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IN SEARCH OF MARITIME SUPPLY CHAIN DECARBONIZATION

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Abstract

European transport has been a catalyst for economic development for centuries. It promotes exchanges between European Union (EU) member states and many other countries worldwide. Sea shipping is the backbone of international exchange and carries about 90 per cent of the total tons traded. Therefore, it accounts for 2.5% of its greenhouse gas emissions. Efforts to reduce the environmental impact of transportation activities focus on better modal integration of common transportation systems, sustainability, green technology in the transportation sector, resource efficiency, and reduction of CO2 emissions. The International Maritime Organization has assigned its members to reduce CO2 emissions by 70% by 2050 or eliminate them. Maritime can apply technologies to reduce emissions to zero or significantly reduce emissions in the shipping sector from a business perspective. This paper aims to assess the essential way to deal with the decarbonization interaction in light of EU vital reports and low-emanation and zero-discharge innovations utilized and created in ocean transport. By assessing the outer expenses caused via ocean delivery, you can evaluate the advantages of applying the advancements and elective energizes proposed in the arrangement.

Because of the outcomes acquired from outside cost evaluations, it will be feasible to gauge the potential for decarbonization in sea shipping.

Keywords: Decarbonization, Maritime Transport, sea shipping, Biofuels, HFO

1. Introduction

The world is covered three-fourths by water and one-fourth by the land from the global aspect. Most of the country in this world is covered by sea except some landlocked countries. About90 per cent of our world economy depends on maritime transport. Maritime supply chain management is crucial for national and international economies if we consider the global aspect. The maritime supply chain consists of a few steps as follows: picking up the goods from the manufacturer, getting goods to the main port by feeder's vessel, and then docking the destination, and distribution of goods by the lorry or the train to the importer by following various modal systems. The maritime supply chain needs to be formulated by innovative, strategic, customer-oriented efforts counteracting uncertainty to sustain competitive intermodal and multimodal maritime transportation systems. In modern days short sea shipping is a significant part of the multimodal or intermodal transportation system. Most continents are very familiar with short sea shipping, an integrated multimodal logistics system, especially European water. Therefore, better maritime logistical strategies are essential to integrate short sea shipping's greater part of maritime transportation. Besides, shortest shipping has become a trend where green logistics is the most important factor for concerned parties and is necessary to identify the attributes and analysis of the modal system. Green supply chain management is significantly important for the society to contribute to the economy and the Environment of a country in which unlimited important factor lies research and development more and more day by day.

The maritime industry is the vital link between sea and land and significantly impacts global supply chain management in the maritime domain or cluster. Maritime shipping is the main component of the world economy, representing 90 per cent of international trade. It has been reported in the IMO Third GHG Study 2014; that CO2emissions from global delivery radiated around 2.2 per cent of all-out anthropogenic (caused by human movement) CO2 outflows in 2012. UNCTAD gauges the World Ocean conceived exchange volumes at 10.7 billion tons in 2017 and starting around January 1 2018, there were 94,171 boats, with a consolidated weight of 1.92 billion deadweights (dwt) on the planet's vendor armadas (UNCTAD, 2019). For impetus and everyday activity, million tons of petroleum products are consumed by marine diesel motors of these vendor's vessels and produces Carbon Dioxide(CO2), Carbon Monoxide(CO), Nitrogen Monoxide(NO), Nitrogen Dioxide(NO2), Sulphur Dioxide (SO2, etc. which cause air contamination, a dangerous atmospheric deviation and other ecological harm. CO2 is one of the greenhouse gases(GHGs)and the fundamental variables of worldwide warming, climatechange, and ocean fermentation. Expanding earth's temperature has been causing the softening of polar ice caps, flooding of low-lying territories, and incrementing the degree of seawater. A worldwide temperature alteration and environmental change have transformed into a consuming issue in the current world. The Paris Agreement commits countries to forestall a climb in worldwide temperatures well beneath two °C above pre-modern levels and attempt to diminish the ascent to 1.5°C. Noticing current information, the World Meteorological Organization assumes an ascent of the typical worldwide temperature of 3-5°C constantly in 2100. Over the last decade, emissions from the shipping industry have continued to attract attention worldwide because of the environmental contributions of greenhouse gas emissions and the growing awareness of the adverse health effects of pollutant emissions. Rice field. Combustion of byproduct fossil fuels from transport. The entire shipping industry is now under regulatory and financial pressure to reduce energy consumption and environmental impact. In April 2018, the International

