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IMO's Carbon Intensity Indicator (CII) as a Mechanism to Reduce Carbon Emission and Fuel Consumption from Ships

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1 Introduction

1.1 Background of the Problem

The shipping industry is an important part of the global economy because it moves about 80% of the world's trade by amount which makes the industry as the backbone of the global trade. But as nothing comes in clean hand, this sector of the global industry heavily depends on fossil fuels which leads to increased carbon intensity in the atmosphere in a great scale[1]. Hence decarbonizing the maritime industry has become a priority for the policy makers[2] and the International Maritime Organization (IMO), which is part of the United Nations and is in charge of making sure that all the vessels are safe and don't engage in the pollution of air and sea, has adopted an initial strategy on the reduction of greenhouse gas emissions from ships in 2018[3] which has been developed through 'Rules on ship carbon intensity and rating system, entered into force in 1st November, 2022' and the recent 'Revised GHG reduction strategy for global shipping, adopted in 7th July, 2023.

The Carbon Intensity Indicator (CII) is a crucial component of the International Maritime Organization's (IMO) strategy to reduce GHG emissions from this vast shipping industry[4] and it measures the operational efficiency of ships in terms of CO_2 emissions per transport work[5]. The CII encourages the shipping industry to improve its environmental performance by reducing the carbon intensity of its operations[6]. The Carbon Intensity Indicator (CII) is a new operational measure which was made in the IMO's initial strategy of 2018 agreement on GHG emissions from ship[7] and this measure has evolved from 2018 to 2023 by IMO's rules on carbon intensity rating system and revised GHG strategy which entered into force on 7th July 2023.

In these strategies IMO has set the rules for all the ships to calculate their yearly operational carbon intensity and measure their energy efficiency. Based on the operational CII, all the ships will be given ratings which will indicate their performance level and this rule has been set as

[1] Zheng Wan and others, 'Decarbonizing the International Shipping Industry: Solutions and Policy Recommendations' (2018) 126 Marine Pollution Bulletin 428.
[2] Shuaian Wang, Harilaos N Psaraftis and Jingwen Qi, 'Paradox of International Maritime Organization's Carbon Intensity Indicator' (2021) 1 Communications in Transportation Research 100005.
[3] 'Initial IMO GHG Strategy' <https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx> accessed 25 October 2023.
[4] Weng Sut Sou and others, 'Reducing the Carbon Intensity of International Shipping – The Impact of Energy Efficiency Measures' (2022) 170 Energy Policy 113239.
[5] ibid.
[6] ibid.
[7] 'Rules on Ship Carbon Intensity and Rating System Enter into Force' <https://www.imo.org/en/MediaCentre/PressBriefings/pages/CII-and-EEXI-entry-into-force.aspx> accessed 25 October 2023.

mandatory rule from 1 January 2023[8]. Within 2023, the first yearly report will be finished, and in 2024, the first CII ratings will be given[9]. As now it is mandatory for all the ships to calculate their annual operational CII, it has been hoped that the regulations will make huge impact on the improvement of carbon emissions and also fuel consumption which are interrelated to each other as how much a ship consumes while moving effects how much emission is going to happen.

The IMO's initial plan of 2018 on reduction of emissions has two main goals[10]

1. Lowering the carbon intensity by at least 40% within 2030 compared to 2008 and by 70% within 2050.
2. By 2050, shipping GHG emissions should be cut by at least half compared to what they were in 2008, and they should be stopped as soon as possible.

Now, on 7 July 2023, new strategy has been adopted by IMO which targets[11]

1. Decarbonization of shipping industry by 2050,
2. Carbon reduction target of at least 20%, striving for 30% by 2030 and at least 70%, striving for 80% by 2040, and
3. Fuel use target or use of efficient energy of 10%, compared to 2008.

As per IMO, shipping industry was responsible for 2.89% of the world's CO_2 emissions from 2007 to 2012. Due to the urgency of the situation IMO has set out on a mission to reduce the shipping industry's carbon footprint.

[8] ibid.
[9] ibid.
[10] Sou and others (n 4).
[11] 'Revised GHG Reduction Strategy for Global Shipping Adopted' <https://www.imo.org/en/MediaCentre/PressBriefings/pages/Revised-GHG-reduction-strategy-for-global-shipping-adopted-.aspx> accessed 25 October 2023.

1.2 The facts and the purpose of the thesis

To reach these targets, IMO has set a rule in place to make ships use less energy and reduce their carbon emissions which include short-term measures and long-term measures, like, a plan of 2018 about cutting greenhouse gas (GHG) emissions by at least 50% compared to 2008 levels by 2050[12], 2022 plan regarding shipping carbon intensity and rating plan to reduce 40% carbon intensity from the ships by 2030 compared to 2008[13] and the recent 2023 plan is to reduce the CO_2 emissions per transport work by at least 40% by 2030 and to reduce the total annual GHG emissions from international shipping by at least 20%, striving for 30% by 2030[14] and among which the Energy Efficiency Existing Ship Index (EEXI) and the Carbon Intensity Indicator (CII) stand out. But the challenges are with putting these steps into action and with the rest of the GHG reduction strategy, as the measures require ship owners, operators, manufacturers, flag states, and a wide range of other stakeholders to follow them. Not only these, but also these rules are hard to follow because the marine industry is a vast global industry and has a lot of different parts, and the problem lies there that almost every shipping body does not follow the rules as per the regulations which makes thing even harder. Besides, even though IMO has the power to set rules, it does not have a way to directly enforce the rules. Flag states, or the countries where the ships are registered, are in charge of making sure that IMO rules are followed. But enforcement effectiveness varies a lot between flag states, which often leads to different levels of compliance.

All the information regarding these strategies of IMO focuses on the regulations themselves, the goals of these regulations, and an impact which is estimated rather than the actual consequences within the maritime industry. Moreover, since these regulations have been implemented, there is not that much concrete data on the achieved reduced carbon emissions, though it is an important fact that these regulations are quite recent and some of which came into effect in January 2023 and the most recent revised strategy has been adopted in 7th July 2023.

Given how complicated things are, the main purpose of this thesis paper is to break down how the IMO sets rules to reduce the energy consumption and annual operational carbon intensity of the shipping industry. It aims to get an in-depth understanding of the current regulatory framework set up by the IMO and evaluate how well the rules are implemented to cut the carbon intensity and energy consumption. This study will critically analyse IMO's regulations of all stages which relate to carbon intensity indicator and energy efficiency, the challenges and obstacles faced by the maritime industry which enforcing these regulations, will also try to offer a thorough and fact-based analysis of the actual impact of the IMO's standards in the maritime industry. The purpose of this paper is to demonstrate whether or not all these regulations will actually make a real impact and will provide a sustainable maritime industry, or if they are just written guidelines with a dream for a sustainable future.

[12] 'Initial IMO GHG Strategy' (n 3).
[13] 'Rules on Ship Carbon Intensity and Rating System Enter into Force' (n 7).
[14] 'Revised GHG Reduction Strategy for Global Shipping Adopted' (n 11).

1.3 Research Questions

This thesis explores the regulations set by IMO, their bindings and applicability, enforcement to understand whether these regulations have actual impact on the marine industry, or they are just theory for now. Hence this study aims to give new perspective on the topic by following the legal framework set by IMO. While doing that, the following research questions will be addressed-

- Regulatory Framework: What are the regulations and how does the International Maritime Organization (IMO) establish them aimed at reducing the shipping industry's operational carbon intensity and fuel consumption?
- Obligations and Applicability: Who is obliged to follow to the IMO regulations? Does this apply over the whole global shipping sector, or are there specific ship type or stakeholder role (such as- shipowners, operators, or builders)?
- Complexity: How can CII be navigated and how to stay compliant with CII?

1.4 Methodology

This thesis mostly uses a qualitative research approach which is complemented by the quantitative data analysis. The primary focus of the paper is figuring out the policy documents, reports, data related to the Carbon Intensity Indicator (CII) of IMO. The primary sources of this paper are Revised MARPOL Annex VI regulations 2021 and the Resolutions adopted in the Marine Environment Protection Committee (MEPC). Besides, academic and industry reports including UNCTAD's review on maritime transport and studies on decarbonizing shipping, online publications and news articles, technical and regulatory guidelines such as CII operation Clause for Time Charter Parties 2022 are used as the secondary sources.

1.4 Outline of the thesis

Part II of this thesis paper will discuss about the main obligations for Carbon Intensity Indicator (CII). This part will focus on the CII rating guidelines which include how does a vessel get a rating and what is the meaning of CII rating in the reduction of carbon emissions. This part of the study will also include calculation of CII that shows the algorithmic process to calculate CII and how does this calculation relate to CII rating. Then, moving further this study will discuss the reference line of annual operational CII and the comparison between reference line and CII rating, reduction factor, Data Collection System to collect the annual data, data collection report from 2020-2022, impact of CII regulation on smaller ships and who are responsible to enforce this rule.

Part III concludes the navigation of CII which will analyse the process to stay compliant with CII and regarding to stay compliant how time charter influences the enforcement of CII, hoe to plan the voyages to get better routes, the global fleet influence on CII and the analysis of the recent regulations.

Part IV will discuss the result of the analysis and connect the found result with the purpose of the thesis.

Part V will conclude the final remarks.

2 Main Obligations for Carbon Intensity Indicator (CII)

2.1 Introduction

The International Maritime Organisation (IMO) introduces operational carbon intensity indicator (CII) to calculate the carbon intensity of every individual ship in grams of CO_2 per capacity mile and this calculation considers the ship's annual CO2 emissions, its travel distance, and cargo capacity[15]. The purpose of CII is to provide transparent data so that the energy efficiency of ships can be achieved by comparing the data of all category's ships[16]. As from January 1, 2023, it has been made mandatory for all ships to deliver the collection of data to report their annual operational CII, ratings will be given to each ship by calculating their annual performance data and will be rated as A (the most efficient) to E (the less efficient)[17]. The "2022 Guidelines for Administration Verification of Ship Fuel Oil Consumption Data and Operational carbon Intensity" provide a detailed instructions on how to calculate, verify, and report the achieved annual operational CII and determine a ship's operational carbon intensity rating[18]. According to section 5.1 of the Guideline, the attained annual operational CII is calculated using collected data of fuel oil consumption and distance travelled and for the verification process, a ship's energy efficiency management plan (SEEMP), evidence of the ship's capacity parameter or a ship's capacity on per distance (deadweight or gross tonnage), and information about any correction measure which has been applied and voyage adjustments, needs to be in the collected in the data documents[19].

This chapter will now focus on the carbon intensity indicator regulations, Data Collection System (DCS), and MARPOL Annex VI, Chapter 4. Following these regulations and obligations and enforcing them in the shipping industry may help to make the shipping industry more sustainable and environment friendly and this is the main goal of IMO regarding the less emission and less use of fuel. This chapter will also discuss about which procedures and regulations the shipowners and operators must follow to fulfil IMO's goal regarding these obligations and how the efforts of ship owners and operators will make contribution in the reduction of the carbon intensity and fuel consumption.

