RIS Discussion Paper Series

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Discussion Paper # 305

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May 2025

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Abstract: The ship recycling industry in India is huge, and has immense potential as a driver ofsustainabledevelopment in India. Empowering this industry has thus been correctly envisioned as a focus area under India's Maritime Amrit Kaal Vision 2047 ("MAKV 2047"). Doing so will not only consolidate India's position as the'Number One' destination for ship recycling, butalso aid and drive India's circular economy. Steel production forms the backbone of industrial growth. Accordingly, empowering the ship recycling industry with certified emission reductions for recycled steel will facilitate sustainable industrial growth in India.Presently, however, the industry fails to quantify and monetisethe substantial emission reductions and energy savings inherent in ship recycling. The presentdiscussion paper accordingly makes a case for quantification of the CO2 emission reductions in the ship recycling industry, and for utilisation and adaptation of existing legal provisions to enable monetisation of the industry's emission reductions and energy savings towards sustainable growth and economic development. This discussion paper also outlines the key role that can be played by academia and practitioners to strengthen this eco-system in India.

Keywords: Ship recycling, carbon credits, emissions reduction, carbon trading, PAT mechanism, Carbon Credit Trading Scheme, Energy Conservation Act, Recycling of Ships Act, law.

1. Introduction

The steel sector is one of the top greenhouse gas (GHG) emitters globally, contributingbetween 7 per cent and 9 per cent of global GHG emissions and 28 per cent of global industrial emissions in 2021 (Sustainable Shipping Initiative, 2023). India's steel industry contributes to around 2 per cent of its gross domestic product; however, it also accounted (in 2022) for 12 per cent of its carbon dioxide (CO2) emissions (Gulia, et al., 2023).In the context of shipping, steel makes up 75-85 per cent of a vessel by weight. This makes it a significant contributory factor in the

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Author is grateful to Professor Sachin Chaturvedi, Director General, RIS for his guidance and initiative for bringing out this paper. Views expressed are personal. Usual disclaimers apply.

overall GHG emissions of the shipping sector (Sustainable Shipping Initiative, 2023).

As mentioned above, India's ship recycling industry is one of the largest in the world and continues to grow year after year. Between 2008 and 2017, about 12 million tonnes of ship volume were recycled in India, mostly in Alang in Gujarat (International LabourOrganisation, 2019). India's share in the global recycling industry, which previously stood at 27 per cent, increased to 33 per cent in 2022 and 2023, reflecting a rise in its contribution even amidst global declines (CareEdge, 2024b).

Thus in 2023, India accounted for 33 per cent of the global gross tonnage (GT) dismantled, second only to Bangladesh, which handled 46 per cent (CareEdge, 2024a). Similar recycling levels (2.3 to 2.6 million GT) are expected in 2024, and thereafter a jump (to over 3.8 to 4.2 million GT) is forecasted for 2025 (CareEdge, 2024a). Going forward, India's ship recycling industry is expected to grow at a compound annual growth rate (CAGR) of ~10 per cent in CY26-CY28 (CareEdge, 2024a).

2. Drivers

Ship recycling refers to the larger process of dismantling and reusing a ship's materials (including its steel) in an environmentally friendly manner, which is different from the process of mere scrapping of ships. It is submitted that India's ship recycling industry, given its close connection to the lifecycle of steel, can contribute to a 'greening' of the Indian economy, and accordingly deserves attention by policymakers. Experts note as follows on its potential:

> *[R]ecycling steel in electric arc furnaces emits significantly less greenhouse gases than the production of crude steel, and as the electricity grid becomes decarbonised, emissions will reduce further. Therefore, ship recycling can continue to play a role in the circular economy…..Many older ships are expected to be recycled earlier than normal due to the ever-tighter limits on greenhouse gas emissions… [W]e estimate that more than 15,000 ships and 600 million deadweight tonneswill be recycled between 2023 and 2032. (Rasmussen, 2023)*

> *Demand for secondary steel – a product of shipbreaking activity - is expected to increase in developing countries. The steel production process is responsible for 25 per cent of industrial carbon emissions*

worldwide. The steel industry, therefore, focuses more on reusing and recycling of scrap steel, and it is forecasted that secondary steel production will exceed primary production after 2060. (Rahman and Kim, 2020)

Indian ship recycling facilities refurbish and re-roll 70 per cent of steel scrap generated compared to that of Turkish facilities that melt all steel scrap. The methods for recycling of steel in South Asia and Turkey contribute to reduced energy use and CO2 emissions…. If steel is not melted but re-rolled, CO2 emissions could be reduced by up to six times [table below]: (Sustainable Shipping Initiative, 2021)

Table 1: The Emission Reductions in Ship Recycling

Post - Recycling				**CO_2 Emissions (Estimation in tonnes CO_2 emitted for producing one tonne of steel)**
Recycle	Melting	100%	Crude steel	0.65 (Virgin steel production = 1.9)
Refurbish		10%	Circle or various size plate (only by cutting)	No data available
Recycle	Rerolling	60%	TMT bars, angles, plates, channels, rounds	0.23 – 0.31
	Melting	30%	Crude steel	0.68 (Virgin steel production = 1.9)

***Source**:* Sustainable Shipping Initiative (2021) and World Steel Association (2019).

The estimates in Table1 (on the difference in carbon emissions between the primary and secondary production of steel) are not far from the estimates produced by Hillman. et al. 2015. (Table 2):

In addition to emission reductions, recycling ships also leads to significant energy and raw material savings. Indeed, according to the World Steel Association (WSA), steel due to its physical properties, reusability, and recyclability, is fundamental to achieving a circular economy.It was estimatedin 2022 that the global steel industry recycles around 630 million tonnes of scrap every year, saving nearly 950 million tonnes of CO2 annually that would have been emitted in the production of fresh, virgin steel (World Steel Association, 2022).