Maritime Organization (IMO) passed a resolution on a new strategy to reduce greenhouse gas emissions from ships. The strategy envisions a 50% reduction in total greenhouse gas (GHG) emissions from international transport by 2050 compared to 2008 levels. MARPOL Convention is supplemented by Annex VI with new regulations on the prevention of air pollution by ships. Energy efficiency requirements are included in Chapter 4 to ensure CO2 emission commitments for the design and construction of new vessels and the operation of all new and existing merchant vessels.

To deal with the decrease in CO2 gas emissions from international shipping, the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) standards went into effect on January 1, 2013 (IMO, 2011). According to the SEEMP, shipping companies must now design, implement, monitor, and self-evaluate possible technological and operational energy efficiency solutions. The EEDI establishes design restrictions for new ships, but the SEEMP aims to continuously enhance vessel performance by increasing energy efficiency. The SEEMP is required for all ships, including non-transport boats such as working vessels, whereas the current EEDI approach only covers cargo ships. The laws do not apply to specialist vessels, such as offshore supply vessels. Because such vessels' propulsion type, speed, and activities change during operation, it can be difficult to specify a fixed design point.

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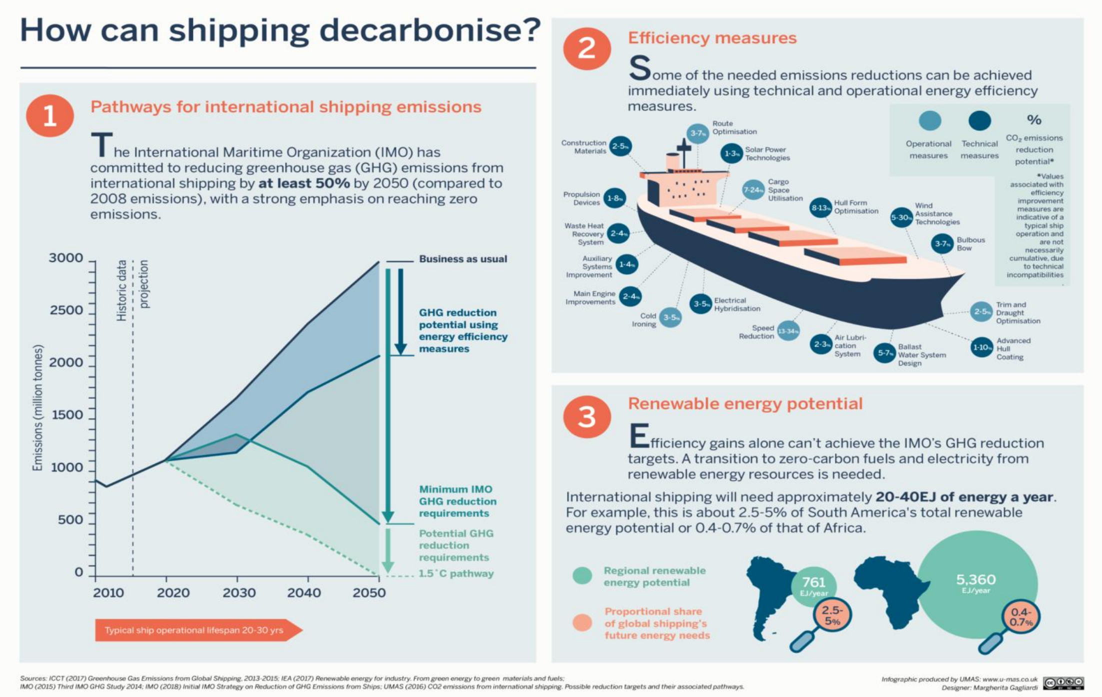


How can shipping decarbonise?

1 Pathways for international shipping emissions

The International Maritime Organization (IMO) has committed to reducing greenhouse gas (GHG) emissions from international shipping by **at least 50%** by 2050 (compared to 2008 emissions), with a strong emphasis on reaching zero emissions.

2 Efficiency measures

Some of the needed emissions reductions can be achieved immediately using technical and operational energy efficiency measures.

