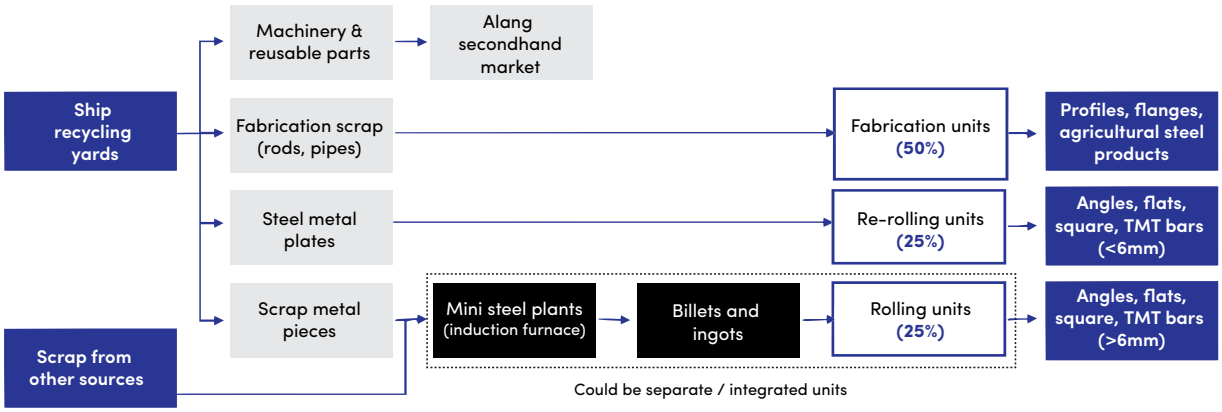


Steel consumption pathways

An analysis of inputs gathered from field visits and interviews with Alang stakeholders provides a quantifiable breakdown of the distinct steel outputs processed in downstream markets:

- Fabrication units use approximately **50%** of the steel, either reusing it directly or upcycling into new products.
- About **25%** of the steel goes to steel rerolling units, which produce TMT bars under 6 mm in thickness, along with bars, angles, and flats. In these units, the steel plates are cut to size, reheated to around 1200°C in coal-fuelled reheating furnaces, and then rolled into various steel products.
- The remaining **25%** is classified as melting scrap, consumed by mini-steel plants equipped with induction furnaces. These plants blend this scrap with scrap steel sourced internationally to produce billets and ingots, which are then rolled into steel products, primarily TMT bars over 6 mm thick.

Figure 12: Downstream pathways for steel outputs from ship recycling



Billets:
Used as raw material for producing bars, rods, and other steel products

Angles/Angle Bars:
Used in structural applications in construction, bridges, and towers.

Flanges:
Utilised in pipe fittings, mechanical connections, and structural applications.

Squares:
Serve in construction, manufacturing machinery, and various industrial applications.

One form of recovered steel can be transformed into another in the nearby rerolling cluster of Alang. Billets, produced through continuous casting or hot rolling into rectangular or square cross-sections, are heated, passed through rolling mills, and then cooled and shaped into various steel products, such as angles and angle bars.

Figure 13: Billets formed from scrap steel

Billets are heated and passed through rollers to reduce thickness and form long, thin bars. The steel's temperature is gradually reduced, altering its shape to the desired bar diameter. After rolling, the bars are rapidly cooled in a process called "quenching," creating a hardened outer layer and a softer inner core, enhancing tensile strength and ductility. The bars are then tempered by reheating to relieve internal stresses, ensuring a balance of strength and flexibility. Finally, the TMT bars are cut, bundled, and tested for yield strength, tensile strength, and ductility.

Figure 14: TMT bars produced from billets

Case study in the economics of ship recycling: Why ship valuations in Bangladesh and Pakistan are higher than in India

Bangladesh and Pakistan, alongside India, are global leaders in the ship recycling industry, collectively accounting for more than 80% of the world's shipbreaking activities. While all three countries have well-established ship recycling sectors, Bangladesh and Pakistan consistently offer higher valuations for end-of-life ships than India. Current prices for purchasing ships stand at $ 550 per LDT in Bangladesh and $ 520 in Pakistan, compared to $ 500 in India.[33] Several key factors explain this price disparity:

Government financial support: Recyclers in Bangladesh and Pakistan benefit significantly from substantial financial backing, which includes long-term, low-interest loans and soft loans facilitated by central banks and private investors. A notable example is the SENREC Project (Safe and Environmentally Sound Ship Recycling) in Bangladesh, where IMO served as the executing agency and the Ministry of Industries of the Government of Bangladesh was the national executing partner. With a budget of $ 1.1 million, this project aims to enhance national yard capacities in preparation for HKC, while also establishing a robust governance framework and delivering targeted training for various stakeholders and the workforce.