[15] 'Rules on Ship Carbon Intensity and Rating System Enter into Force' (n 7).
[16] ibid.
[17] ibid.
[18] Resolution MEPC.348(78)' (IMO Publications and Documents 2022) https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.348(78).pdf
[19] ibid.

2.1.1 CII Rating Guidelines: An Instrument for Operational Carbon Intensity Assessment

Regulation 28 of MARPOL Annex VI (which is the international convention for the prevention of the air pollution from marine industry and which was developed through International Maritime Organisation), describes how to attain annual operational carbon intensity indicator, how this annual operational carbon intensity indicator can be required, rating of CII, correctives, and incentive actions[20]. On the other hand, the 2022 Guidelines on the Operational Carbon Intensity Rating of Ships (CII Rating Guidelines, G4) is a guideline (which is adopted in the 78th session of the Marine Environment Protection Committee concerning the functions of IMO as a required guideline for the amendments of MARPOL regarding the technical and operational measures to reduce carbon intensity of shipping industry and this Guideline represents the extensive understanding of Regulation 28.6 of MARPOL) that is essential to process the rating of ships based on their annual operational carbon intensity[21]. These guidelines play an important role in legalizing carbon intensity regulation on a global level.

In accordance with Regulation 28 of MARPOL Annex VI, it was implemented and offers a system for classify ships by rating them from A to E, which produce a wide range of performance levels. These ratings represent major superior (A), minor superior (B), moderate (C), minor inferior (D), or inferior (E) performance, providing a thorough overview of the vessel's carbon intensity profile[22].

In addition, the section 5.2 of the 2022 Guidelines for Administration Verification of Ship Fuel Oil Consumption Data and Operational Carbon Intensity (which is adopted in the 78th session of MEPC and which contains the mandatory amendments of MARPOL concerning the regulation 27.7 of MARPOL that requires the ship fuel oil data to be verified following the procedures made by the Administration and also regulation 28.6 of the MARPOL), states that the achieved annual operational CII must be verified using data from the entire calendar year[23]. In cases where data for the entire year is unavailable, such as for a newly delivered ship, the available data for the corresponding period of the previous calendar year should be used for verification[24]. Under the regulation 28.6 of MARPOL Annex VI, the achieved annual operational CII is compared to the required annual operational CII for the purpose of determining a ship's operational carbon intensity rating (A, B, C, D, or E)[25]. Section 5.7 of the Guideline states that the rating boundaries are specified with three decimal places, and if the attained CII falls on a rating boundary, the ship may assign to the higher of the two ratings[26].

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[20] Resolution MEPC.328(76) , 2021 Revised MARPOL Annex VI https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.328(76).pdf

[21] (Resolution MEPC.354(78), 10 June 2022), https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.354(78).pdf

[22] Resolution MEPC.328(76) (n 20)

[23] Resolution MEPC.348(78)' (n18)

[24] ibid.

[25] Resolution MEPC.328(76) (n 20)

[26] Resolution MEPC.348(78)' (n 18)

Besides, section 5.6 of the Guidelines clarifies that the losing Administration is not required to verify the attained annual operational CII or determine the annual CII rating for that year, (which is also outlined in regulations 27.4, 27.5, or 27.6 of MARPOL Annex VI) and the receiving Administration is responsible for confirming the achieved annual operational CII utilizing data from the entire calendar year[27]. In accordance with the Regulation 6.6 of MARPOL Annex VI which is outlined in section 6.1 of the Guidelines, the Administration must issue a statement following the receipt of the reported data and successful result of the verification process and the Administration shall inform the company and ask for a new revised SEEMP which includes a corrective measure plan if a corrective action plan was required but had not been submitted[28].

The legal motivation of these rules is that the ships holding higher ratings (A and B) may help them to get a legal basis and advantages in the market field, such as increasing market value, decreasing operational cost, customer preferences and also, these regulations of higher rating may give the ship owners a legal reason to improve their limits of carbon intensity. On the other hand, according to Part 1.3.3.6 of the Guideline[29] and Regulation 28 of MARPOL Annex VI, the ships having poor CII rating (D and E) for three consecutive years, have to provide a corrective plan which needs to be carried out to improve CII rating[30].

2.1.1.1 Analysis of the calculation of CII and it's relation with CII Rating:

The CII calculates the ratio of the total mass (M) of CO_2 emitted to the total amount of transport work (W) completed within a specific calendar year. This calculation offers a useful method to assess each vessel's carbon efficiency, enabling the improvement of operational procedures to lower carbon emissions.

$$\text{attained } CII_{ship} = \text{M/W}^{31}$$

The sum of the CO_2 emissions from all the fuel oil used onboard a ship during a specific calendar year is used to calculate the total mass (M) of emitted carbon by,

[27] ibid.
[28] Ibid.
[29] (Resolution MEPC.346(78), 10 June 2022), https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.346(78).pdf
[30] Resolution MEPC.328(76)' (n 20)
[31] (Resolution MEPC.352(78), 10 June 2022), https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.352(78).pdf

M= $FC_j \times C_{F_j}$, where j is the fuel oil type; FC_j is the total mass in gram of consumed fuel oil type (j) in the calendar year and C_{F_j} is the fuel oil mass to the conversion factor of total CO_2 mass[32].

According to the 2022 Guidelines on the method of calculation of the attained Energy Efficiency Design Index (EEDI), various fuel oil types have unique conversion factors, such as LFO (Light Fuel Oil)- carbon content 0.894 and C_f or conversion factor is 3.206 (t-CO_2/t-Fuel) whereas HFO (High fuel Oil- carbon content is 0.8493 and C_f or conversion factor is 3.114 (t-CO_2/t-Fuel) whereas LPG (liquified petroleum gas)- carbon content is 0.7500 and C_f or conversion factor is 2.754 (t-CO_2/t-Fuel)[33] If the type of fuel oil is not covered by the guidelines, the conversion factor should be requested from the fuel oil supplier and supported by documentary evidence[34].

The sum of a ship's carrying capacity and the distance travelled within a specific year is referred to as the transport work (W) is calculated by,

$W_s = C \times D_t$, where C represents the capacity of the ship and D_t represents the total distance travelled[35].

Deadweight tonnage (DWT)[36] is used as the capacity for some types of vessels (C), which includes bulk carriers, tankers, container ships, gas carriers, LNG carriers, general cargo ships, refrigerated cargo carriers, and combination carriers. On the other hand, gross tonnage (GT) is used as the capacity of the ship (C) like cruise passenger ships, ro-ro cargo ships (vehicle carriers), ro-ro cargo ships, and ro-ro passenger ships[37].

For example, a ship named M/V Diana which is a bulk carrier, DWT is 279000, annual distance travelled 5000 NM, fuel oil type is HFO (Heavy Fuel Oil), and annual fuel consumption is 25900 MT and time period is 1st January to 31st December 2023. After calculating the CII, the attained CII is 57.815 where the required CII was in 2023 1.848. So, the CII rating would be 'E' for M/V Diana. This calculation is acquired in the CII calculator by Lloyd's Register[38] following the Appendix IX of Annex VI concerning about 'Information to Fuel Oil Consumption Database' be submitted to the IMO Ship which include the ship's name, type of

[32] ibid.
[33] (Resolution MEPC.364(79, 2022) page 4 https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.364(79).pdf
[34] Resolution MEPC.352(78), (n 31)
[35] ibid.
[36] DWT means the difference in tonnes between the displacement of a ship in water of relative density of 1025 kg/m^3 at the summer load draught and the lightweight of the ship, in accordance with Resolution MEPC.364(79), 2022, (n 33).
[37] Resolution MEPC.364(79), 2022, (n 33).
[38] 'CII Calculator | Lloyd's Register | LR' <https://www.lr.org/en/services/technical-advisory/carbon-intensity-indicator/cii-calculator/> accessed 21 November 2023.

carrier, type of fuel oil, period of calendar year, DWT, annual fuel oil consumption and annual distance travelled[39].

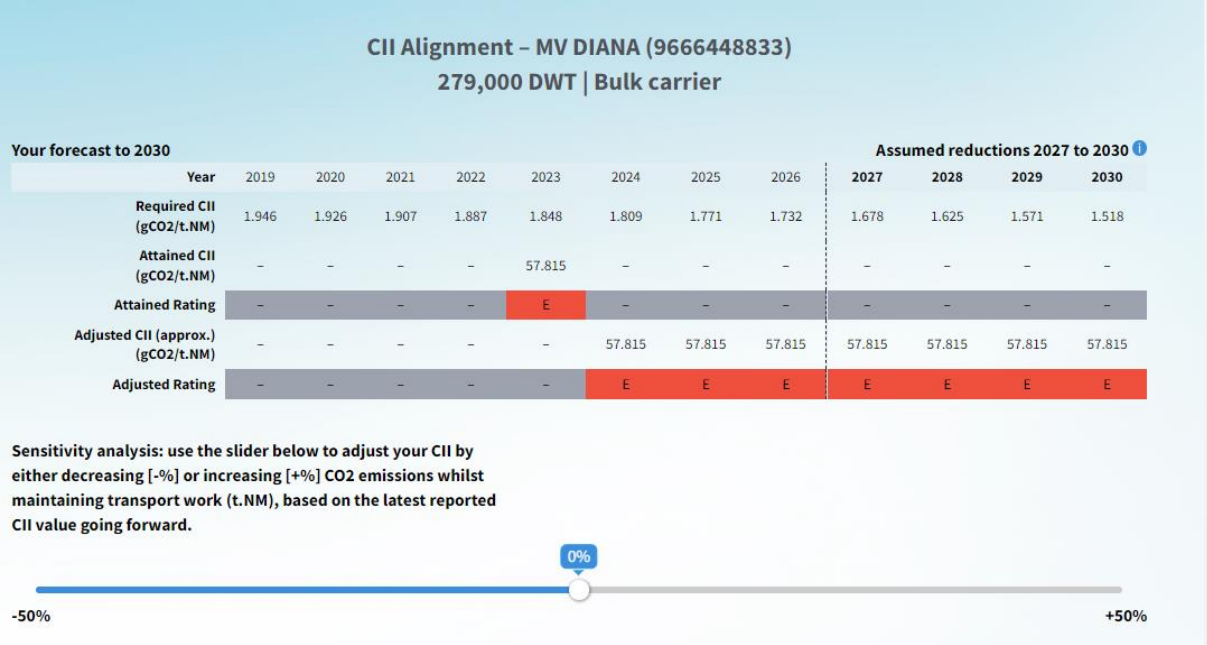


Figure 1: The calculation of M/V Diana attained from CII calculator by Lloyd's register. This illustrates the attained CII of M/V Diana and the required CII of 2023 under IMO regulations and the attained rating of the vessel which is 'E' (the inferior rating)[40].