Table 2: Carbon emissions in Primary vs Secondary Production of Steel

Analysed data for steel in kg CO2 – equivalent/kg material. Data used for calculating the proposed average is marked by italics. NA indicates that data is not available			
Study No	**Region**	**Secondary Production (Kg CO2-eq./kg)**	**Primary Production (Kg CO2-eq./kg)**
No 2	Norway	0.11	1.56
No 4	Austria	1.89*	2.37
No 4	Austria	0.32*	2.37
No 10	US	0.54	1.65
Proposed Average		0.3	2.4

Source: Karl Hillman *et al*., "Climate Benefits of Material Recycling: Inventory of Average Greenhouse Gas Emissions for Denmark, Norway and Sweden" (2015).

Note: *The higher number of secondary production in the Austrian study is for blast furnace and the lower is for electric arc furnace.

Furthermore, as per the WSA studies, recycling one tonne of steel scrap saves 1.5 tonnes of CO2, 1.4 tonnes of iron ore, 740 kilograms of coal, and 120 kilograms of limestone (World Steel Association, 2022). In addition to ferrous and non-ferrous metals, a whole host of non-metallic materials - like oils, paint, concrete, etc. - are also generated in the recycling of ships (Taylan, 2013). Table 3 below, by Jun-Ki Choi et al. 2016,demonstrates this wide range:

Table 3: Average Components from a Demolished Ship

Material Recovered	**Weight (%)**	**Value (%)**
Re – rollable ferrous scrap and iron plates	72 - 85	65
Re – conditioned machinery	10 - 15	25
Re – melting scrap	3	2
Non – ferrous metal	1	7
Furnace oil and oils	2	0.5
Wood and Furniture	2	0.5
Burning, cutting losses and waste	5 - 10	0

Source: Jun-Ki Choi *et al*., "Economic and environmental perspectives of end-of-life ship management" (2016).

On the subject of savings, data compiled by the Gujarat Maritime Board sheds further light on the savings inherent in the recycling of ships:

Table 4: Savings in Ship Recycling

Comparison of Natural Resource consumption in production of 2 million ton of steel through Steel Plant & through Ship Recycling			
Natural Resources	**Steel Plant**	**Ship Recycling Industry**	**Saving in Ship Recycling**
Iron ore	3508000 t	0	3508000 t
Fuel	3094000 t	0	3094000 t
Process Chemicals	80610 t	0	80610 t
Water	50 – 120 Mm3	1825 m3	50 – 120 Mm3
Solid waste aspect	878967 t	12500 t	866467 t
Cost aspect	>Rs. 1000 crores	<Rs. 100 crores	Rs.900 crores

Source: Gujarat Maritime Board.

Data by Japan International Cooperation Agency (JICA). 2016. also demonstrates the savings and sustainability that can be achieved through India's ship recycling yards:

Table 5: Resource Requirement Differences Between Ship Recycling and Conventional Steel Production

Resource Requirements for Producing 4 Mt Steel by Conventional Route and By Ship-Recycling Route		
Resource	**Through Integrated Iron & Steel Route**	**Ship Recycling Route (including Re-rolling)**
Iron Ore (t)	7,000,000	Nil
Refractory materials/ additives (t)	2,800,000	Nil
Coal (t)	6,200,000	Nil
Process Chemicals (t)	160,000	Nil
Oxygen (Nm^3)	260×10^6	72×10^6

Continued...

Continued...

Water (Million m^3)	100 – 240	0.80
Fuel Oil (t)	120,000	220,000
LPG (t)	Nil	16,000
Energy (as fuel and electricity)	80,000 x 10^{12} J $	80,000 x 10^{12} J
$ Does not include energy required for transport of raw materials to plant site		

Source: Japan International Cooperation Agency (2016), MECON Ltd (2001), and UNEP (1997).

3. Emission Reductions

Reductions in carbon emissions are quantified in terms of"tCOe", where tCOe refers to tonnes of CO_2 equivalent saved from going into the atmosphere. Industry experts have worked on this, and state ballpark figures show reductions in terms of tCOe. Table 6 below depicts these reductions (and monetisation thereof):

Table 6: Computation Provided by Industry Source

Computation of Emission Reductions and Monetisation thereof
• The rough calculations (based on industry sources and available data) are as follows:
• Assume that 1.25 million tonnes of steel is recycled annually through the process of re-rolling at shipyards.
• Recycling one tonne of steel scrap saves 1.5 tonnes of CO_2.
• Total emission reduction = 1.25 X 1.5 = 1.875 million tonnes of CO_2 saved.
• One carbon credit typically represents the reduction or removal of one metric ton of CO_2 or its equivalent in other greenhouse gases.
• Thus, annual carbon credits earned through ship recycling in India = 1.875 million carbon credits.
• This annual generation of 1.875 million carbon credits could be monetised (at current carbon credit prices, which vary between $10 - $50 per tonne of CO_2, depending upon the market) to generate - annually - financial incentives of $18.75 million to $93.75 million for Indian shipyards.