3 Renewable energy potential

Efficiency gains alone can't achieve the IMO's GHG reduction targets. A transition to zero-carbon fuels and electricity from renewable energy resources is needed.

International shipping will need approximately **20-40EJ of energy a year**. For example, this is about 2.5-5% of South America's total renewable energy potential or 0.4-0.7% of that of Africa.

Sources: ICCT (2017) Greenhouse Gas Emissions from Global Shipping, 2013-2015; IEA (2017) Renewable energy for industry. From green energy to green materials and fuels; IMO (2015) Third IMO GHG Study 2014; IMO (2018) Initial IMO Strategy on Reduction of GHG Emissions from Ships; UMAS (2016) CO2 emissions from international shipping. Possible reduction targets and their associated pathways.

Infographic produced by UMAS: www.u-mas.co.uk
Designer: Margherita Gagliardi

Figure 1: Process of de-carbonization

2. Comparison between HFO, LNG and Biofuels

➢ Heavy Fuel Oil (HFO)

HFO and MGO, produced from refinery crude oil, are the most commonly used marine fuels. Compared to other transportation fuels such as aeroplanes and roads, these fuels are often inferior in quality and therefore cheaper. Large vessels travelling between the EU and the United States can consume up to 140-150 tonnes per day, while very large vessels consume 200-250 tonnes per day. Similarly, the world's largest container vessels can use up to 16 tonnes of fuel per hour, for 380 tonnes per day. Oil businesses and shipping companies are affected by the IMO2020 and IMO2050 standards planned to control greenhouse gas emissions from the shipping industry. For example, IMO 2020 allows vessels to consume HFO only if equipped with scrubbers or other equivalent techniques. As a result, global demand for HFOs will be below. According to a CE Delft study, by 2020, approximately 4000 of 17 vessels will be equipped with scrubbers, which underpinned the IMO's decision-making process. Analysis revealed that after the implementation of IMO 2020, only HFOs accounted for 6% of the fuel mix, and by January 2019, 2800 vessels had scrubbers installed or ordered.