This financial support enables recyclers to offer more competitive prices for ships, alleviating the immediate financial pressures on the industry. In contrast, Indian recyclers encounter stricter financing conditions, with fewer available loan programmes that support the capital-intensive purchases of end-of-life ships. As a result, the disparity in financial assistance creates challenges for Indian ship recyclers, limiting their ability to compete effectively in the global market.

Fewer restrictions on rerolled steel: In Bangladesh and Pakistan, the regulatory environment surrounding the sale and use of rerolled steel is comparatively lenient, allowing steelmakers to operate with greater profitability. This, in turn, enhances the prices they are willing to offer for end-of-life ships. Of the 300 steel plants in operation in Bangladesh, around 150 are re-rolling plants, and 30 are auto steel mills. Notably, approximately 60-70 % of the steel utilised in Bangladesh's re-rolling mills is sourced from the ship recycling sector, significantly bolstering their foreign currency reserves.

In contrast, Indian steelmakers contend with stricter quality controls on rerolled steel, which diminishes the market's attractiveness and constrains the prices recyclers can pay for ships. The Ministry of Steel's Quality Control Order regulates the production of TMT bars from ship-recycled plates, imposing limitations on the use of recycled scrap in manufacturing re-rollable bars with diameters greater than 6 mm. As a result, these plates must be melted before being converted into billets or ingots, ultimately reducing profitability for steelmakers in India.

High share of domestic steel demand being met by ship recycling: In Bangladesh, the shipbreaking industry supplies 80-90% of the raw materials needed for domestic steel production, with the recycled steel used primarily for construction materials such as rebars. The high demand for steel products in Bangladesh has driven recyclers to offer higher prices for ships to meet domestic steel consumption. Similarly, Pakistan's steel industry relies heavily on shipbreaking to supply scrap steel for rerolling mills, particularly in Karachi, which drives up the valuation of ships. In contrast, India faces more fluctuating

33 Annual Reports. NGO Shipbreaking Platform 2019, 2020 Reportt: https://shipbreakingplatform.org/annual-reports/.

demand for steel, and the market is more affected by global competition from cheaper alternatives, such as Chinese billets, reducing the price Indian recyclers can offer.

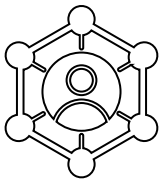
Volatility in Indian market: Ship recycling constitutes a relatively small segment of India's steel market, accounting for only 0.5-2% of total production. On the contrary, it plays a much more significant role in Bangladesh, where it influences the overall dynamics of the steel industry. This limited share contributes to greater volatility in India's ship recycling market, which is heavily impacted by fluctuations in steel prices, local currency instability, and changing import trends. This unpredictable environment diminishes the ability of Indian recyclers to compete effectively on price against their Bangladeshi and Pakistani counterparts, who benefit from a more stable and larger ship recycling sector.

While Bangladesh and Pakistan benefit from financial support, regulatory flexibility, and strong domestic demand for steel, these advantages come at a cost. Worker safety and environmental sustainability remain ongoing concerns in both countries, as less regulatory oversight often leads to hazardous working conditions and environmental degradation. Nevertheless, the ability to offer higher valuations for end-of-life ships has helped maintain their competitiveness in the global ship recycling market, positioning them as key players in this lucrative industry.

Looking ahead, the ship recycling landscape is likely to see significant changes driven by stricter global norms and regulatory compliance. As Indian shipbreaking yards achieve compliance with the HKC, a larger number of ships are expected to be redirected to India, particularly to the yards in Alang. This shift could be facilitated by providing Indian recyclers with long-term loans aimed at transforming their yards into environmentally compliant "green" facilities, aligning with HKC's timeframe. Such financial support would help Indian recyclers to overcome the current competitive disadvantages they face due to stricter regulatory requirements and limited financial backing.

Simultaneously, the ongoing growth of the steel rerolling industry in Bangladesh and Pakistan may encounter challenges as the market moves towards product standardisation. This could potentially slow down the recycling processes and lead to lower bidding prices for end-of-life ships. While the current advantages enjoyed by recyclers in Bangladesh and Pakistan have positioned them as key players in the global market, evolving industry standards and practices are likely to level the playing field.