Calculating the carbon emissions per unit of transport work may provide ships a clear path to cut down their carbon footprint. The fact the calculation uses the transport work can change based on other operational factors, such as, ships on the same route could have different transport work because of different carrying good, which might lead to different CII for the same distance. Beside the fact that the types of ships and their Deadweight Tonnage (DWT) and Gross Tonnage (GT) measure may make the comparison of carbon intensity among them hard as calculation will differ from one type of ship to another. Additionally, the CII may not take into consideration other operational energy efficiency measures a ship is taking to reduce the emission and using the energy efficient fuel, because a ship using renewable energy may still produce the same emission as the ship which is using non-renewable energy. This can be another lacking the calculation method of operational CII has. For example, as the calculation of operational CII depends in a large scale on the type of fuel the ship is using, the system has mentioned in the guideline about every possible type of fuels a ship may use[41] and lacking this information about type of fuel in the guidelines or system may cause a miscalculation for the CII, as it leaves a gap for the operators or owners to provide false information intentionally or accidently. Also, different fuel types have a lot effects in the attained CII as they possess

[39] Resolution MEPC.328(76)' (n 20)
[40] 'CII Calculator | Lloyd's Register | LR' (n 38).
[41] Resolution MEPC.352(78), (n 31)

different carbon content and conversion factor[42] but the lack of information about the distinction of renewable and non-renewable fuels in the system leaves the risk of not having enough reason for ship to switch to different fuels, because the general knowledge of merits and demerits of using renewable and non-renewable fuels may be known by everyone, but it gets more priority when the system imposed it on the whole shipping sector and gives the sector a clear idea.

2.1.1.2 Analysis of reference line of operational CII and CII rating compared to the reference line

According to regulation 28.4 of MARPOL Annex VI, for each type of ships reference line needs to be established and 2021 Guidelines on the reference line for use with operational CII has explained the method of calculating operational carbon intensity, which has been adopted in the 76th session of MEPC to give a clear explanation about the reference line[43]. Now the definition of the reference line can be set as a curved line which represents the middle number of operational carbon intensity performance by each type of ship on their function of capacity[44]. The attained CII of a vessel is calculated on the distance travelled and how much cargo work done by a ship but that also differs on the capacity of the vessels. As the data of year 2008 is limited, the year 2019 data of operational CII of the ships is taken as the reference line and the formula for it is[45]-

$$CII_{ref} = aCapacity^{-c}$$

Here, CII_{ref} is the reference value year 2019, a and c are the parameters which represents the median number of the attained CII and the capacity of individual ships that is collected through IMO Data Collection system (DCS) of year 2019[46].

[42] Resolution MEPC.364(79), (n 33).
[43] (Resolution MEPC.337(76), 17 June 2021) https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.337(76).pdf
[44] ibid.
[45] 'Annex - 2022 Guidelines on the Reference Lines for Use with Operational Carbon Intensity Indicators (CII Reference Lines Guidelines, G2)' <https://imorules.com/GUID-3D89CD6D-A4CE-44C7-8CB9-70F67D95A6A8.html> accessed 23 November 2023.
[46] ibid.

Table 1: Table of parameters of reference line of different ship type in year 2019. This table illustrates the individual ship capacity and their acquired CII. These reference lines are part of calculating CII by considering the improvements between 2008 to 2019[47]

Ship type		Capacity	*a*	*c*
Bulk carrier	279,000 DWT and above	279,000	4745	0.622
	less than 279,000 DWT	DWT	4745	0.622
Gas carrier	65,000 and above	DWT	14405E7	2.071
	less than 65,000 DWT	DWT	8104	0.639
Tanker		DWT	5247	0.610
Container ship		DWT	1984	0.489
General cargo ship	20,000 DWT and above	DWT	31948	0.792
	less than 20,000 DWT	DWT	588	0.3885
Refrigerated cargo carrier		DWT	4600	0.557
Combination carrier		DWT	40853	0.812
LNG carrier	100,000 DWT and above	DWT	9.827	0.000
	65,000 DWT and above, but less than 100,000 DWT	DWT	14479E10	2.673
	less than 65,000 DWT	65,000	14479E10	2.673
Ro-ro cargo ship (vehicle carrier)		GT	5739	0.631
Ro-ro cargo ship		DWT	10952	0.637
Ro-ro passenger ship		GT	7540	0.587
Cruise passenger ship		GT	930	0.383

In Table 1 , a is a factor that shows the capacity of the ships and c is a carbon factor which corelates the carbon intensity and fuel consumption of a ship in accordance the size and capacity of the ship. These parameters are used together to establish a reference line which determine the efficiency rating of individual ships. Here the reference year is 2019 because in this year the verified DCS data had been reported to IMO for the first time and this data was better than the highly uncertain AIS (automatic identification system) data of 2008 which would not be a strong perfect fit for the reference line[48].

The reference line is a standard target for ships to measure their carbon efficiency. It determines a specific point of carbon intensity performance for individual type of ship with which a ship can compare own performance and by that CII rating can be determined. If a ship's carbon intensity is lower than the performance line than it will get the higher rating that signifies the ship's better energy efficiency and lower carbon emissions. On the other hand, if the carbon performance is lower than the reference line, it will get lower CII rating. But reference line might not take into consideration certain facts, such as the routes each ship is following, operational variation among the ships, each ship's age (which meant how old or new the ship

[47] ibid.

[48] 'CII – Carbon Intensity Indicator' (*DNV*) <https://www.dnv.com/Default> accessed 23 November 2023.

is), or the which technologies they are following. CII is such factor which will consider all these aspects as for getting precise data every possible fact in the sea and the vessel following is important.

The IMO reduction targets for 2050 is based on the data of 2019 though the CII regulation has come into force in 2023 and there has not yet any calculated data of operational CII after 2019 come. The reduction factors of carbon emissions of a ship required is described till 2026 and the targets are set based on the reference line and it has been hoped to get stronger afterward and the most important factor for a vessel will be its CII rating based on the reference[49]. So, the data of 2019 will be the base of carbon performance of a ship and the CII rating will be affected like this.

2.1.1.3 Analysis of the reduction factor and a ship's operational carbon footprint

According to 4th IMO GHG strategy of 2020, there are four versions or metrics of CII which are used to estimate the CII of marine industry[50]-

1. AER (Annual Emissions Ratio) which is used to estimate for supply-based CII by gCO_2/ dwt/nautical mile.

$$CII_{supply} = \frac{Annual\ carbon\ emission\ of\ the\ ship\ (g)}{ship's\ deadweight\ tonnage\ times\ the\ sailing\ distance\ in\ the\ year}$$

2. EEOI (Energy Efficiency Operational Indicator) which is used to estimate for demand-based CII by gCO_2/tonne/nautical mile.

$$CII_{demand} = \frac{Annual\ carbon\ emission\ of\ the\ ship\ (g)}{Actual\ tonne-miles\ carried\ by\ the\ ship\ in\ the\ year}$$

3. Distance, which is estimate for carbon emissions per distance travelled, in kgCO_2/nautical mile.
4. Time, which is estimate for carbon emissions per hour in tonneCO_2/hour.

In these four metrics, AER and EEOI is particularly used to estimate the carbon intensity of the international shipping in 2008 and from 2012 to 2018 and the average carbon intensity improved by 22% and 31.8% in comparison to 2008 which was measured under these two metrics[51]. But IMO faced challenges in setting carbon intensity reduction targets because there was difficulty in comparing EEOI or demand-based metrics which considers the amount of

[49] 'Carbon Intensity Indicator – Frequently Asked Questions' (*StormGeo*, 17 February 2022) <https://www.stormgeo.com/products/s-suite/s-insight/articles/carbon-intensity-indicator-frequently-asked-questions/> accessed 24 November 2023.
[50] 'Fourth-IMO-GHG-Study-2020-Full-Report-and-Annexes_compressed.Pdf' <https://greenvoyage2050.imo.org/wp-content/uploads/2021/07/Fourth-IMO-GHG-Study-2020-Full-report-and-annexes_compressed.pdf> accessed 24 November 2023.
[51] ibid.

cargo per transport work done and AER or supply-based metrics which considers the capacity of a ship because of the differences of how the transport work is calculated[52]. In spite of that the result obtained from these two sources cannot be directly compared as under DCS of IMO there was no consistent data in Fourth IMO GHG Strategy 2020. To make sure the equivalence of the calculation of carbon intensity of international maritime industry through the year 2023 to 2030 IMO set a target of reducing emissions by at least 22% by 2030 taking data of 2019 as the reference line[53] or target between 31% and 53% to meet the 1.5◦C temperature reduction to align with the Paris Agreement[54].

Table 2: Reduction factor (z%) for the CII taking 2019 as the reference line which illustrates Z factors percentages of goals to reduce CII till 2026[55]

Year	Reduction factor relative to 2019
2020	1%
2021	1%
2022	1%
2023	2%
2024	2%
2025	2%
2026	2%
2027	Z factors for the years of 2027–2030 to be further strengthened and
2028	developed taking into account the review of the short-term measures
2029	
2030	

As IMO member states could not reach to a valid agreement of the demand-based CII reduction target of 11% and the supply-based target of 22%, they agreed on a CII reduction rate of 11% by 2026 and that's why from 2020-2022 3% reduction (1% per year) , 2023-2026 8% (2% per year), total 11% reduction rate has been set indicated in Table 2[56].

As per regulation 28 and 2022 Guidelines on the Operational Carbon Intensity Rating of Ships, after the completion of year 2023 and every year after 2023, a ship has to calculate the operational CII by following the rules. After submitting the attained data, each ship will be

[52] (Resolution MEPC.338(76), 17 June 2021), https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC.338(76).pdf

[53] ibid.

[54] boxcar-admin, 'Choose Wisely: IMO's Carbon Intensity Target Could Be the Difference between Rising or Falling Shipping Emissions This Decade' (*International Council on Clean Transportation*, 18 May 2021) <https://theicct.org/choose-wisely-imos-carbon-intensity-target-could-be-the-difference-between-rising-or-falling-shipping-emissions-this-decade/> accessed 25 November 2023.

[55] Resolution MEPC.338(76), (n 52)

[56] Hoijun Kim and others, 'Proposal and Analysis for Effective Implementation of New Measures to Reduce the Operational Carbon Intensity of Ships' (2023) 280 Ocean Engineering 114827.

given the ratings of A to E resembles of major superior to inferior on their performance. The CII rating, which is exercised in a year, largely depends on the achieved annual operational carbon intensity indicator of the ship. It describes how a ship's operational carbon intensity compares to the desired or superior level in a fundamental way. As CII rating system is graded with five-grade, this will help the ratings are given in an effective manner. This system will be in effect from 2023 to 2030, which presents superior, lower, upper, and inferior boundaries[57]. To be sure where each ship falls on the performance level, its attained annual operational CII is compared to these established limits. The distribution of CII of individual ship happened in 2019 which created the rating boundaries. The guidelines make sure that the rating accurately reflects a ship's performance by following the system in actual data. According to this framework, in terms of the achieved annual operational CIIs, 30% of ships would receive the middle "C" rating, lower than 20% will receive "B" rating and lower than 15% will receive "A" rating respectively and others may receive "D" or "E"[58] . The fact that the distribution of ratings among ships may not always reflect the situation in 2019. In some years, the ratios may change, possibly resulting in 20% of ships earning an "A," 30% earning a "B," 40% earning a "C," and 8% and 2% of the others earning "D" and "E" ratings, respectively and the nature of this system also highlight the importance of reducing carbon emissions in the maritime sector[59] .