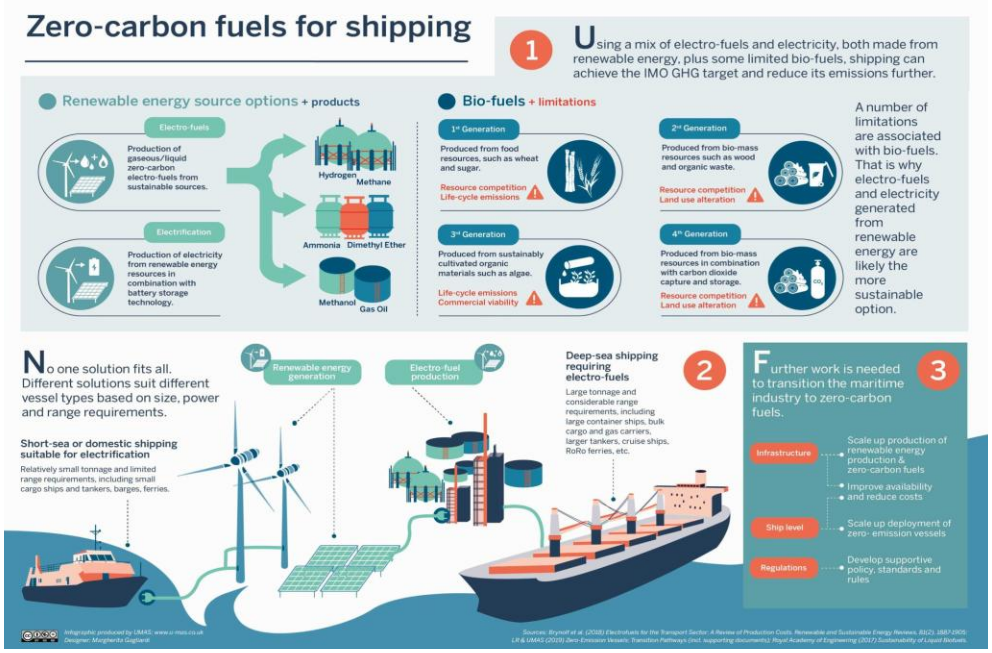
- **Liquefied Natural Gas (LNG)**

As a result of the changing business environment, the maritime sector is increasingly turning to Liquefied Natural Gas (LNG) (LNG). Liquefied Natural Gas has been commercially viable and available for many years (DNV GL, 2019). A modest number of LNG-powered ships were recently built and brought to the market in 2010. (IEA Bioenergy, 2017). Qatar has become the world's largest LNG exporter, meeting the needs of 1/3 of the world's economies and local communities (QatarGas, 2019). More countries have begun to produce LNG throughout the years, and Australia recently overtook Qatar in output (Jaganathan, 2018). Australia generated 6.5 million tonnes of LNG for export in November 2018, compared to 6.2 million tonnes for Qatar (Jaganathan, 2018). However, because LNG is a relatively new maritime fuel, access to bunkering stations is limited, and ports must yet develop the requisite storage facilities to enable LNG use (IEA Bioenergy, 2017). LNG is an environmentally friendly fuel for low-carbon transportation since it emits less CO2 than distillate and residual fuels. In other words, LNG is a viable choice for meeting the forthcoming emission standards for the major categories. Analysts predict that demand for LNG will increase shortly due to its low sulfur content and its ability to absorb more energy per ton (IEA Bioenergy, 2017).

Nonetheless, environmentalists and other industry stakeholders claim that LNG production causes methane leaks, one of the most well-known greenhouse gases (Gordon, 2018). .. As a result, it can be argued that LNG does not address its dependence on climate change and does not help mitigate the effects of climate change. The use of LNG does not require the construction of new processing techniques from an infrastructure perspective. However, compared to common heavy oil storage tanks, cryogenic storage containers designed for inboard LNG transport and storage consume more DWT and require additional safety measures.

- **Biofuels**

Given that LNG is dependent on fossil fuels, biofuels can be an important part of the marine industry's fuel mix. Biofuels are made from biomass, a renewable resource that does not contain sulfur (IEA Bioenergy, 2017). As a result, biofuels are expected to reduce the shipping industry's reliance on fossil fuels and reduce greenhouse gas emissions by at least 50% by 2050. The main reason shipping companies study biofuels is that biomass burning is "carbon neutral" throughout its life cycle, as it emits the same amount of CO2 as the plants absorbed during its growth. The ability of biofuels to reduce emissions is production method dependent (DNV GL, 2019). Biofuels are made from naturally renewable resources such as animal fat waste, plant sugars, oils and terpenes (IEA Bioenergy, 2017). Biofuels are produced commercially around the world. However, most biofuel research has focused on either road-based mobility or power generation, so the maritime industry has not yet gained biofuel experience. Biofuel production also causes other socio-economic problems such as land use and hunger. From an operational perspective, it is conceivable to produce biofuels on existing infrastructure to save money adapting it.