Source: Dr. Joshua Ebenezer, NuCov Facilitrade Pvt Ltd (2024).

India being one of the largest ship-recycling hubs, large quantities of steel are being recycled - and are set to be recycled – at Indian shipyards. As mentioned above, figures by the WSA suggest that tCOe has a value of 1.5 – i.e., recycling one tonne of steel scrap saves 1.5 tonnes of CO_2 from going into the atmosphere. However, the steps involved in arriving at this figure are not mentioned by WSA.

The specific issue of CO_2 emission reductionthus needs to be examined more closely to arrive at exact quantification. Accordingly, the Department of Materials Science and Engineering at IIT Delhi undertook calculations on this subject for detailed, process-based insights. The most conservative calculations, arriving at a figure of 1 tCOe,are shown in the Table 7: [1]

Table 7: Calculations for the Wire Arc Additive Manufacturing process (or WAAM process)

Resource	Conventional Steel Plant	Recycled Steel plant	Tonnes of CO_2 emissions saved (in producing 2 million tonnes of steel)
Procurement of steel scrap	N/A	0.0614 tCOe	-
Purification (addition of lime)	N/A	0.0537 tCOe	-
Addition of additives (Manganese, Silicon, and Copper)	N/A	0.2053 tCOe	-
Electricity consumption in Electric Arc Furnace	N/A	1.3612 – 1.7056 tCOe	-
Wire production process	N/A	0.1148 tCOe	-
Other operations	N/A	0.15 tCOe	-
Total emissions	2.5-2.7 tCOe	1.95 – 2.29 tCOe	(11 – 8.2)* 105tonnes of CO_2

Source: Study undertaken by Prof. R Laxmi Narayan and Ashwani Kumar at the Department of Materials Science and Engineering, IIT (Delhi).

Table 8: Calculations focusing solely on recycling (i.e. excluding the processes of wire production and other operations)

Resource	Conventional Steel Plant	Recycled Steel plant	Tonnes of CO_2 emissions saved (in producing 2 million tonnes of steel)
Procurement of steel scrap	N/A	0.0614 tCOe	-
Purification (addition of lime)	N/A	0.0537 tCOe	-
Addition of additives (Manganese, Silicon, and Copper)	N/A	0.2053 tCOe	-
Electricity consumption in Electric Arc Furnace	N/A	1.3612 – 1.7056 tCOe	-
Total emissions	2-5 – 2.7 tCOe	1.68 – 2.03 tCOe	(1.64 – 1.34) million tonnes of CO_2

Source: Study undertaken by Prof. R Laxmi Narayan and Ashwani Kumar at the Department of Materials Science and Engineering, IIT (Delhi).

The analysis in this discussion paper shows that reductions/savings in terms of tCOe present vast potential as well as the opportunities for quantification and monetisation. In the next section, this paper examines the possibility of legal and institutional facilitation of India's ship-recycling actors and activities, and the accrual of carbon credits and offsets thereto.

4. Legal and Institutional Landscape

Presently, the relevant Indian legislation for carbon credits is 'The Energy Conservation Act, 2001', (hereinafter "ECA".) Some key features of ECA are examined below.

The term 'vessel' is defined – widely - in ECA, and includes ships. The law thus clearly recognises the connection between energy conservation and shipping.

Section 2 of the ECA lays down context-dependant definitions of accredited energy auditor, carbon credit certificate, and carbon credit trading scheme ("CCTS").

Chapter II forms the statutory underpinning of India's Bureau of Energy Efficiency (BEE), under the Ministry of Power. Per section 4(2)(gf) of ECA, the Secretary in the Ministry of Ports, Shipping and Waterways, Government of India ("MoPSW") is an ex-officio member of BEE.

Chapter IV lays down the powers and functions of BEE, and these include empanelling technical experts (under section 13(2)(td)) to promote energy efficiency and carbon credit trading activities undertaken to meet the objectives of ECA. Section 8(3) similarly empowers it to constitute technical committees of experts for the formulation of energy consumption standards or norms in respect of processes – including, it is argued, processes facilitating accrual of carbon credits and offsets for ship recycling.

Chapter V of ECA is titled 'Power of Central Government to Facilitate and Enforce Efficient Use of Energy and its Conservation,' and contains a whole host of useful and relevant powers and functions.

Per section 14(a) read with 13(2)(a) of ECA, the Central Government may, by notification and in consultation with BEE, specify the norms for processes and energy consumption standards for any vessel/ship. It is reasonable to assume – and legally sound as a matter of statutory interpretation - that the processes facilitating the accrual of carbon credits and offsets for ship recycling can also be specified under these provisions, and this deserves to be done by the authorities.

Section 14(w) grants powers for the specification of CCTS. This was done through Notification S.O. 2825(E) ("CCTS Notification"), issued by the Ministry of Power and dated 28th June 2023 (Ministry of Power, Government of India. 2023a.). Some key features of the CCTS Notification are outlined below.