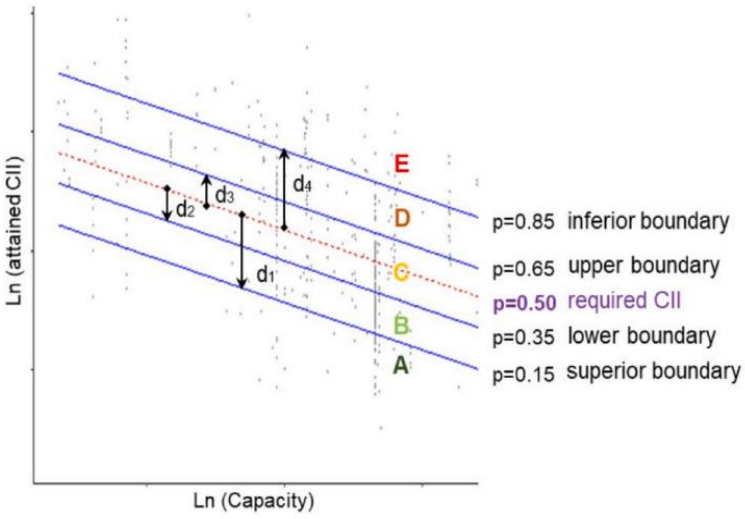


Figure 2: The CII Rating and Boundary Framework. This illustrates the relation between the capacity of the ship and CII Rating[60]

In Figure 2 the horizontal line is attained CII rating levels which categorized from A (superior) to E (inferior) and the vertical line (d1 to d4) shows the variation from the target

[57] ibid.
[58] Resolution MEPC.354(78), (n 21)
[59] Kim and others (n 56).
[60] Resolution MEPC.354(78), (n 21)

CII of each individual ship according to their size and capacity where dd vectors is determined by the attained annual operational CII of the ships of the concerned type which can be estimated through the data of DCS of 2019 as sample and the typical quantile which is denoted as p, indicates the proportion of observation of lower value[61]. Here, p= 0.15 indicates superior boundary which means the most efficient ships which would be given A rating and p= 0.85 indicates inferior boundary which means the ship would be given E the lower rating on its poor performance of attaining the targeted CII.

2.1.2 Data Collection System (DCS): A system which connects to carbon intensity and fuel consumption reduction.

Under MARPOL Annex VI, the Data Collection System (DCS) (at 70th session of MEPC DCS was proposed concerning the data collection system for fuel oil consumption under MARPOL Annex VI) is a requirement for ships of 5,000 gross tons or more[62]. It was implemented to make easier the process the collection and reporting of fuel consumption data, which is necessary for calculating the CII and monitoring the shipping industry's overall energy efficiency[63]. Data on fuel consumption must be gathered annually on a per-voyage basis and provided to the flag state or RO (Recognised Organisations), so they can submit the information to the IMO Ship Fuel Consumption Database later[64]. The information which are gathered through the DCS, will be used to examine how much fuel has been consumed and to measure the success of the IMO's energy efficiency programs[65]. The purpose of DCS or Data Collection System is to gather, validate, and analyse data on fuel oil consumption from ships according to the requirements of MARPOL Annex VI, Regulation 27. The gathered information supports to increase the understanding of the overall energy consumption and emissions profile of the shipping sector, assisting in the creation of efficient policies and regulations[66]. The DCS has several key elements:

Data Collection:

A requirement of MARPOL Annex VI, Regulation 27 for ships is that every ship, fall under the jurisdiction of MARPOL Annex VI, needs to monitor, record, and report its fuel oil consumption data annually. The data must be submitted in a standardized format according to

[61] Resolution MEPC.354(78), (n 21)
[62] (Resolution MEPC.278(70), 28 October 2016), https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.278(70).pdf
[63] ibid.
[64] ibid.
[65] ibid.
[66] Resolution MEPC.328(76)' (n 20)

Appendix 3 of Resolution MEPC.346(78), which contains instructions for establishing Ship Energy Efficiency Management Plan (SEEMP)[67].

The main information of the database of Appendix IX of Annex VI concerns the type of ship or it's character, gross tonnage of the ship, how much power the ship is using, how much fuel oil is consumed in the required travelled distance and the hours taken in this distance[68]. According to Regulation 27 of MARPOL Annex VI, it is a requirement for the operators to monitor, collect and report these data on how much fuel they have used in the travelled distance which make sure that exact and correct data is submitted, so the Operational CII can be calculated[69].

Data Verification:

In accordance with MARPOL Annex VI, Regulation 6.6, the Administration, or any other properly authorized organization which will verify the submitted information after receiving the reported data and the organization issues a Statement of Compliance no later than five months after the start of the calendar year if the data is found to be accurate and complete[70].

This verification regulation adds the responsibility on the ship operators and owners to process the report and this rule may make it hard for them to submit an incorrect report as the data are checked by an Administration body. After checking the validity of the report, as a Statement of Compliance is issued by the regulatory body, this makes a legal record about that the ship is following the regulations regarding operational carbon intensity. Besides, as there is a deadline of 5 months, the whole process might not take longer time.

Data Analysis:

As required by MARPOL Annex VI, Regulation 27.10, the IMO Secretariat creates an annual report summarizing the data on fuel oil consumption gathered through the DCS and it also states that the Organization's Secretary-General must report to the Marine Environment Protection Committee a summary of the data gathered, the status of missing data, and other important details[71].

2.1.2.1 Analysis of Data Collection System report from 2020-2022

After 2019, the first report for the fuel oil consumption data was submitted in the database of GISIS (Global Integrated Shipping Information System) under IMO in 2020. In this report, the fuel consumption data for 2020 was reported that based on the regulation 22A of MARPOL

[67] Resolution MEPC.346(78), (n 29)
[68] Resolution MEPC.328(76)' (n 20)
[69] ibid.
[70] ibid.
[71] ibid.

Annex VI which is regulation 27.3 of revised MARPOL Annex VI[72] 27,723 ships out of 32,558 ships were reported to GISIS which covers 85.1% of the total ships[73]. 203 million tonnes with slightly increased in use of LNG in comparison to 2019 was the fuel consumption that was reported, and the majority of fuel used was HFO (Heavy Fuel Oil), LFO (Light Fuel Oil), LNG, diesel which made 99.91% of total fuel used[74].

The second report of fuel oil consumption data of 2021, reporting period 1 January 2021 to 31 December 2021, submitted by 2 August 2022 in GISIS. In the report 28,171 ships were reported out of 32998 ships which covers 85.4% of the total number under 139 Administrations and 212 million tonnes of fuel was consumed compared to 2020[75]. The types of 99.89% fuel used in 2021 were HFO, LFO, LNG (Liquified Natural Gas) or diesel or gas oil but the use of LNG was increased compared to 2020 for bulk carriers, containerships and cruise passenger ships and majority of fuel oil was consumed by these three types of ships[76].

The 2022 fuel oil consumption data was published on 9 October 2023 by the International Maritime Organization (IMO) which is most recent data. According to the regulation 27.10 of MARPOL Annex VI, the Secretariat has prepared the summary of the fuel oil consumption of 2022 reporting year. In this data report 28834 ships were reported out of 33991 potential ships with a gross tonnage of 1289 million gross tonnage which covers 84.8% of the total number under 108 Administrations out of 135 administrations and 213 million tonnes of fuel was used compared to 2021 data report[77]. Category of fuel used for reporting year 2022 was either HFO, LFO or diesel or gas oil which was 94.65% and other category was 5.35%[78].

[72] Regulation 27.3 of revised MARPOR Annex VI says that within three months after the end of each calendar year, a ship will provide a report of the annual data of its energy consumption in the whole year to the Administration or any other organization authorized by the Administration via electronic communication.
[73] (MEPC 77/6/1 Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption, 20 August 2021)
https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC%2077-6-1%20-%202020%20report%20of%20fuel%20oil%20consumption%20data%20submitted%20to%20the%20IMO%20Ship%20Fuel%20Oil%20Consumption%20Database%20in%20GISIS.pdf
[74] ibid.
[75] (MEPC 79/6/1 Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption, 10 September 2022)
https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC%2079-6-1%20-%20Report%20of%20fuel%20oil%20consumption%20data%20submitted%20to%20the%20IMO%20Ship%20Fuel%20Oil%20ConsumptionDatabase...%20(Secretariat).pdf
[76] ibid.
[77] 'IMO Published the Report of Fuel Oil Consumption Data (2022)' (*Marine Regulations News*, 23 October 2023) <https://www.marineregulations.news/report-of-fuel-oil-consumption-data-submitted-to-the-imo-ship-fuel-oil-consumption-database-in-gisis-2022/> accessed 27 November 2023.
[78] ibid.

Table 3:Number of reported ships from 2020-2022

Year	Total ships	Party ships	Non-party ships
2020	32558	30319	2239
2021	32998	30799	2199
2022	33991		
Year	**Total reports**	**Party ships reports**	**Non-party ships reports**
2020	27723	26716	1007
2021	28171	27196	975
2022	28834	…..	……

In the verification of submitted data of 2020, it had been observed that 327 ships were with errors, 197 duplicate reporting where same data had been repeated several times, 69 ships were reported as hours underway, 94 ships were identified incorrectly and after the verification only 0.68% out of 217 ships were reported fuel consumption data in terms of the gross tonnage[79]. In the reporting year 2021, 313 ships were found with errors, 173 ships had duplicate reporting and 64 ships reported as hours underway[80]. And last but not least, reporting year 2022 verification shows, some fuel oil was reported incorrectly, such as VLSFO and LFO reported under 'others' fuels category where it was moved in the heavy fuel oil category in fourth IMO GHG study 2020 and biofuel was reported using 32 different names[81]. So, it's been seen that there is no accuracy in the submitted data. The reports are full of errors. The most important part is that wrong and duplicate information had been submitted in these reports.

2.1.2.2 Analysis of the CII reduction under DCS

According to data on fuel consumption from 2020-2022 reporting period, 99.89% fuels that has been used are- diesel/gas oil, heavy fuel oil, light fuel oil, and liquefied natural gas. In comparison to 2019, there was a significant increase in the use of LNG (liquefied natural gas) for bulk carriers, containerships, and cruise passenger ships and three EEDI ship types- Containerships, Bulk Carriers, and Tankers are responsible for most of the reported fuel oil consumption[82].

[79] MEPC 77/6/1 Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption, 20 August 2021, (n 73)
[80] MEPC 79/6/1 Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption, 10 September 2022, (n 75)
[81] 'IMO Published the Report of Fuel Oil Consumption Data (2022)' (n 77).
[82] MEPC 79/6/1 Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption, 10 September 2022, (n 75)

Figure 3: The consumed fuel oil report from 2019-2022 which illustrates each type of fuel consumed by all ships of 5000 GT[83]

The Figure 3 show that fuel had been decreased in 2020 compared to 2019 but that again increased by 2022 rather than going down. This proves that because of the covid outbreak in 2020 and its impact on the restriction in the ports, travelling from one place to another, decreasing trade interests, the less fuel consumption happened during that year which increased from the very next year. Though the use of HFO (Heavy Fuel Oil) has been decreased in compared to 2019 and the use of LFO (Light Fuel Oil) has increased. The Secretariat has been focusing on improving the IMO Ship Fuel Oil Consumption Database module in GISIS (Global Integrated Shipping Information System) in response to the identified data issues and also, the annual lists of missing ships falling under the jurisdiction of MARPOL Annex VI regulation 27 will be improved and sent them to RO (recognized organizations) so that they can quickly remove duplicate reports and update them[84].