Future of ship recycling and its contribution to India's steel sector



Projecting trends for this sector through

2040

enables stakeholders to make informed decisions, seize emerging opportunities, and navigate challenges in a shifting economic, environmental, and regulatory landscape

Projections for the ship recycling industry's market until 2024

As the maritime industry evolves, ship recycling is taking on a more crucial role in sustainable development. Projecting trends for this sector through 2040 enables stakeholders to make informed decisions, seize emerging opportunities, and navigate challenges in a shifting economic, environmental, and regulatory landscape. This analysis highlights expected growth, major drivers, and potential obstacles shaping the future of the ship recycling market.

These projections are derived from a comprehensive study involving primary consultations with industry experts and thorough secondary research. This section elucidates the methodologies, sources, and assumptions underpinning these projections, with a specific focus on India's market share under three distinct industry scenarios: Business as Usual (BAU), Moderate, and Accelerated.

Table 8: Ship recycling market projection scenarios

Business as Usual (BAU):
Capacity constraint: It is assumed that India's current ship recycling capacity, primarily located in Alang, remains at 4.5 million LDT until 2035.
Utilisation rate: The capacity utilisation is projected to reach 100% by 2030.
Growth limitation: Post-2030, no additional capacity is added, potentially leading to a stagnation in India's market share as global ship recycling volumes continue to grow.
Moderate scenario:
Capacity expansion: This scenario anticipates full utilisation of the existing capacity by 2030, followed by a doubling of capacity in Alang by 2035.
Infrastructure development: Investments in infrastructure and technology upgrades are presumed to facilitate this expansion.
Market dynamics: The increased capacity allows India to capture a larger share of the growing global market, but the expansion is limited to Alang only.
Accelerated scenario:
Rapid expansion: This scenario envisages a more aggressive approach, with the existing capacity in Alang doubling by 2028.
New clusters: Establishment of a new ship recycling cluster on India's Eastern Coast (potentially in West Bengal, Andhra Pradesh, or Odisha) by 2035, adding another 4.5 Million LDT.
Strategic positioning: The new cluster is assumed to strategically position India to attract more global business, leveraging geographical advantages and advanced facilities.

To enhance the robustness and reliability of the projections, the study utilised a comprehensive approach that combined both primary and secondary data sources.

The graph below depicts the total global volume of ship recycling activity expected until 2040, represented by the bars, and India's market share calculated based on three industry scenarios, shown by lines.

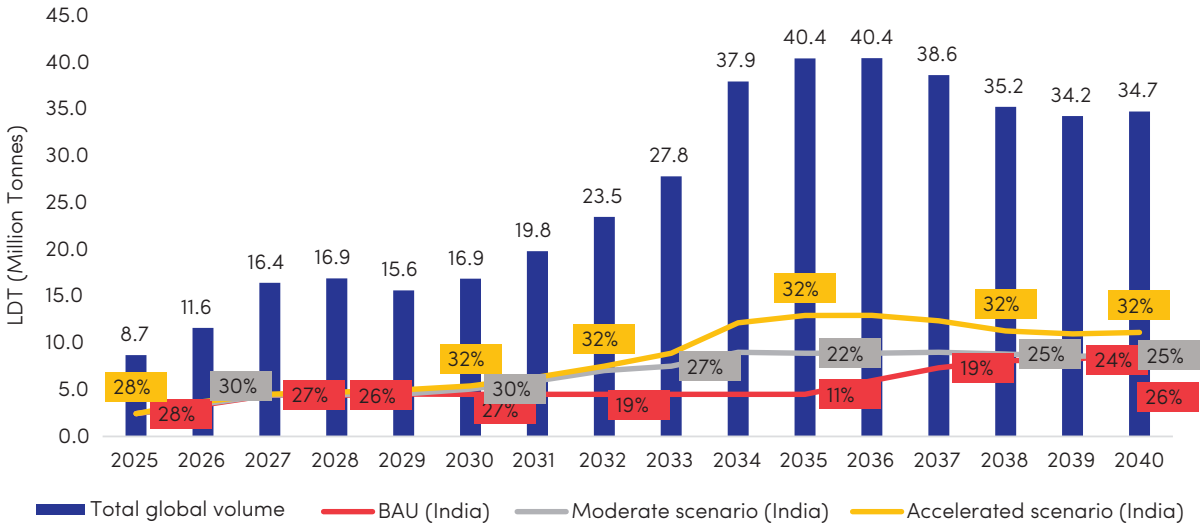


Figure 15: Market projections: ship recycling in India till 2040

The projections are based on the data available on Dead Weight Tonnage (DWT) which is a measure of a ship's carrying capacity. It represents the total weight a ship can safely carry, including cargo, fuel, fresh water, ballast water, provisions, passengers, and crew. DWT is expressed in metric tons (tonnes) or long tons.