Section 2 of the CCTS Notification defines and establishes various parts and facets of this trading scheme, including carbon credit, carbon

credit certificate, accredited carbon verification agency, and the Indian carbon market framework. Section 2(j) sets up a Meta-registry (meaning the National Greenhouse Gas registry) that serves two purposes - of data management, including Market Based Mechanisms and National Inventory Management Systems, and, of transaction with features of establishing the linkages with any national or international registry of any market-based mechanism. Section 2(m) puts in place a Power exchange (an electronic trading platform), and section 2(o) establishes a Registry to perform functions in respect tocarbon credit trading schemes.

Section 7 of the CCTS Notification empowers India's Central Electricity Regulatory Commission (CERC) to act as a Regulator for trading activities under the Indian Carbon Market.Section 13 of the CCTS Notification empowers BEE to issue,with the approval of the Central Government, such directions and orders to the registered entities as are considered appropriate for the implementation of India's carbon credit trading scheme.

Section 3 of the CCTS Notification sets up India's 'National Steering Committee for Indian Carbon Market, and section 3(2) declares that the governance of the Indian carbon market and direct oversight of its functioning shall vest in the National Steering Committee for the Indian carbon market. Section 5(1) of the CCTS Notification establishes BEE as the Administrator for the Indian carbon market. Section 4(2)(gf) incorporates Secretary (MoPSW) as an ex-officio member of the Governing Council of BEE.

However, despite its key role, the National Steering Committee does not include representation from MoPSW, even as other Ministries, like the Ministry of Power, etc., are represented.

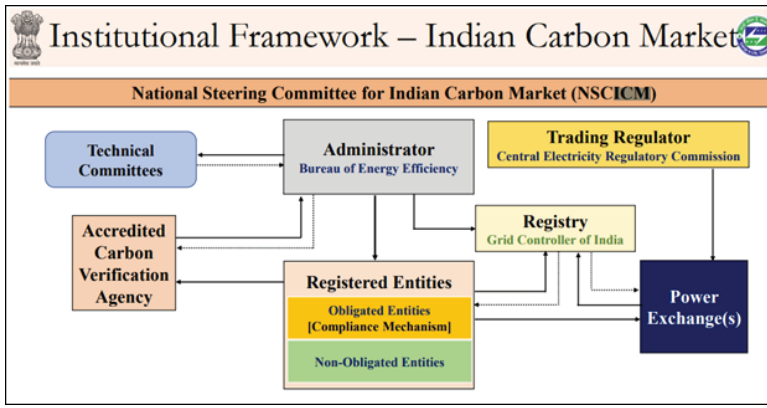
5. Exploring the Indian Carbon Market

Between 2010 and 2022, India issued a total of 278 million credits in the voluntary carbon market, accounting for 17 per cent of the global supply (Keshari, 2024). Furthermore, voluntary market transactions in India grew from $520 million in 2020 to $2 billion in 2021 (Keshari, 2024).

Clearly, in addition to the law, it is simultaneously imperative to explore the existing institutional framework and structure(s) that pertain to carbon credits and offsets in ship recycling.

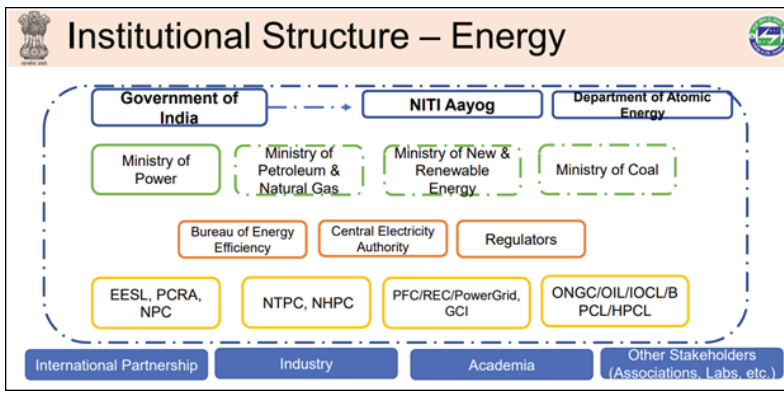
The institutional structure of the Indian Carbon Market (ICM) is illustrated below through Figures 1 and 2, reproduced from the Ministry of Power, Government of India. 2023b.:

Figure 1: Institutional Framework of the Indian Carbon Market (ICM)



Source: Ministry of Power (Government of India), 2023b.

Figure 2: The Governance Structures in the Indian Carbon Market (ICM)



Source***:*** Ministry of Power (Government of India), 2023b.

As mentioned above, India notified its Carbon Credit Trading Scheme (CCTS) in June 2023 (Ministry of Power (Government of India). 2023a). This principal scheme was amended in December 2023, whereby "non-obligated entities" can now also register for generating carbon credits, and can thereby participate in India's tradable carbon credits market. As part of the amendment, a provision was also made for an offset mechanism (Ministry of Power, Government of India, 2023c).

The amended scheme does not,however,mention ships, shipping, or ship recycling. A similar absence prevails in the recently released 'Detailed Procedure for Compliance Mechanism under CCTS' (Bureau of Energy Efficiency, 2024). This absence prevails despite the finding, during the drafting stage, that a corresponding emissions trading system in South Korea does include shipping as a sub-set of a larger 'transport' sector (Ministry of Power, Government of India, "National Carbon Market: Draft Blueprint for Stakeholder Consultation). Figures 1-2 also show that the MoPSW (Govt. of India) is missing from the institutional and governance frameworks as they are presently conceptualised and implemented. This is despite the fact that the DG Shipping under MoPSW is the designated National Authority in India for the recycling of ships (Press Information Bureau, 2020).