A small number of ships were also misclassified in their EEDI ship type, particularly in the "Passenger ship" and 'other' categories. Administrations and recognized organizations have been invited to keep carefully checking the classification of ships before reporting and the Secretariat is updating the GISIS module to take ethane and biofuels into account which would make it easier to report these fuels to the GISIS module with the proper CF values[85]. The fuel consumption data report concludes by highlighting both areas that still require improvement and the progress made in the reporting process. This shows the practical implementation of the regulation 27 of the Annex and the types of fuel that has been changed in the shipping industry

[83] 'IMO Published the Report of Fuel Oil Consumption Data (2022)' (n 77).
[84] MEPC 79/6/1 Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption, 10 September 2022, (n 75)
[85] 'IMO Published the Report of Fuel Oil Consumption Data (2022)' (n 77).

which is Liquified Natural Gas (LNG). As LNG produces 40% less carbon, this data shows that the marine industry is using more clearer fossil fuel to improve the carbon emission. Another fact that Container ships, bulk carriers and tankers are more responsible to report data, these ships can be targeted for using more efficient energy and improve the emission. But LNG produces other harmful substances in the environment, so it is necessary to adopt more alternatives fuel such as biofuels and ethane which the current rules may not consider as it is hard for the shipping companies to use such fuels.

After 2018-1019 the Carbon intensity was reduced in a good percentage due to the covid outbreak that year because after 2020 the emission has been increased. Though there is no actual data available about how much carbon emission is reduced from the marine industry. But gathering other information and data in the hand, it can be seen that there has been 5% growth in the emissions in 2022 which bounced back from 2020 reduction of the emissions and are back now in the levels of 2017-2018 emissions[86].

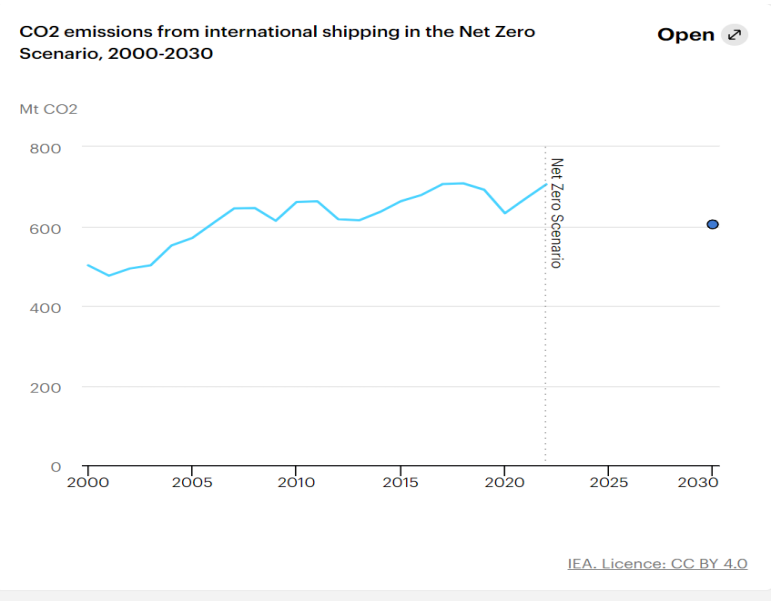


Figure 4: CO2 emission data chart which illustrates how much carbon emission has been produced from 2000-2030[87]

The Figure 4Figure 4 shows that in 2020, the carbon emission was 633 Mt which became 670Mt in 2021 and 706 Mt in 2022. It is visible that the emission is increasing again, and all the rules are no helping in cutting down the emissions. Because of the covid outbreak which created port closures, limited trade opportunities and restriction on the travel that year, the fuel consumption happened much less than other years, so the emission automatically decreased. But after everything came back in normal, the emission is increasing again, though it's not an outburst yet, reason may be the current war situation in Ukraine which making an effect.

[86] 'International Shipping' (*IEA*) <https://www.iea.org/energy-system/transport/international-shipping> accessed 27 November 2023.
[87] ibid.

2.1.3 Impact of smaller Ships on the Carbon Intensity and existing Regulations for smaller ships

The regulations of IMO have created a lot of directions for the shipping industry to cut down their carbon emission. These regulations cover every type of vessel and fuels. But the vessels with gross tonnage of 5000 or more are basically covers by these laws. Regulation 5.4 of the MARPOL Annex VI states that all the ships of 400gt and above must go under the survey that they are following the regulations of IMO[88]. The Ship Energy Efficiency Plan (SEEMP) also states that the ships of 400gt and above must follow the plan, in accordance with regulation 26 of MARPOL Annex VI[89]. SEEMP has three parts and of rules which all the ships to need to follow to get the efficient energy and part I has mentioned to all the ships of 400 gt and above to improve their energy efficiency[90]

The regulations of IMO regarding operational CII which comes into force from 1 January 2023, has made it mandatory for all the ships to calculate their Operational CII which includes the ships of 400 GT and above[91]. According to the UNCTAD Review of Maritime Transport (2022), the percentage of smaller ships in the global shipping fleet by deadweight tonnage is 10%[92]. In a recent statistics estimation model by OECD (Organisation for Economic Co-operation and Development) shows that around half of the total carbon emissions is emitted from the container and bulk carrier ships and other 1/5th is emitted from oil and LNG tankers[93]. The smaller types of ships such as cruise ships has very little impact on the total carbon emissions.

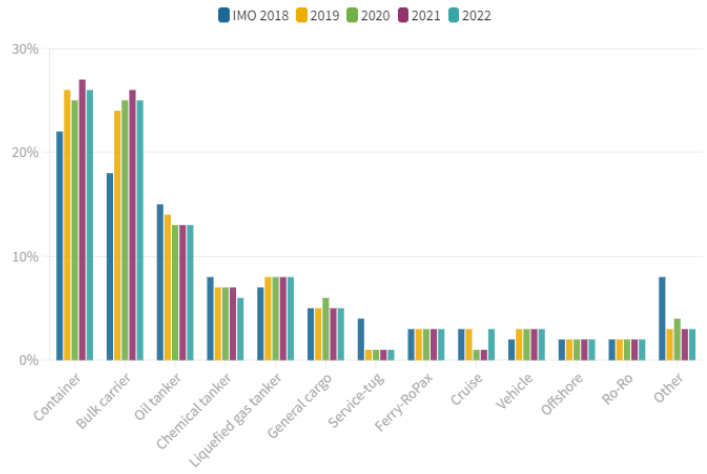


Figure 5: Different types of ships carbon emission statistics[94]

[88] Resolution MEPC.328(76)' (n 20)
[89] ibid.
[90] ibid.
[91] 'Rules on Ship Carbon Intensity and Rating System Enter into Force' (n 7).
[92] United Nations Conference on Trade and Development, 'Chapter 3: Decarbonizing Shipping' (2023) <https://unctad.org/system/files/official-document/rmt2023ch3_en.pdf> accessed 27 November 2023.
[93] Oecdstatistics, 'New Estimates Provide Insights on CO2 Emissions from Global Shipping' (15 June 2023) <https://oecdstatistics.blog/2023/06/15/new-estimates-provide-insights-on-co2-emissions-from-global-shipping/> accessed 1 December 2023.
[94] ibid.

Figure 5 shows smaller ships like cargo, cruise ship, ferry, RO-RO (Roll on/Roll off) and other types of ships has very little impact on the carbon emission. But this emission has cut during Covid pandemic as that time cruise and ferry types of ships had been affected by the restrictions. After the 2020, these ships emissions have reached up their before 2020 level.

Even though SEEMP and EEDI rules mention about 400 GT and above ships, the standards of CII don't meet here which may raise a number of difficulties. It might initially make smaller ships less bound to improve their energy efficiency and reduce their carbon emissions. If there is no regulatory pressure, shipowners might not consider these modifications. Secondly, there can be less knowledge regarding the carbon intensity and energy efficiency of smaller ships because they are not subject to reporting and monitoring requirements. Because of this, estimating the shipping sector's overall contribution to emissions of greenhouse gases and developing targeted plans for reducing these emissions are difficult. Smaller ships may also face competitive disadvantages if they are not bound by the same regulatory standards as larger ships of 5000GT and above. They might not be eligible for certain advantages, such as, the Administration provides to ships of 5000 GT and above with high CII ratings based on their annual operational CII data report. Smaller ships may find it more challenging to enter the market and to successfully compete because of this.

2.1.4 The division of responsibilities among the Administration body, shipping bodies, member states, flag states and port states

To reduce greenhouse gas emissions in the maritime industry, it is essential to establish and enforce the Carbon Intensity Indicators (CII) according to MARPOL Annex VI. In accordance with MARPOL Annex VI regulations 27.7 and 28.6, two key stakeholders- administrations and shipping bodies which include shipowners, seafarers, and ship operators, are responsible for ensuring the enforcement of these environmental requirements. Each has a specific role to play in this process[95].

Administration is a body who is the national or regional authority of the flag states, or an organization who is permitted by the national or regional maritime authority to become an authorised Administration body whose primary responsibilities are regulatory and administrative, ensuring that the specific information on ship fuel oil consumption is gathered, checked, and used to calculate operational carbon intensity ratings.2022 Guidelines for Administration Verification of Ship Fuel Oil Consumption Data and operational CII represents the regulation 27.7 of MARPOL Annex VI which requires the verification of the fuel oil consumption data by the Administration and regulation 28.6 of the Annex VI which requires the verified documentation of the attained annual operational CII compared to required operational CII to determine the CII rating[96]. Here, a legal issue can be raised that is it possible for a flag state who possesses the most important role of enforcing the regulations, to delegate

[95] Resolution MEPC.348(78)' (n 18)
[96] ibid.

away its responsibility to such an organization named as Administration. Though the flag states have the utmost responsibility, it may pass on some authorities to the Administration body verified under the regulations of IMO and MEPC for the verification of data provided by the ship operators, to develop the national laws of the flag states in relation with MARPOL under IMO and to put across them with ship owners and operators. As marine industry is a vast industry, one regulatory body cannot carry out every duty. Diving the parts of duty to Administration body by the flag state can make the long way of cutting down the emission of carbon sort of easy for the industry. This most recent guideline highlights the need of annual operational CII. The goal is to increase data accuracy and reliability while lowering expenses and burdens on ship entities and Administrations. Administrations are invited to take these recommendations into account when they develop and act national laws in accordance with MARPOL Annex VI's regulation 27 and 28 and they must also communicate these regulations to different maritime stakeholders, including shipowners, seafarers, and ship operators[97]. Besides, Regulation 28 of MARPOL Annex VI states the documentation and comparison of the annual operational CII that has been achieved with the annual operational CII that is required. The operational carbon intensity ratings A, B, C, D, or E are determined with the help of this procedure. Any organization that has been properly authorized by the Administration to do so to carry it out. By implementing this verification process, both the ship and the Administration reduce workload, save time and expense while they ensure that the data is accurate and reliable[98].