The DWT, that will become available for recycling is converted to LDT, using suitable conversion factors for different vessel types as given in the table below:

Conversion factors	Tanker	Bulker & GC	Container & vehicle	Other
LDT/DWT[34]	0.3	0.33	0.44	0.34

An analysis of the projections reveals a few important insights regarding the future of ship recycling in India:

- **Dwindling market share:** Under the BAU scenario, India might face a capacity constraint signalling a loss in market share as the entire ship recycling capacity is likely utilised by 2030.
- **Retain market share:** In a moderately growing scenario, complete utilisation of Alang's capacity is expected by 2030, along with timely capacity additions that would enable India to retain its share in the global ship recycling market.
- **Capture new market opportunities:** For the accelerated scenario to materialise, significant capacity expansion must materialise by 2028, complemented by the establishment of a new ship recycling cluster in India by 2035. This proactive approach will be essential for India to capture emerging opportunities in the global ship recycling landscape. An establishment of new ship recycling cluster on India's Eastern Coast (West Bengal, Andhra Pradesh or Odisha) by 2035 with a similar capacity of 4.5 million LDT has also been highlighted in the Maritime Amrit Kaal Vision 2047.

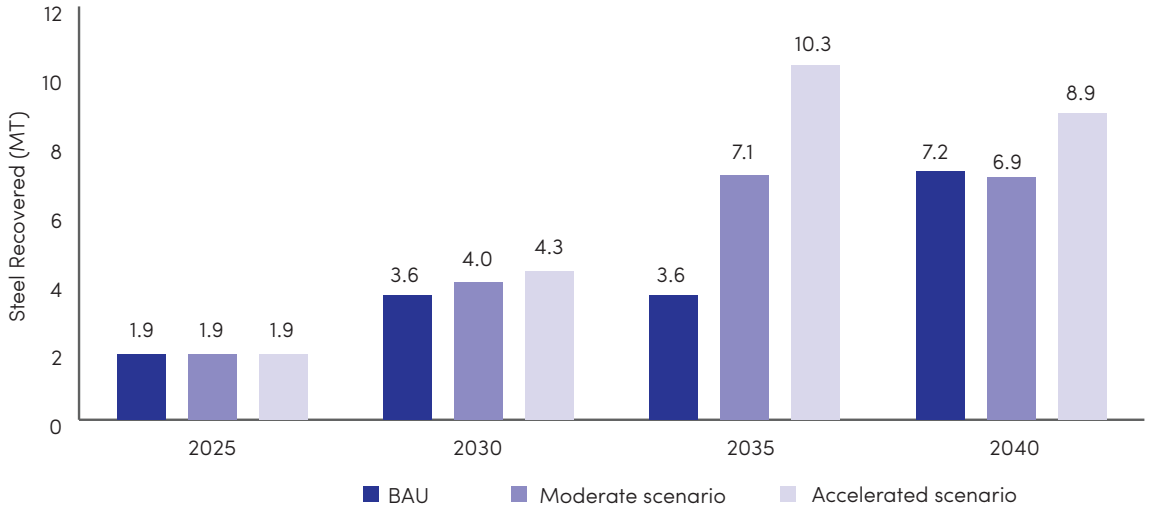
Steel availability from ship recycling

Ships dismantled at Alang produce significant volumes of various steel types, including mild steel, high-tensile steel, stainless steel, and specialty alloys, available as plates, beams, pipes, and scrap. During raw material preparation, scrap metal sheets are sorted by thickness and length, then cut to desired sizes using shearing machines and gas cutters, typically resulting in sheets of 5–6 feet in length. Units that use billets also utilise gas cutters, with any surplus sheet material sold to steel melting units. The steel is then processed and graded; re-rollable scrap is transformed into construction materials such as reinforcement and angle bars, while melting scrap is refined in furnaces to produce billets used for rods, bars, and sheets. Mills using billets or ingots manufacture round bars and TMT bars. Mills working with sheets primarily produce mild steel (MS) angles, flats, and squares. High-value steel and specialty alloys are repurposed into precision components and high-grade products.

The graph below illustrates the forecasted total steel recovery from recycled ships in the ship recycling industry:

34 ECORYS. The Ship Recycling Fund. Available at: https://shipbreakingplatform.org/wp-content/uploads/2022/01/ECORYS-survey-on-a-ship-recycling-fund_compressed.pdf.

Figure 16: Steel outputs recovered from ship recycling in India (MT)



The total availability of steel products from ship recycling, in all forms, is shown in the following table for 2023. The projections are till 2030.