Other applicable Indian rules are also silent on the issue of carbon credits for the ship recycling industry. In 2009, the IMO adopted the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships("HKC"), and India acceded to the same in 2019 (International Maritime Organisation, 2019). However, the relevant Indian legislation (which gives effect in Indian law to India's obligations under theHKC) is silent on the subject of carbon credits and offsets pertaining to India's ship recycling industry.

Thus, the words "carbon credit", "carbon", "carbon credits", "offset", or "carbon offset", do not appear anywhere in The Recycling of Ships Act, 2019. The same is true for The Environment Protection Act, 1986, or the rules framed there under.

This silence in the law is not encouraging, since it weakens any enforcement/compliance mechanisms that India needs to pursue in

this regard. The absenceof clear terms in the Acts and Rules also fails toincentivise industry stakeholders who require clarity in order to, inter alia, earn legal carbon credits.

Relevant insertion(s) in the law and/or rules will strengthen India's circular economy, including in the recycling of ships. Furthermore, aforesaid insertion(s) must be worded in such a manner that the meaning/ description of 'carbon credit' in one legislation (like The Recycling of Ships Act) does not conflict with or contradict the corresponding insertion in another Indian legislation (like the Environment Protection Act 1986). The US approach to doing such alignment can be seen, for instance, in the provisions of its Inflation Reduction Act 2022, and the provisions for 'carbon offsetting' therein.

Insertion of relevant terms and definitions into the legal landscape does not necessarily require statutory amendment (though statutory/ legislative backing for 'carbon credits' or 'carbon offsets' would be ideal). Some existing legislative provisions which can be invoked to insert provision(s) for carbon credits, offsets, etc. into Indian law are outlined below.

The Recycling of Ships Act, 2019 contains several useful provisions. Section 42 (titled 'Power to make rules') empowers the Central Government to make rules to carry out the provisions of The Recycling of Ships Act, 2019, and section 46 enables it to "remove difficulties." Section 43 similarly empowers the DG Shipping, as the designated National Authority which shall administer, supervise, and monitor all activities relating to ship recycling under the Act, to make regulationsrelating to various aspects of ship recycling.

The Environment (Protection) Act, 1986 (and associated rules) can be similarly helpful for policymakers. Section 3 of this Act empowers the Central Government to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution, and sections 6 and 25 enable it to make rules in this regard. Section 5 similarly empowers the Central Government (as a part of its powers and functions under this Act) to give binding directions to

"any person." Sections 7-8 allow for the prescription of standards and procedural safeguards for the prevention, control, and abatement of environmental pollution.

6. Recommendations

6.1 Interim Measures

The mammoth activity of ship recycling needs to be incorporated into CCTS and ICM. A September 2024 report by the Ministry of Steel explored how to achieve 'greening' of India's steel sector, and correctly observes:

> *"The ICM will have significant implications for the steel industry, which is one of the largest and most carbon-intensive sectors in India. The steel industry will have to adopt low-carbon technologies and practices to meet the emission reduction targets and avoid penalties under the ICM. The steel industry will also have to compete with other sectors for the limited supply of carbon credits. Additionally, the ICM will create opportunities for the steel industry to access new sources of finance, innovation, and market access. The steel industry can also leverage the ICM to enhance its competitiveness and reputation in the global market, especially in light of the emerging carbon border adjustment mechanisms in the EU and other regions. The ICM will incentivise the steel industry to invest in advanced technologies, such as green hydrogen and carbon capture, utilisation and storage (CCUS), which will allow for deep decarbonisation of steel production." (Ministry of Steel, Government of India, 2024)*

Additionally, the potential of existing provisions of the Environment (Protection) Act, 1986 has also been noted above. Accordingly, section 3 therein should be utilised to promote carbon credits in ship recycling, as measure(s) to protect and improve the environment. Rules should be made (under sections 6 and 25) to establish emission-reduction standards and enable accrual of carbon credits and offsets for ship recycling activities.

The MoPSW should be included and integrated into India's National Steering Committee for Indian Carbon Market. This will ensure that the carbon-related rules, procedures and policies are developed in consultation with relevant maritime stakeholders. For instance, the

MoPSW can coordinate with the BEE to create a sector-specific carbon credit certification process for shipyards. A 'Ship-Recycling Carbon Working Group' can be established under the MoPSW to monitor and measure emission reductions (and energy savings) in ship recycling activities, and facilitate the industry's participation in national, regional and global carbon markets. Indeed, building a real-time monitoring program to track key health, safety, and environmental KPIs across India's ship recycling areas is a focus area under MAKV 2047.

Ship recycling involves significant manual labour, particularly in the initial stages of dismantling and processing vessels. Workers in this sector also face hazardous conditions and require specialised skills. Accordingly, workers engaged in this industry may be added as targets and beneficiaries of PM Vishwakarma Scheme, which is aimed at citizens engaged in such activities. Doing so will offer several benefits. It will enhance the training and skills of workers in the sector, including in areas like safety, environmental protection, and modern recycling techniques. Workers will also be able to access financial assistance for tools, equipment, and technology adoption, and this will further help them to access new markets and opportunities in the circular economy. The scheme will be an enabler for implementing efficient waste segregation and management systems in India's ship recycling industry. Finally, it will promote safer and healthier working conditions in the ship recycling industry.