On the other hand, operational procedure, such as, monitoring the data of the annual operational carbon intensity, collecting the data, making the report from the data, and submitting the report, is the primary concern of the shipping bodies, such as shipowners, ship operators, masters, and seafarers. They are required to submit the exact data for validation under the data collection system for fuel oil consumption and the operational carbon intensity rating of ships. They are required to follow the established annual operational CII and are important in the process of calculating the operational carbon intensity rating.

The IMO established the 2022 Guidelines for the Development and Management of the IMO Ship Fuel Oil Consumption Database after understanding the importance of keeping track in the data management according to Regulation 27.13 of MARPOL Annex VI which is controlled by the Organization's Secretary-General, and this contains the data which is only used for analysis and consideration of the data[99]. As requested by the Committee, the IMO Secretary-General is responsible to submit an annual report at the beginning of each calendar year to the marine environment protection committee about the data gathered, the status of any missing data, and other important information in accordance with the regulation 27.10 of Annex VI[100]. While regulations provide the framework, active collaboration and engagement from all maritime stakeholders are essential to the success of achieving the goal of reduction

[97] ibid.
[98] ibid.
[99] (Resolution MEPC.349(78), 10 June 2022) https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.349(78).pdf
[100] ibid.

of emissions. The Maritime Protection Committee requests that Member States and international organizations adopt legislative, operational, technical, and economic measures to encourage the reduction of GHG emissions from ships[101]. The Member States are also invited to support the business of shipping industry, to encourage the cooperation between bunker suppliers, ports, and shipping companies and to promote the measures to cut the emissions[102].

Here, the flag states have the crucial role to enforce and implement the regulations of IMO because the flag states have the regulatory control, such as, applying the law and imposing penalties if the registered shipping entities do not follow the rules[103]. As the flag states are in charge of enforcing the regulations, they can impose the rules regarding the emission of carbon and usage of efficient energy on the ships that are registered under their jurisdiction[104]. The flag states are bound to make sure that ships registered under them use right amount of fuel and give the correct information in the annual data report about how much fuel they have used, and they can also offer benefits to the ship registered under them to cut their carbon emission and can provide better services as they can see the involvement of the business opportunity[105]. Though the flag states have the regulatory control, they already hold the responsibilities of carbon emissions increase from the maritime industry. The major flag states Liberia, Panama, and the Marshall Islands will be accounted for a third of carbon shipping emissions[106].

[101] (Resolution MEPC.366(79), 16 December 2022))
https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.366%2879%29.pdf
[102] ibid.
[103] 'Decarbonizing Shipping: What Role for Flag States? | UNCTAD' (24 March 2020) <https://unctad.org/news/decarbonizing-shipping-what-role-flag-states> accessed 27 November 2023.
[104] ibid.
[105] ibid.
[106] United Nations Conference on Trade and Development, *Review of Maritime Transport 2023* (2023) <https://unctad.org/system/files/official-document/rmt2023_en.pdf> accessed 27 November 2023.

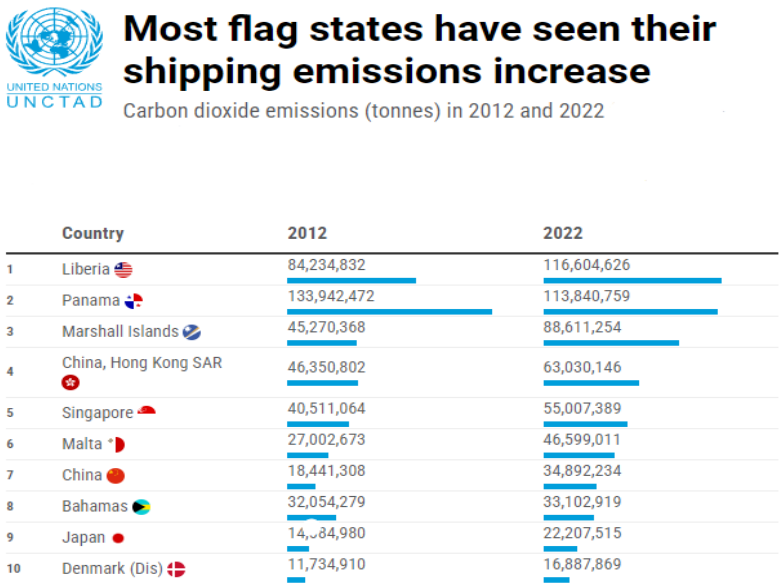


Figure 6 Ten flag states carbon emissions from shipping industry which shows the CO2 emissions in tonnes, and how it increased from 2012-2022[107].

From Figure 6, it can be understood that the CO_2 has increased over the past decade rapidly. The international shipping industry is responsible for 3% of the worldwide carbon emissions but if it goes like this it will be 130% in 2050 which will be unaffordable[108]. The regulations are here, and the revised regulations has also been published, but there is not slightly decrease in the carbon intensity of the marine industry.

Additionally, the Port State has the control on several procedures of the ships. Port State Control or the PSC is a right of port states which they exercise when a foreign ship enters into the ports of the port states, and they exercise this right to ensure that the ship meets the requirements of international safety, pollution, and other demands by inspecting the ship[109]. Although flag states and the owner of the ship have the primary responsibilities to ensure these requirements, PCS compliments this role by exercising their rights to catch the ships which does not fulfil the standard[110]. A PCS inspection process includes checking the documents and certificates of the ship which presents the condition survey of the ship[111].The PSCO (Port State Control Officer) has the clear ground to check the operational requirements during the Operational control inspection that the master and crew are familiar with the procedures of the protection of the environment and are able to apply such procedures during the travel time in the sea and during inspection, the PSCO should assess the ship to prevent pollution of the

[107] ibid.
[108] ibid.
[109] 'Port State Control | ClassNK - English' <https://www.classnk.or.jp/hp/en/info_service/psc/> accessed 27 November 2023.
[110] 'Port State Control' <https://www.imo.org/en/ourwork/msas/pages/portstatecontrol.aspx> accessed 27 November 2023.
[111] 'Port State Control | ClassNK - English' (n 109).

environment through its entire voyage[112]. Though these regulations don't clear the fact that this environment pollution covers carbon emission and fuel consumption, but port state has the control to detain the ships of all sizes if they do not follow the rules or fail to implement the rules[113]. But PSCO cannot alone detain the ship without informing the flag state unless there is a serious threat of harm made by the ship to the marine environment[114]. This ensures that as much ships as possible to be inspected but this is also time consuming which can create unnecessary delay[115]. To avoid this delay and multiple inspections in different ports, International Maritime Organization adopted resolution A.682 (72) which states that a ship going to a port in one country can visit other, so a coordinated inspection can be done which is more efficient and less time consuming[116] but this often leaves the gap of the information.

Though there are no straight mentioned penalties for not following the rules, the Port States can control to detain a ship and put any penalties for non-compliance not alone but discussing with the flag states, which may include negative operational outcomes, reputational harm, and legal consequences[117]. The purpose of the regulations may be defeated if the cost of non-compliance is sometimes considered a legitimate business expense. A comprehensive strategy is needed to effectively enforce GHG and carbon intensity regulations.

In conclusion, it is the responsibility of large number of entities in the marine industry to implement and maintain the Carbon Intensity Indicator. While governments and organizations involved with ships play the key responsibilities, all sectors in the maritime industry are important to accomplish these sustainability goals.

2.2. Conclusion

The main obligation of IMO is to reduce carbon emissions from the international marine industry. IMO has targeted at the 80th session of meeting at the Marine Environment Protection Committee to reduce 40% carbon emission by 2030 compared to 2008 and cut down fuel or energy consumption at least 5%, striving for 10% by 2030[118]. From 1 January 2023 it has made mandatory for all the ships to follow up the regulations and provide operational annual CII data which will be verified, documented, calculated, and based on that individual ships will be rated by CII rating A, B, C, D, E[119]. But throughout the upper discussion and analysis of the

[112] Maggie Tang, 'PROCEDURES FOR PORT STATE CONTROL, 2021'.
[113] ibid.
[114] ibid.
[115] 'Port State Control' (n 110).
[116] ibid.
[117] Tang (n 112).
[118] 'Revised GHG Reduction Strategy for Global Shipping Adopted' <https://www.imo.org/en/MediaCentre/PressBriefings/pages/Revised-GHG-reduction-strategy-for-global-shipping-adopted-.aspx> accessed 12 November 2023.
[119] 'Rules on Ship Carbon Intensity and Rating System Enter into Force' <https://www.imo.org/en/MediaCentre/PressBriefings/pages/CII-and-EEXI-entry-into-force.aspx> accessed 8 November 2023.

regulations, it is not ensured that the regulations are working actually in the marine industry. The fuel consumption has not yet been decreased which automatically increases the carbon footprint. The calculation of CII is complex method which can easily be calculated mathematically but there are certain other points like the routes each ship is following, operational variation among the ships, each ship's age (which meant how old or new the ship is), or the which technologies they are following matters which needs to be considered while calculating the annual operational CII.

3 Navigation of CII

3.1 Introduction

To response the immense pressure of acting for ongoing climate change, which was coming after the Paris Agreement, IMO established its GHG strategy in 2018[120] that has involved now to reduce the fuel consumption leading the reduction of carbon intensity from the international marine industry. But CII is such a complex term which needs every part of the marine sector to coordinate together to fulfil the target of reduced carbon and each factor such as routing, weather, technology, types of fuel, speed need to be measured. For example, a ship has been bought which is the most energy efficient and that may fulfil the term EEXI (energy efficiency index for existing ships) but if that most energy efficient ship is not used efficiently and not following the rules, speeding up, using every engine while traveling, it may end up with poor CII rating. And a ship has to follow up the rules every time it's traveling, otherwise it may end up with poor rating, for instance, a ship with CII rating C, does not follow or could not follow the rules because of certain circumstances for two years, it may end up with rating E and also may increase the carbon emissions unexpectedly. This part of the study will discuss whether a ship can stay compliant with CII and how different facts effect it.

3.1.1 Analysis of time charter and impact of the enforcement of CII

Since CII is introduced, critics are giving their voices concerning whether enforcing the regulations of CII under IMO have an actual reduction of carbon intensity or it will increase the emissions rather than decreasing it because of the twisted trading patterns. When a ship gets rating A to E for its annual operational CII value, it will automatically affect the commercial value of the ship which complexes the charter party contracts. CII regulations for the calculation to give CII rating (ignoring other factor such as route, weather, speed) may seem not intricated but CII is commercially complicated as it concerns how the ship is traded and it is the owner's responsibility to manage the ship's performance to attain the desired CII rating

[120] Elina Furustam, 'How to Navigate CII: What It Is and How You Can Stay Compliant' (*NAPA*, 19 October 2021) <https://www.napa.fi/how-to-navigate-cii-what-it-is-and-how-you-can-stay-compliant/> accessed 27 November 2023.

on a spot voyage[121]. If it is seen from a charter's point of view, the CII is an operational measure and it can be managed through efficient trading patterns, but the problem is that operational CII has other factors which needs to be held accounted such as, the design of the ship, gross tonnage, transport work, maintenance, technical performance, and types of fuel. If these terms are not taken in consideration, it will cause increased carbon emissions and also if they are not mentioned in the charter, it will arise a dispute eventually.