Table 9: Availability of steel products from ship recycling

Availability of steel products from ship recycling			
	2023	2025	2030
Total ship recycling volume, MT LDT	1	2.4	4.5 - 5.4
Steel products recovered (@0.8 conversion factor), MT	0.8	1.9	3.6 - 4.3
Comparison with India's overall steel production, %	~0.5%	~1%	~1.4%

Steel consumption pathways and downstream market economies

Steel outputs from ship dismantling are channelled into various downstream processing activities, each selected to maximise market value. Certain outputs, such as plates and pipes, find direct application within the steel fabrication industry, while the remainder is utilised as scrap in electric furnaces. Notably, each processing pathway and subsequent end-use application yields different price points for ship recyclers. For instance, products manufactured from ship plates by fabrication units typically command a premium in the market due to the material's perceived superior quality, durability, and tensile strength.

Conversely, scrap destined for melting in induction furnaces generally fetches a lower price, as it also competes with imported scrap on cost and usability. The following table summarises various end-use applications and provides an approximate price range of the different steel outputs traded in the market.

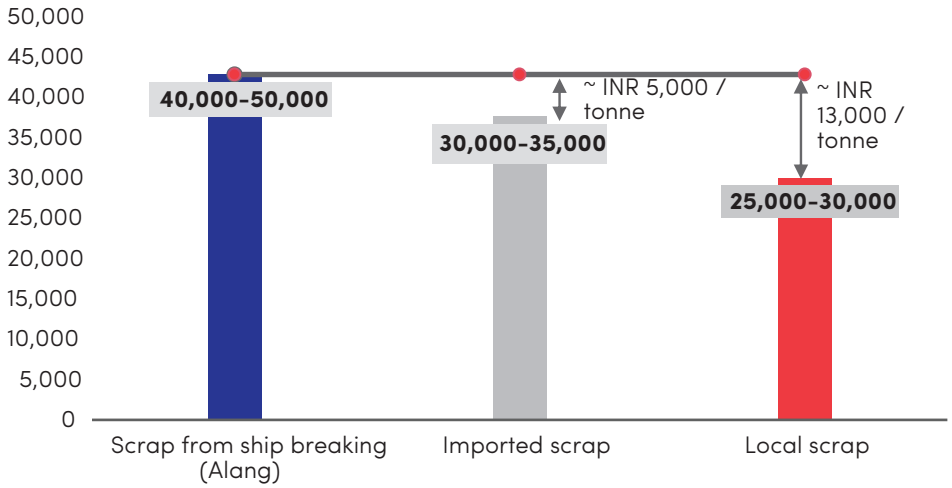
Table 10: Steel pathways and economics

Material	Ship metal plates	Melting scrap	
Used by	Fabrication and steel re-rolling units at Alang	Induction Furnace (IF) units near Alang	Steel producers (IF/EAFs)
Source	Ship recycling	Ship recycling, imported scrap	Local old scrap
Price (₹/tonne)	40,000 - 45,000	30,000 - 35,000	25,000 - 30,000

Approximately 25% of ship recycling outputs in 2024 are expected to comprise scrap steel used as raw material for induction furnace units, while the remaining 75% will be utilised in fabrication and rerolling.[35]

Scrap steel used for melting in induction furnaces is categorised based on expected yield, typically ranging from 0.9 to 0.98. Locally sourced scrap generally has a lower yield, while imported and **Alang-origin scrap tend to offer higher yields.** The following figure illustrates yield differences among domestic scrap, imported scrap, and steel outputs generated from Alang.

Figure 17: Price of scrap (₹/tonne) from various sources



Insights from Alang

Despite the high quality of marine-grade steel in scrap from ships, it is not always the preferred choice for scrap buyers within the Alang ecosystem. Some businessmen in Alang own both shipyards and induction furnaces but often opt for imported scrap over local materials. This preference is largely driven by cost economics. Currently, Alang's scrap is more expensive than imported scrap sourced from regions such as Africa, America, and Europe. Buyers must pay a premium of around ₹13,000 compared to local scrap and ₹5,000 compared to imported scrap to acquire high-quality scrap from Alang's ship recycling yards.

1 Scrap from Alang is not only being sent to melting units for steel-making, but also being used in manufacturing of value-added steel products.

2 Up to 75% of the total recovered steel from ships in Alang is upcycled into value-added steel products. Examples of such products include steel plates, bars, pipes and other forms of finished steel products.

3 The upcycled steel products fetch a higher price for the recyclers due to their perceived high quality and suitability for several applications.

4 The remaining 25% of the recovered steel, which cannot be directly upcycled, becomes steel scrap, which is processed in induction furnaces for the production of crude steel.