The DG Shipping is India's notified National authority for matters relating to the recycling of ships, and is empowered to administer, supervise and monitor all activities relating to ship recycling under the Recycling of Ships, Act. Accordingly, it should take the lead in pushing initiative(s) towards carbon credits and offsets for the ship-breaking and ship-recycling industry in India. Furthermore, its efforts in this direction should include the Ship Recycling Industries Association (India) (hereinafter "SRIA") as a partner in execution as well as research.

6.2 Statutory Provisions

The Recycling of Ships, Act 2019 is recommended to be amended to include clear provisions for carbon credits and offsets pertaining to ship

recycling activities and actors. This will enable the latter to earn carbon credits and offsets for the recycling of ships, and incentivise the adoption of low-carbon recycling methods in India's ship recycling industry. Alternatively, short of statutory amendment through Parliament, section 42 of this Act can be utilised to nevertheless insert relevant rules into the law. Irrespective of how such insertion(s) are made, the substantive content of inserted provisions should align with India's existing Carbon Credit Trading Scheme (CCTS).

As revealed by the analysis in this paper, the ECA provides an additional avenue that can be used as a substitute to - or supplement/ complement for - relevant insertions that are made into the Recycling of Ships Act, 2019. Per section 14(a) read with 13(2)(a) of ECA, the Central Government may, by notification and in consultation with BEE, specify the norms for processes and energy consumption standards for any vessel/ship. It is reasonable to assume – and legally sound as a matter of statutory interpretation - that the processes facilitating the accrual of carbon credits and offsets for ship recycling can also be specified under these provisions. This deserves to be done by the authorities.

6.3 Revenue Generation

Revenues from the trading of carbon credits could be used by the Government of India to, among other things, fund tax breaks and subsidies to shipyards that invest in green technologies and processes. This will incentivise shipyards to upgrade their infrastructure, adopt low-emission technologies, and thereby ably compete in regional and global carbon markets.

The Government of India and/or state governments can establish public-private partnerships (PPPs) with private ship-recycling entities to develop and promote energy-efficient technologies. This will contribute to the sustainability and profitability of India's ship recycling actors.

6.4 Harmonisation and Positioning

In addition to domestic legal and administrative measures like those outlined in this paper, steps must also be taken to provide an advantageous 'external' orientation to CCTS and ICM. This can be done inter alia

through the mutual and/or reciprocal recognition of carbon credits and offsets, sustainability certifications, and manufacturing units producing recycled steel or otherwise engaged in the ship recycling industry. It will require insertion of relevant clauses in India's existing (and sometimes new) Mutual Recognition Agreements/Arrangements, Trade Agreements, and Comprehensive Economic Partnership Agreements (CEPAs).

For instance, mutual recognition of carbon credits and offsets between India and the UAE can facilitate Indian exports of green, recycled materials (including steel) not just into the UAE, but further thereon into Europe. Indeed, Article 6.10 in India-UAE CEPA (titled 'Authorised Economic Operators') already envisages work towards such an arrangement between the two countries. The specifics of such insertions, however, need further examination.

An additional way of improving the external orientation of CCTS and ICM is to incorporate therein the best practices from, and seek maximum possible alignment and/or harmonisation with, the equivalent systems of other countries (especially target countries/regions). This will allow Indian exports of recycled steel to benefit from lower carbon tariffs in such countries. Some immediate examples here are the equivalent systems of South Korea, Turkey, the EU, and the People's Republic of China (including the port of Shanghai). A useful starting point for such a comparative study is the following snapshot, reproduced from Ahmet (2024),of some key statistics pertaining to implemented Emissions Trading Systems (ETSs) around the world:

6.5 Industry Facilitationand Handholding

Academic analyses regarding the quantification of tCOe and savings generally will be complemented by the use of emerging technologies – like blockchain, IoT sensors, etc. - to create a trusted ledger for stage-wise certification, verification, and validation of savings by industry. This will bring audit abilities, transparency, conformity, and verifiability to the generation (and eventual trading) of carbon credits and offsets. The use of technologies in this way is represented below:

Table 9: Emission Trading Systems/Schemes in Other Countries

Name - Country	Year	Price (USD/ ton CO2e)	Revenue (billion USD)	Sectoral Scope	GHG Emissions Scope (Mt CO2e)	2023 Share (% Global Emissions)	2023 Share (% Jurisdiction Emissions)
Fujian pilot ETS - China	2016	5	0.0002	Manufacturing, Aviation	125	0.25	51
Hubei pilot ETS - China	2014	7	0.013	Manufacturing	125	0.25	27
Shanghai pilot ETS – China	2013	9	0.02	Manufacturing, Electricity, Transport, Buildings	107	0.21	36
RGGI – USA	2009	15	1.194	Electricity	83	0.17	14
Tianjin pilot ETS – China	2013	5	0.012	Manufacturing, Buildings	75	0.15	35
Chongqing pilot ETS - China	2014	5	0.012	Manufacturing	73	0.14	51
Quebec CaT – Canada	2013	30	1.338	Manufacturing, Electricity, Transport, Buildings	59	0.12	77
Washington CCA – USA	2023	22	0	Manufacturing, Electricity, Transport, Buildings, Waste	57	0.11	70