Under a time charter[122], the scenery is quite complex as the CII rating is retrospective, a ship on a time charter could be traded and used inefficiently which can cause an inferior CII rating and can put owner following the time charter in a stake of commercial disadvantages with poor rating[123]. As per tanker broker Gibson, CII will change the trading patterns and a ship could emit more carbon rather than decreasing while chasing for a better CII rating, for instance, a non eco which do shorter voyages will go for longer voyages to attain the required CII which would engage in more carbon emissions as cargo capacity, distance sailed also matter[124].

BIMCO has published CII time charter clause which provides a reasonable blueprint for the charter parties with the new CII regulations in practice and parties are encouraged to consider the facts about how the rules fits in their individual industry, their specific trading patterns, duration of the time charter agreement and commercial relation between the parties[125]. This clause outlines the agreement between the ship owners and charterers regarding the operational CII under the regulations of IMO. According to this clause[126],

- the parties of the time charter shall have a cooperative relation to collect, share and report on the daily data which may help in monitoring and assisting the ship acquire the required CII.
- In regards of the planning of voyages and selecting fuel types, the parties shall adjust the voyages or take an alternative voyage or take instructions from time to time for the direction of the voyages during the charter period.
- BIMCO recommends the parties to agree to the CII values that is inconsistent with the required CII or better.
- If the time charter agreement extends beyond 31 December 2026, the parties shall review the acquired CII compared to required CII from time to time in the end of each calendar year.
- The charterers are not entitled to adjust the speed, consumption, or RPM (revolutions per minute) going outside the safe operational limits.

[121] Sam Chambers, 'IMO's Carbon Intensity Indicator Comes in for Further Criticism' (*Splash247,* 12 September 2022) <https://splash247.com/imos-carbon-intensity-indicator-comes-in-for-further-criticism/> accessed 27 November 2023.
[122] Time charter is a contract which is given for specified period for the cargo space of a manned ship.
[123] Chambers (n 121).
[124] ibid.
[125] 'CII Operations Clause for Time Charter Parties 2022' (1 January 1AD) <https://www.bimco.org/contracts-and-clauses/bimco-clauses/current/cii-operations-clause-2022> accessed 28 November 2023.
[126] ibid.

- The owners shall operate the ship in such a way which minimizes the fuel consumption but of course, taking care of the ship's engines, hull and other equipment and ensure the best use of the ship's navigation equipment, weather routing, voyage optimization and monitoring system.
- The charterers shall ensure that there is no breach of contract such as the terms of bills of lading, waybills, or other documents.

Some of the biggest charterers of ships majority of which are the members of BIMCO and also owns ships have criticised time charter clause of BIMCO. They believe that both the owners and charterers are equally responsible for required operational CII, but BIMCO's CII charter clause unreasonably shifts the CII requirements to charterers only which does not secure the right balance between the charterers and the owners[127]. A group of 23 signatories conducted an open letter to BIMCO that the clause fell short of expectations and this clause is imbalanced and unusable that only transfers the most responsibilities to the charterers[128]. The charterers added that they are not shy to move away from their responsibilities towards the ship's operating efficiency and CII regulations, but they will not agree to the fact that they are hold responsible only whereas the owners are equally responsible, and this clause is keeping a hole for the owners to escape away from the losses. In the response to this criticism BIMCO said that all the positive and negative responses are invaluable for already published clause and there is a scope for better development in the future goals[129].

3.1.2 voyage planning with better routing

The target of the recent Revised GHG strategy 7th July 2023 for carbon emission reduction is 40% by 2030, compared to 2008 which is quite ambitious target, but it can be achieved if each and all factors are taken into consideration. Voyage optimization has been a primary factor of ship routing for decades and it can help the owners and operators in decarbonization. Voyage optimization is a factor which starts before the voyage starts and the vessel departs, and it can be continued throughout the voyages.

For voyage optimization, few steps can be considered which include the first factor which is the speed profile[130]. In the pre-stage of a voyage started, the charterers or freight traders needs to do the calculation of the expected sea margin which includes the weather, sea, current

[127] Nick Blenkey, 'Charterers to BIMCO: CII Clause Won't Work' (*Marine Log*, 22 December 2022) <https://www.marinelog.com/news/charterers-to-bimco-cii-clause-wont-work/> accessed 28 November 2023.
[128] 'BIMCO Responds To Criticism On CII Charter Clause | Ship Nerd' (22 December 2022) <https://shipnerdnews.com/bimco-responds-to-criticism-on-cii-charter-clause/> accessed 28 November 2023.
[129] ibid.
[130] Elina Furustam, 'Voyage Planning for MR Tankers - Achieving Average 15.9% Emission Savings with Better Routing!' (*NAPA*, 4 November 2020) <https://www.napa.fi/voyage-planning-for-mr-tankers-achieving-average-15-9-emission-savings-with-better-routing/> accessed 28 November 2023.

conditions and also, the best estimation of fuel consumption[131]. After that various routes will be available and taking into consideration of all the terms on the latest forecast or expected average condition of climate, the best route can be selected which resonates with the specifics of the ship and weather conditions and this pre-plan voyage optimization will help the ship to have the most efficient passage[132].To avoid the estimated time arrival (ETA), ships often sail faster at the beginning of a voyage and slowdown in the middle of the voyage[133]. Voyage optimization can predict the arrival time accurately which help the crew to meet their targeted ETA and keep a balanced speed profile.

The second factor is about the route which is taken in the first place that means except the case of extreme weather, maximum ships take the default route for the voyage[134]. Though it looks like an easy and simple planning for a voyage rather than planning the whole optimized voyage, the ships will miss out a lot of benefits of a planned optimized route and which can lead to increase the carbon emission. During the sea voyage, the optimum route can be updated in accordance with the latest weather forecast and any change can be recommended to the ship to keep a balance between distance, time, and consumption[135].

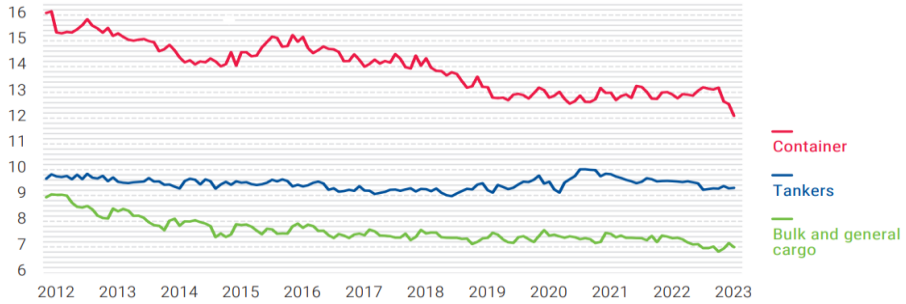
Sail faster in the beginning of the voyage started and then slow down in the middle for the arrival at the estimated arriving time can be seemed correct but this is a kind of paradox which means it feels like to be correct formula but it's not as fuel consumption has growing relation with the speed. Different speeds within and outside of the zone will emit more carbon than the constant speed which may produce less carbon if all other factors are considered[136].

3.1.3 Global fleet impact on Carbon Intensity Indicator (CII)

In the shipping market, the CII is affecting the sale & purchase (S&P) activity of ships by having an influence on the liquidity of the vessel[137]. Ships in band E which is the least efficient have less liquidity than ships in higher bands[138]. According to the CII bands, the frequency of transactions varied, such as, 10% or more cargo fleet was traded in 2022 and majority of these traded ships were band B rating ships which suggests that the market favours the compliance-

[131] 'Voyage Optimization and How It Can Help Decarbonization' (*StormGeo*, 13 June 2023) <https://www.stormgeo.com/products/s-suite/s-routing/articles/voyage-optimization-and-how-it-can-help-decarbonization/> accessed 28 November 2023.
[132] ibid.
[133] Furustam, 'Voyage Planning for MR Tankers - Achieving Average 15.9% Emission Savings with Better Routing!' (n 130).
[134] ibid.
[135] 'Voyage Optimization and How It Can Help Decarbonization' (n 131).
[136] Pierre Cariou and Ali Cheaitou, 'The Effectiveness of a European Speed Limit versus an International Bunker-Levy to Reduce CO2 Emissions from Container Shipping' (2012) 17 Transportation Research Part D: Transport and Environment 116.
[137] 'Carbon Intensity Indicator (CII): Global Fleet Impact Assessment | Hellenic Shipping News Worldwide' <https://www.hellenicshippingnews.com/carbon-intensity-indicator-cii-global-fleet-impact-assessment/> accessed 28 November 2023.
[138] ibid.

ready vessels[139]. Tanker's market showed the strong difference with CII band E and the tankers trading was particularly less may be because of the increased inspection and concerns about operating efficiency. But the world fleet of LNG carriers has expanded fast and close to 20% of existing fleet capacity[140]. Under this condition, some concerns have been raised that there will be a shortage of ships that follow the CII values and rules from 2025 to onwards which would limit the charterers options for compliant ships[141]. Also, carbon intensity varies from the types of ships, such as, a container ship emits more carbon per transport work than dry and liquid bulk shipping[142].



Source: UNCTAD, based on data provided by Marine Benchmark, July 2023.

Figure 7: World fleet of three main vessels per ton-mile which illustrates carbon emissions from 2012-2023 per ton-mile of these vessels[143]

Figure 7 shows that three types of main vessels have different levels of carbon emission and container ship has the most emissions than other two ships.

Old steam engine ships that are supposed to be powered by "Boil-Off" gas from their LNG cargo are a problem for the shipping industry because they don't work well. More than half of the current fleet might not be able to meet the future CII rates, even though newer ships with dual-fuel diesel-electric systems are more efficient. When CII tests get tougher after 2027, they might have an even bigger effect on older ships. This problem is a big problem for LNG as a temporary energy source in the process of lowering carbon emissions around the world. LNG needs to be used instead of coal to make electricity, but there may not be enough ships to carry it, and it costs a lot[144].

[139] ibid.
[140] 'LNG Fleet Seriously Exposed to CII Impact | LR' <https://www.lr.org/en/knowledge/insights-articles/lng-fleet-seriously-exposed-to-cii-impact/> accessed 28 November 2023.
[141] ibid.
[142] (n 92).
[143] ibid.
[144] 'LNG Fleet Seriously Exposed to CII Impact | LR' (n 140).