35 Based on our Consultation with Triveni Shipbreakers, Alang

Emissions avoidance from steel products recovered from ship recycling

A small yet noteworthy contribution to India's steel industry comes from ship recycling. Here, value-added products, fabrication items, and rerolled or rolled steel products are produced from materials recovered during ship recycling. This approach involves fewer manufacturing steps, resulting in lower energy use and emissions, although it currently represents a smaller portion of India's total steel production.

Reusing steel from ship recycling also reduces the need for raw material extraction (iron ore and coking coal), which are essential in the BF-BOF route. The process of recycling ships into scrap steel is less energy-intensive, avoiding the high energy consumption associated with both the BF-BOF and the initial stages of the EAF routes. Additionally, since India's steel production needs and volumes are substantial, ship recycling alone cannot fulfil the demand but can play a valuable complementary role.

However, the scrap steel obtained from ship recycling industry is of high quality and could play a crucial role in the EAF/IF route, if availability was not an issue. By integrating scrap steel from recycled ships into the steel production process, reliance on the BF-BOF route can be reduced. Reusing steel from scrapped ships conserves natural resources and helps in avoiding the energy intensive processes, otherwise happening in making steel products.

Alang's ship recycling cluster plays a valuable role in supplementing steel demand in India, making it essential to understand the associated emissions savings. The following analysis attempts to quantify the emissions avoided when steel products are derived from Alang's recycled scrap rather than new production.

- The calculation of total emissions avoided references India's average emission intensity for steel production, currently at 2.54 t-CO_2/tcs.
- Approximately 75% of the total scrap recovered at Alang is directed to fabrication and rerolling units, with the remaining 25% used as raw material for units. Since the 25% used as scrap is already factored into the national emission intensity, only the emissions associated with the 75% directed to fabrication and rerolling are calculated for this analysis.
- Based on market forecasts and projected steel recovery from ship recycling, emissions savings can be estimated under different industry scenarios—BAU, Moderate, and Accelerated. For instance, in the BAU scenario for 2025:
    - Avoided emissions = India's Average Steel Emission Intensity (2.54 t-CO_2/tcs) x 75% x total steel recovered in 2025 (1.9 MT), resulting in 3.7 t-CO_2/tcs of avoided emissions.

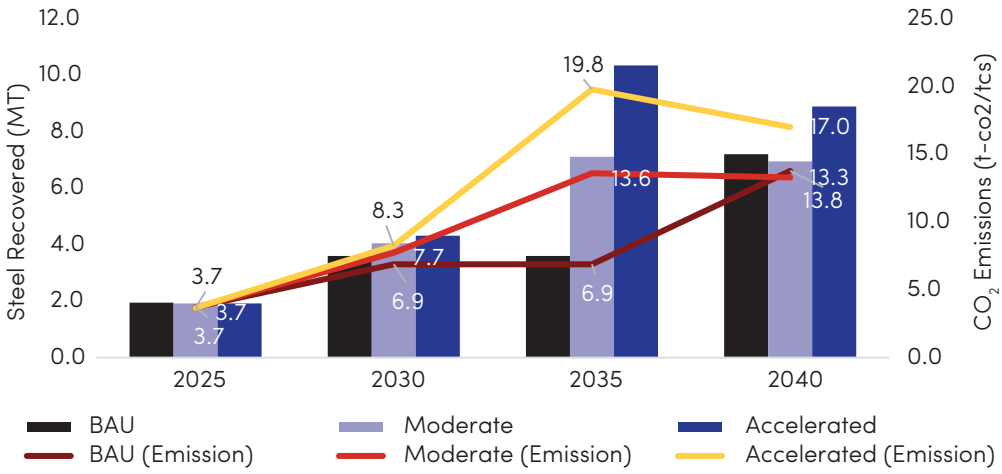
This approach can be applied to other industry scenarios for respective years, illustrating the emission reduction potential through the reuse of steel from decommissioned ships and helping to bypass the emission-intensive processes involved in producing new steel.

Table 11: CO_2 emission avoidance

Steel Recovered (MT)	2025	2030	2035	2040
BAU	1.9	3.6	3.6	7.2
Moderate scenario	1.9	4.0	7.1	7.2
Accelerated scenario	1.9	4.3	10.3	8.9
BAU (Emission)	3.7	6.9	6.9	13.7
Moderate (Emission)	3.7	7.7	13.5	13.7
Accelerated (Emission)	3.7	8.2	19.7	16.9

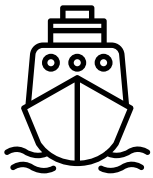
The quantity of total emissions avoided is illustrated in the following graph:

Figure 18: CO_2 emissions from steel recovered through ship recycling (t-CO_2/tcs)



India's ship recycling industry can thus help in avoiding CO_2 emissions arising out of steel consumption by 2040, with projections estimating a peak annual avoidance of 19.8 million tonnes CO_2.