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New Zealand ETS	2008	34	1.274	Manufacturing, Electricity, Road Transport, Buildings, Aviation, Waste, Forestry	38	0.08	49
Beijing pilot ETS – China	2013	13	0.016	Manufacturing, Electricity, Transport, Buildings	35	0.07	24
Ontario EPS – Canada	2022	48	0	All installations with >50 kt CO_2 e/year	38	0.07	25
Austria ETS – China	2022	35	0	Manufacturing, Electricity, Buildings, Agriculture, Transport	32	0.06	40
Shenzhen pilot ETS – China	2013	9	0.004	Manufacturing, Electricity, Buildings, Transport	25	0.05	30
Oregon ETS - USA	2021	0	0	Liquid fuels, Propane, Natural Gas utilities	21	0.04	43
Nova Scotia CaT – Canada	2019	21	0.038	Manufacturing, Electricity, Transport, Heating	13	0.03	87
UK ETS	2021	88	7.592	Manufacturing, Electricity, Aviation	113	0.03	28
Saskatchewan OBPS – Canada	2019	48	0	All installations with >25 kt CO_2 e/year	9	0.02	13

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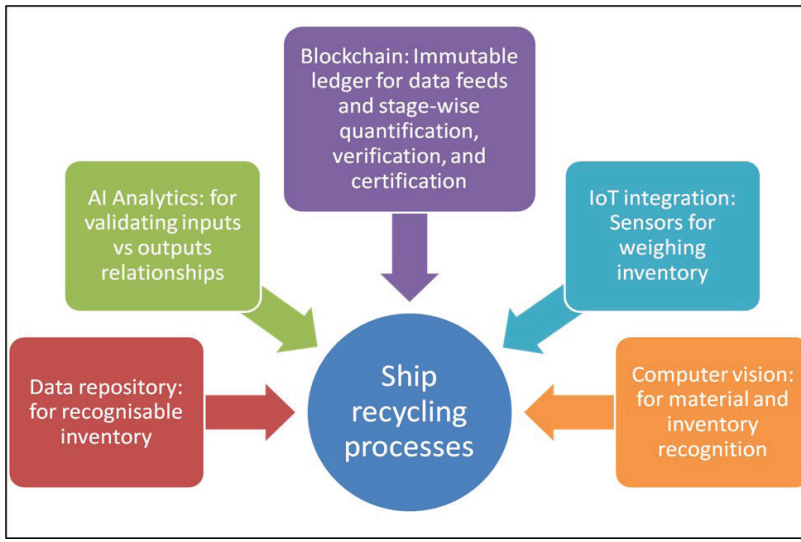
Tokyo CaT - Japan	2010	5	0	Manufacturing, Electricity, Buildings, Transport	12	0.02	20
Canada federal OBPS	2019	48	0.086	All installations with >50 kt CO_2 e/year	7	0.01	1
New Brunswick ETS – Canada	2021	48	0	All installations with >50 kt CO_2 e/year	6	0.01	50
Newfoundland and Labrador PSS – Canada	2019	48	0.0001	All installations with >25 kt CO_2 e/year	4	0.01	43
Saitama ETS - Japan	2011	1	0	Manufacturing, Electricity, Buildings	7	0.01	17
Switzerland ETS	2008	94	0.047	Manufacturing, Electricity, Aviation	5	0.01	11
BC GGIRCA - Canada	2016	18	0	LNG facilities	0	0	0
Massachusetts ETS - USA	2018	12	0.054	Electricity	5	0	8
Montenegro ETS	2022	N/A	0	Manufacturing, Electricity	N/A	N/A	N/A
Total			65.6		9160.9	17.7	-

Source: Ahmet AtılAşıcı, "A Preliminary Analysis of the Turkish Emissions Trading System" (2024).

Figure 3: Using Technology to Facilitate and Administer Ship Recycling in India

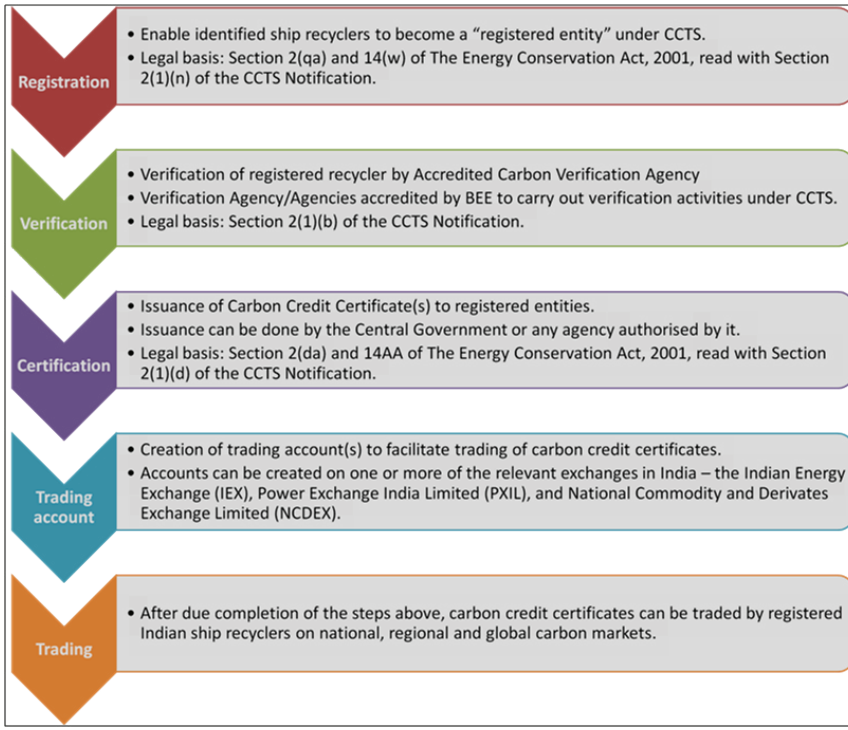


Source: Author's compilation.