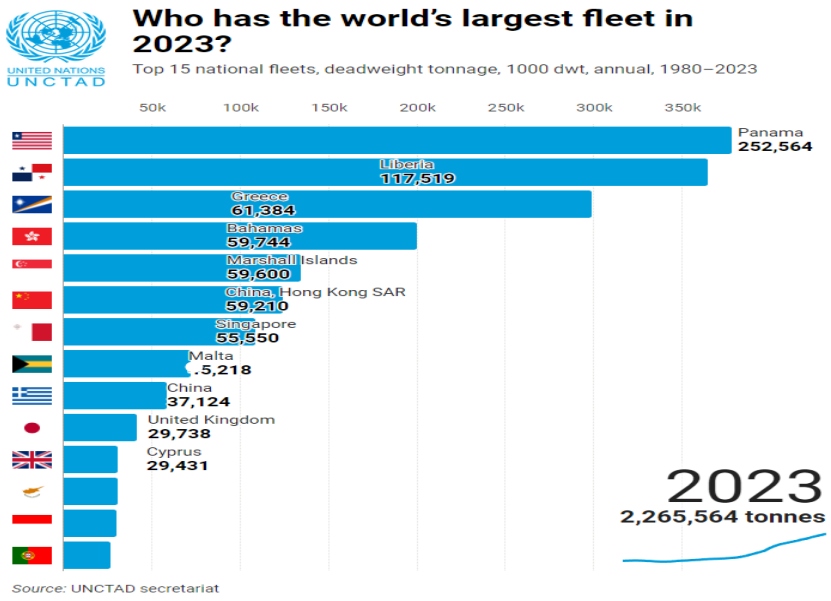


Figure 8 Bar chart from UNCTAD ranking the top 15 national fleets by DWT for 2023[145]

Figure 8 demonstrates the distribution of shipping capacity among different registered nationals which indicates the relative size of individual country's merchant fleet in comparison to their carrying capacity. Countries with larger fleets have a greater responsibility to enforce the CII regulations and requires investing in energy efficient improvements to improve their CII ratings[146].

3.1.4 Analysis of the recent regulations and their enforcement

MEPC 80 adopted on 7 July 2023 is the most recent regulations of IMO which gives an insight regarding 2023 IMO strategy on reduction of GHG emissions from ships[147]. This strategy provides the continuation work of IMO towards the reduction of emissions. The vision of this strategy is that IMO is committed to reducing emissions from the international shipping. The goals of this strategy are[148]-

- Reducing carbon intensity of the ships by improving the energy efficiency for new ships
- By 2030, reducing the CO_2 emission per transport work by at least 40% compared to 2008.
- By 2030, the use of fuel or energies by at least 10% and represent the sources of fuel or energy by 5%, and to use zero or nearly zero GHG technologies.

[145] (n 106).
[146] ibid.
[147] 'Revised GHG Reduction Strategy for Global Shipping Adopted' (n 118).
[148] ibid.

So, now the target is decarbonized shipping industry by 2050, reduction target of at least 20%, striving for 30% by 2030 and at least 70%, striving for 80% by 2040, and fuel use target of 10%, compared to 2008. All these targets are on a well-to-wheel[149] basis rather than tank-to-wheel[150] basis and the fuel production will come under greater observation[151]. Though IMO has provided the continued strategy of reducing emissions, but this is only a strategy and as this strategy again repeats what are the targets and what can be done for achieving the targets in the regulations, but it doesn't discuss how to implement and enforce these regulations in the practical sense. According to this recent strategy, IMO has agreed to take technical measures for the new ships and introduce a standard fuel use relates to GHG emissions[152] but the further discussion for implementation and enforcing are still in hold. MEPC 81 of Spring 2024 is the target to discuss the impact assessment.

Yet there is no discussion on establishing the regulations in practice, for example, the technical measures are still in the guidelines. These measures have not been enforced and implement in practice yet. The shipping industry is a vast industry, and targets regarding reducing emissions and use of energy from the industry need implementation in practice, not only discussion in the guidelines.

The MEPC has adopted LCA guideline or life cycle assessment guideline which target to end the GHG emissions from the fuel production a ship uses and also an interim guidance on the use of biofuel under the regulations of 26,27 and 28 of MARPOL Annex VI[153]. But yet MARPOL regulations do not recognize the reduction of carbon emission by the biofuels, so there are no benefits of the DCS strategy and operational CII observance[154]. Additionally, the issue regarding the flag states still remains the same, as they follow the regulations in different ways, and some follow the rules, and some does not follow [155] as there is no strict implementation and enforcement and no legal consequences.

But the implementation and enforcement of the regulations arises one question that what is this implementation, and the answer can be- the target is set, regulations are set and now it needs a clear and strict declaration for the shipping sector what they have to do in practice[156].

[149] Well-to-wheel- emissions from the full fuel life cycle.
[150] Tank-to-wheel- emissions within the vehicle.
[151] 'Which New Regulations Will Accompany IMO's Revised GHG Strategy? - DNV' (DNV GL) https://www.dnv.com/expert-story/maritime-impact/Which-new-regulations-will-accompany-IMOs-revised-GHG-strategy.html
[152] ibid.
[153] Patricia Santos, 'REDUCTION OF GHG EMISSIONS FROM SHIPS'.
[154] Which New Regulations Will Accompany IMO's Revised GHG Strategy? - DNV' (DNV GL) (n 145)
[155] ibid.
[156] ibid.

3.2 Conclusion

The targets to reduce carbon from the marine industry is highly ambitious as they concern about the practical implementation of the regulatory framework. The complexity of CII is that it possesses diverse factors and each and every factor is important while enforcing the rules. Following all the crucial factors and getting the targeted CII level is challenging. To overcome the challenges all types of vessels have to start using the factors effectively, such as, it is high time use weather-routing solution to avoid the possible resistance in the sea. The ships can sail slowly but they have to steady in the whole voyage, otherwise the emission can increase rather than decreasing, though speeding up at first, then sail slow and just-in-time rules has been quite complicated globally in the reality[157].

4 Results of the analysis

Carbon Intensity Indicator is an extensive term of GHG strategy under International Maritime Organization. According to the analysis of the regulations regarding annual operational CII, CII rating, Data Collection System annual report of fuel consumption data, several facts have come in the front. The calculation of annual operational CII may not seem complicated and after the end of the calendar year, the CII can be calculated by putting the capacity of the ship, distance travelled, transport work, type of fuel, total mass of the consumed fuel and the conversion factor of the total CO2 mass into the CII formula and result of the annual operational CII can be found after the calculation. But it's not that much easy as it seems. There are other main factors which have which impact on the ship while it's travelling in the sea, such as, route, weather, speed, or the age of the ship. Besides, different types of fuel have different impact on the calculation, different operational variation and technology used by individual ships also have impact on the calculation of CII. These facts have to be kept in mind before giving CII rating to the ships. But most of time, there can be a scope of space for intentionally or unintentionally skip these factors. The calculation cannot possibly be correct all the time. Though after end of a calendar year the CII calculation is important for giving the CII rating, for actual data after end of the calendar year 2023 and based on that CII ratings from A to E presented to ships is not possible from these estimates.

[157] Elina Furustam, 'How to Navigate CII: What It Is and How You Can Stay Compliant' (*NAPA*, 19 October 2021) <https://www.napa.fi/how-to-navigate-cii-what-it-is-and-how-you-can-stay-compliant/> accessed 1 December 2023.

The demand-based and supply based data has scarcity in the past years. In Table 2 reduction factor is given relative to 2019 as the reference line, which just provide a percentage of how much carbon emissions will be reduced. But according to the data on fuel consumption from 2020-2022, there is not any significant reduction. On the other hand, the emission has increased rather than decreasing. Data Collection System report from 2020-2022 has also shown that several duplicate information was reported, several ships were reported with errors, some ships were identified with errors, some were under hours away. This is happening because shipping industry is a vast industry, and it is quite impossible to get every information properly and without errors. Besides, the regulations of IMO have not still been followed properly. The regulations are right there but they are not strictly enforced yet.

From Figure 4, it can be seen that carbon emissions were reduced in the year 2020. In 2020, because of covid out-brake and port closures, limited trade opportunities and restriction on the travel, the consumption of fuel was automatically decreased. Due to that carbon intensity also reduced that year. But it has increased the very next years 2021 and 2022 when everything came back to normal situation. And this provides the fact if fuel consumption reduces, the carbon footprint automatically decreases, and the ships can be provided with better routing.

In a Poll about a question that is the shipping doing enough to curb the carbon emissions, it's been seen that still Ship Technology Readers believe the fact that the industry is not doing enough to reduce the carbon emissions and out of 1337 respondents to the poll 58.71% which is 785 declared that they thought the shipping sector is not doing enough to curb the emissions, while only 246 or 18.40% acknowledged the sector's efforts and the remaining 206 or 22.89% were uncertain[158].A study published by the University Maritime Advisory Services (UMAS) and Energy Transitions Commission (ETC) revealed that the shipping industry will have to invest at least $1tn in the shipping industry to meet the carbon reduction target set by IMO[159]. The study further said that $400bn will be required further to fully decarbonize the sector.

There is no available present data which shows how much CII target has been achieved and how much the regulations of IMO have set the impact on the reduction. It is developing year by year and though the regulations of IMO regarding operational CII and energy efficiency are not strictly enforced, they are not mere rules because the rules are already in field and the industry is trying to follow them.

[158] Adele Berti, 'Poll: Is the Shipping Industry Doing Enough to Curb Carbon Emissions?' (*Ship Technology*, 3 April 2020) <https://www.ship-technology.com/features/shipping-carbon-emissions/> accessed 28 November 2023.

[159] Varsha Saraogi, 'Decarbonising the Maritime Industry Will Cost $1tn, Study Says' (*Ship Technology*, 20 January 2020) <https://www.ship-technology.com/news/decarbonisation-in-shipping/> accessed 28 November 2023.

5 Final remarks

Though the goal to reduce Carbon emissions and fuel consumption in the global shipping industry is highly challenging and difficult, but it is necessary to control the emissions and consumption to have the contribution in saving the global climate. The main purpose of this thesis was to present the existing IMO's regulations of Carbon Intensity Indicator (CII) and their critical legal analysis towards the reduction of carbon emission and the fuel consumption to have control over the GHG emissions.

Regulations of MARPOL Annex VI of IMO have particularly contributed on controlling, regulating, and enforcing the rules of Carbon Intensity Indicator (CII) for reducing the emission and consumption. IMO has constantly worked in reducing the carbon footprints of the international shipping and to have a sustainable future. The regulations of MARPOL Annex VI regarding CII have imposed the responsibility on the ship operators and owners to work on their annual carbon intensity which can either increase their CII rating or lower their rating and having the higher or lower CII rating can decide the contribution of the ships in the process of carbon reduction and more usage of efficient energy in the shipping business. The existing regulations of MARPOL Annex VI; the resolutions of Maritime Environment Protection Committee (MEPC) have speed up the development of using efficient energy to emit less carbon which may include adapting energy-efficient technologies or using alternative fuels.

Though these regulations have established the standard of lowering the carbon footprints from the global shipping industry, there are some potential gaps in these standard that limitations with enforcement; contradiction with different ways of enforcing the rules in different member states; measures like using alternative fuel has its own perks, such as, using electricity as an alternate depends on the type of the ship, how it is made, and it's infrastructure; and not having any clear legal consequences which the ship may face if it doesn't follow the rules. This paper has searched the answer through the regulations that whether they are enforced in the real maritime industry and the industry has followed the rules and reduced their emissions or the regulations are just rules waiting yet to be enforced.

Finally, the path to have a carbon-free shipping industry is full of complications and challenges. But IMO is determined to the goal of reducing the carbon emission and using efficient energy. IMO has invited the countries to come together and work on implementing the rules. The thesis has explored that with the existing rules, their implementation, and the results derived from that.

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