Way forward for India's ship recycling industry



More ships are expected to enter the ship recycling market as geopolitical conditions stabilise and the global freight market begins to decommission its vessels

India's ship recycling sector holds significant potential to drive steel decarbonisation, increase domestic scrap steel production, and create employment opportunities. However, precise data to fully quantify this potential remains insufficient. As the sector grows, reliance on imported scrap steel will decrease. Despite the current downturn, there is an opportunity for growth. More ships are expected to enter the ship recycling market as geopolitical conditions stabilise and the global freight market begins to decommission its vessels.

If India does not expand its current capacity, there is a risk of losing market share to competitors in Bangladesh and Pakistan, which could significantly undermine the market ecosystem of Alang. To capitalise on future opportunities, collaboration among key stakeholders—including ship recyclers, industry associations, shipping companies, and policymakers—is essential. A collective, forward-thinking approach will be key to unlocking the sector's full potential and ensuring its sustainable growth.

Recommended action plan	
Compliance with international codes/ regulations	❯ Indian ship recycling yards will require time to fully transition to a physical and policy infrastructure which is compliant with EU SRR. However, proactive steps during this transition period will ensure that opportunities are not lost. ❯ One effective approach would be to implement a Key Performance Indicator (KPI) Monitoring Framework for both existing and new yards, aligned with HKC and EU SRR. ❯ Establishing a trauma centre is an urgent priority. Setting up relevant infrastructure should be prioritised by the governance apparatuses involved. ❯ Additionally, ministries and maritime boards must broaden their initiatives to enforce health and safety measures that meet global compliance standards (improved working conditions) and conduct regular audits to ensure adherence. ❯ A real-time monitoring programme should be developed to track critical Health, Safety, and Environment (HSE) KPIs across ports, shipyards, and recycling areas, promoting greater transparency and accountability within the industry.
Expanding ship recycling capacity with new technology in compliance with global regulations and streamlining downstream industry for greenfield investments and repurposing	❯ As the ship recycling market expands with more vessels arriving at Indian yards, Alang needs to nearly double its capacity and comply with OHS standards. New ship recycling clusters in Andhra Pradesh, Odisha, and West Bengal should align with the Maritime Amrit Kaal Vision 2047. To enhance sustainability and economic viability, these yards can be repurposed into shipbuilding yards, leveraging their existing infrastructure and expertise. By integrating advanced technologies and forming industry partnerships, these clusters can develop new revenue streams and position themselves as hubs for both ship recycling and shipbuilding. A Ship Recycling Facilitation Centre should be developed and an integrated steel cluster created to promote recycling activities. This initiative should enhance the marketability of ship by-products. Trade fairs could be organised at ship-breaking yards. It is essential to engage with a wide range of stakeholders - from shipowners to downstream industries - to foster synergies and support economic viability.
Linking industry with low emission steel discussion	❯ The downstream steel industry has a unique opportunity to produce low-emission steel if green electricity is supplied to these industrial units at a competitive price. This will necessitate the development of business models that aggregate such demand and link to the anticipated rise in demand for low-emission or net zero steel.
Incorporating best practices & technological advancements	❯ By expanding capacity and adopting cutting-edge ship recycling technologies and methods, Indian yards can gain a competitive edge in the global market. ❯ Government grants and subsidies for technology upgrades can encourage the adoption of advanced, green technologies in ship recycling, improving efficiency while minimising environmental impact. ❯ Research and training programmes in the maritime sector should be developed to foster innovation. This includes establishing incubators, accelerators, and Maritime Knowledge Clusters (MKCs) to promote a collaborative research approach.
Addressing low bidding prices from competition	❯ To address low bidding prices in the Indian ship recycling industry. • Central Ministry: The Central Ministry can support on establishing bilateral agreements with five countries to secure more ships annually. • State Maritime Boards: Provide tax incentives (Reduction in landing and Development Tax (LDT), water charges and other development charges to the extent possible), introduce performance or production-linked incentives.
Credibility and awareness	❯ A robust reporting framework to track the number of ships entering for recycling should be developed and implemented. ❯ A formal communication channel between ship recyclers and steel producers should be established. This will effectively convey the processes followed and data related to ship recycling, and foster trust by improving business practices between the two parties.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What experts are saying