Assuming ship recyclers as 'Designated Consumers' specified under section 14(e) of the ECA, BEE's Perform, Achieve, and Trade mechanism (or PAT Mechanism) can also be used as a structural facilitator for the adoption of technologies in the aforesaid manner. Of course, the associated infrastructure and platform would need to be developed.

Now, one considers the issue of trading the carbon credits and offsets. After assessing risk(s) and performing other due diligence, BEE mayalso facilitate carbon trading by identified recyclers and/or members of SRIA. The institutional flow for such facilitation would look as follows:

Figure 4: Facilitation and Handholding for India's Ship Recycling Industry



Source: Author's compilation.

Indeed, such facilitation can be provided by certified agencies empanelled with BEE, as consultancy services to India's ship recyclers (and over time, to other identified entities). Such services have the potential to become an additional source of revenue for BEE.

This paper has noted that the powers and functions of BEE include empanelling technical experts for the promotion of energy efficiency and carbon credit trading activities, and the formulation of energy consumption standards or norms in respect of ship-recycling processes. Here, service providers or consultant agencies can play the role of a relevant technical expert and accordingly synergise efforts with BEE, the MoPSW, and other stakeholders to continually quantify (including

through technological interventions) carbon savings in ship recycling activities. Thereafter, the carbon credits and offsets so earned can be traded by industry at exchanges.Another such consultative and facilitatory interface in this regard is present in section 3(3)(n) of the CCTS Notification, whereby two expert members who have knowledge in the areas of emissions, carbon trading, climate change, environment and energy can be co-opted by the National Steering Committee for Indian Carbon Market.

7. Conclusion

Almost every part of a ship – the hull, machinery, equipment, fittings, generators, batteries, furniture – can be re-used, and nearly nothing goes to waste. Thus, ship recycling can also be seen as an integral part of a larger 'waste to wealth' strategy of sustainable development in a circular economy, which simultaneously provides jobs, raw materials, and economic benefits (Puthucherril, 2010)(Mannan, Rizvi and Dai, 2024)(Ağırkaya, 2021).In addition to safety officers and inspectors for monitoring and ensuring environmental compliance, some specific 'green' jobs that would be created include roles in inventorying and documenting hazardous materials, developing and implementing safe removal procedures, and operating specialised equipment for treatment and disposal.

Arguably, a sub-optimal carbon market thus also leads to job losses. Quantifying such losses can be challenging; however, indications thereto can nevertheless be achieved using figures pertaining to the current size of the ship recycling workforce, the potential growth of the industry under a robust carbon market, the number of jobs created per unit of investment in green technologies, and the estimated carbon credit revenue that could be generated through sustainable practices.

Development and incentivisation of India's ship recycling industry will give it a competitive edge and advantage by enabling demonstrable compliance with the HKC. This will attract ship owners who are more likely to choose recycling facilities which are compliant with the HKC. Furthermore, HKC-compliant facilities may have better access to green

finance, which can help offset the costs of implementing sustainable practices. Adhering to the HKC's standards can also reduce environmental and health risks, and lead to lower insurance premiums. Indeed, MAKV 2047 also envisages the development – and incentivisation – of India's ship recycling yards, particularly on India's eastern coast so that the ship recycling market in Bangladeshcan be captured.

A whole set of measures is required to achieve such incentivisation and development. Government needs to adjust the policy and legal landscape to enable accrual of carbon credits and offsets to the ship recycling industry. Hardware and software, incorporating new technologies like blockchain and IoT, needs to be established to enhance ease of doing business and facilitate stage-wise verification and certification of energy savings and emission reductions inherent in the industry. India's carbon market also needs to be aligned and positioned favourably with equivalent systems abroad. Above all, the MoPSW needs to be included and integrated into India's National Steering Committee for Indian Carbon Market.

Industry stakeholders can provide vital inputs on multiple relevant aspects – like quantification methodology, BEE- approved certification processes and improvements therein, and carbon trading. Accordingly, their inputs need to be proactively sought and absorbed.

Academia, too, can provide expert inputs and help with the patenting of relevant processes, whether as empaneled experts or otherwise. They can also handhold industry and help build the requisite capacities and capabilities therein. Accordingly, academia has an important role to play in facilitating India's carbon market and the ship recycling industry.

The absence ofstructural facilitation in India's relevant legal and policy frameworks has been outlined in this paper. It is hoped that the facts and measures outlined herein will bring legal and administrative clarity to all stakeholders, and enable and empower India's ship recycling industry overall.

Endnote

[1] Study performed by Prof. R Laxmi Narayan and Ashwani Kumar at the Department of Materials Science and Engineering, IIT (Delhi), https://mse.iitd.ac.in/faculty-profile/13

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