"Global analysis by industry experts indicates that demand for ship recycling will grow significantly in the coming years, driven by an increase in newbuild orders and stricter IMO regulations aimed at decarbonizing the shipping industry. Typically, 75-85% of a vessel is made of steel, as the ship recycling industry expands, it has the potential to contribute meaningfully to the decarbonization of the global steel value chain. Increased use of scrap steel is one of the well-established pathways for steel decarbonization. The anticipated rise in ship recycling volumes could position this sector as a meaningful supplier of scrap steel for steel production. Maersk has set an ambition to ensure safe and responsible ship recycling globally, benefiting workers, the environment, responsible yards, and ship owners. Maersk actively engages with key stakeholders to support compliance with European Union ship recycling regulations and is also studying its role in the decarbonization of the global steel value chain."

– Shobhit Agarwal (Head of Ship Recycling, Maersk)

"Since inception, steel recycling and circularity have been the very backbone of the industrial ecosystem in Alang. Continuous improvement efforts, in terms of Health, Safety & Environment have placed Alang as the most favourable ship recycling destination globally. At current capacity of 4.5MMTPA of Ship Recycling, the industry is poised to reduce over 2.7MMTPA of CO_2 emissions by production of steel vis-à-vis traditional routes, without any new investment at all."

– Rushi Kanakiya (Executive Partner, Triveni Shipbreakers LLP)

"At the Ship Recycling Transparency Initiative (SRTI), we view ship recycling as a vital component of the circular economy. Rising global expectations for transparency and sustainability are reshaping the industry, with scrap steel from ships emerging as a key contributor in the race to decarbonize steel production. As a major recycling hub and steel producer, India is uniquely positioned to demonstrate how responsible ship recycling can drive positive impact across the ecosystem."

– Prof. Dr. Ing. Christoph Wolff (CEO, Smart Freight Centre)

"Alang's ship recycling infrastructure has seen remarkable advancements with the recent HKC and EU SRR certifications. These milestones highlight our dedication to sustainable and environmentally responsible practices, establishing Alang as a premier hub for green ship recycling. This progress not only ensures adherence to global standards but also stimulates the local economy by attracting more business and generating job opportunities. As more ship recycling yards align with HKC and EU SRR regulations, we are poised to secure a competitive edge in the global market."

– Madhur Agarwal (Managing Partner, Baijnath Melaram Ship Recycling)

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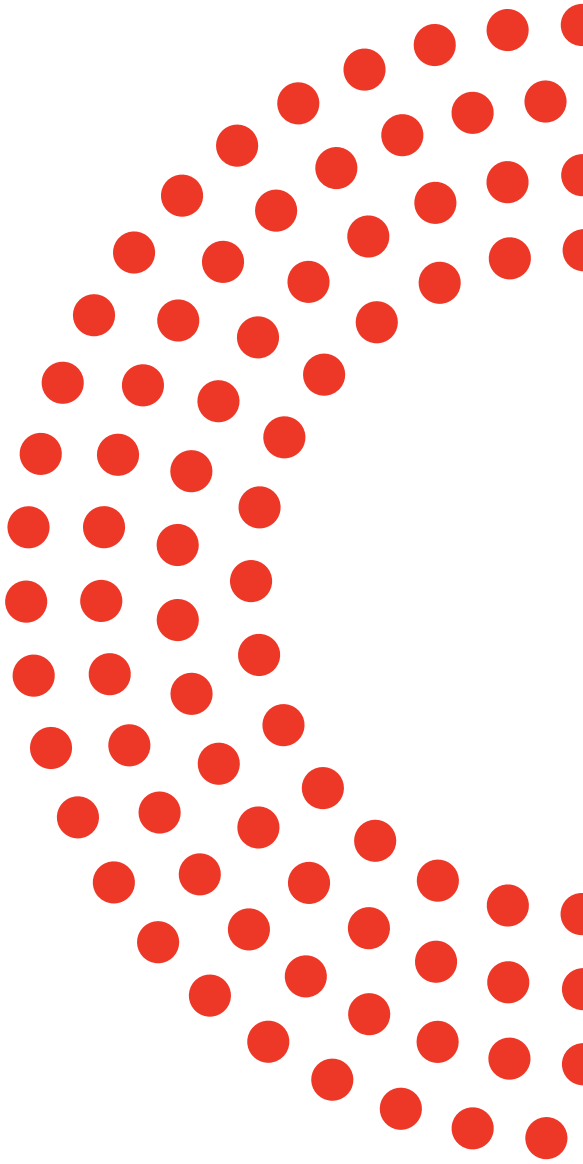

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