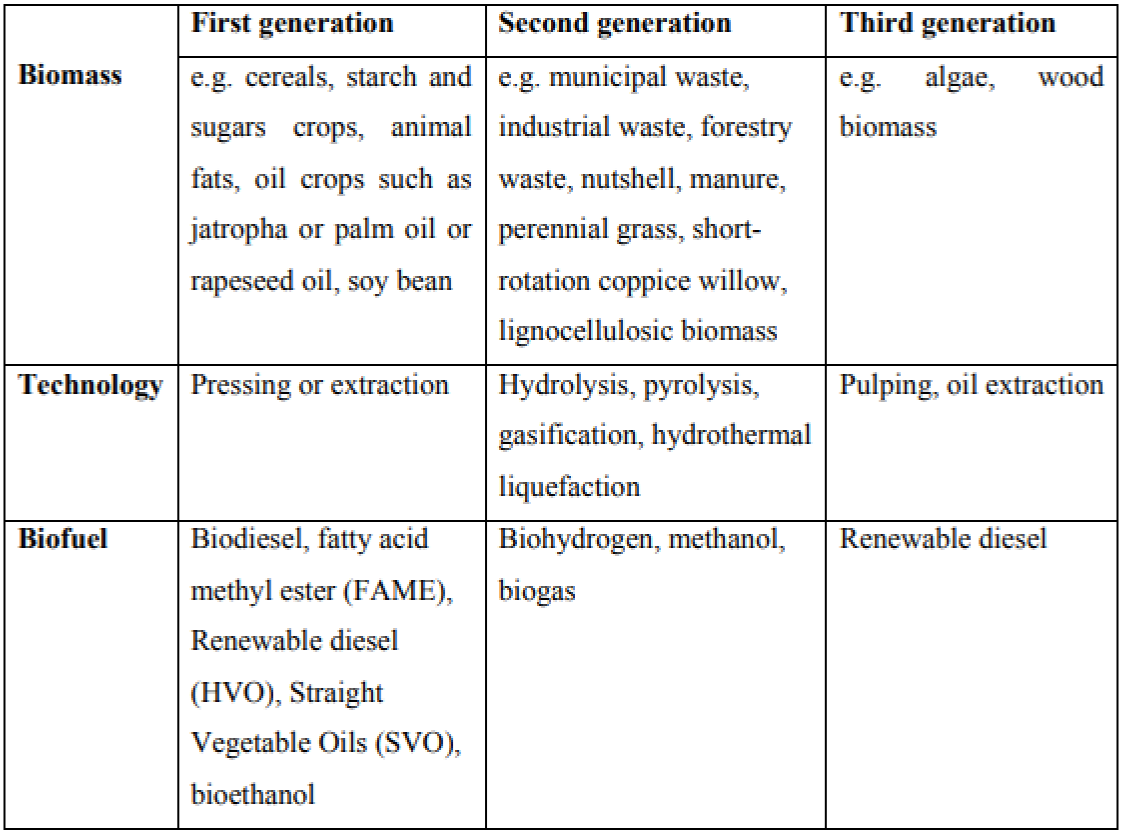
Fugure :2.1 Example of fuel process:

3. Strategic option for shipping companies

Shipping firms must balance the three pillars of sustainability: social, economic, and environmental, to adapt to changing conditions (Purvis, Mao, &Robinson, 2019). Climate change will greatly impact businesses and supply chains if nothing is done. Changes in manufacturing schedule, location, and access to distribution channels and customers are possible outcomes (Linnenluecke & Griffiths, 2015). Increasing the energy efficiency of ships, using renewable energy on board, or using cleaner alternative fuels are all adaptation options for the shipping industry to meet the Paris Agreement targets and contribute to the reduction of GHG emissions targets by 2050 (lçer, Kitada, Dalaklis, & Ballini, 2018). The usage of cleaner alternative fuels is explored as a strategic adaptation option in the following dissertation. According to major research, alternative fuels are advancing for two main reasons. First, reduce pollution and greenhouse gas emissions. Second, reduce the impact of climate change while complying with the law. Based on the comparison in Table 4 and the ultimate goal of decarbonizing the global supply chain, biofuels appear to be the most viable option. Biofuels have sustainable and renewable properties, biodegradability, abundant local supply, potential to create more agricultural jobs, contribution to local economic development, and capacity to reduce greenhouse gas emissions. Because of this, it is certainly preferred over fossil fuels.

Biofuels are plant-based products that were first developed in the 19th century. The first Rudolf Diesel engine, powered by peanut oil and boasting 75% efficiency, was built in 1897. Plant-based oil was considered a viable transport fuel until the 1940s, but the fast-growing fossil fuel refining sector, coupled with falling prices, has hampered biofuel research and development. Biofuels can be divided into different generations based on the biomass used and production method. (1) It comes from crops such as grains and oilseeds, leading to discussions about competition with other sectors. (2) From lignocellulosic materials such as waste. This avoids competition with other sectors, but it is not without challenges. (3) From algal biomass (Bengtsson, Friedll & Andersson, 2012). Table 2 summarizes the different biofuel classifications.

Table.2: Generations of biofuels



	First generation	Second generation	Third generation
Biomass	e.g. cereals, starch and sugars crops, animal fats, oil crops such as jatropha or palm oil or rapeseed oil, soy bean	e.g. municipal waste, industrial waste, forestry waste, nutshell, manure, perennial grass, short-rotation coppice willow, lignocellulosic biomass	e.g. algae, wood biomass
Technology	Pressing or extraction	Hydrolysis, pyrolysis, gasification, hydrothermal liquefaction	Pulping, oil extraction
Biofuel	Biodiesel, fatty acid methyl ester (FAME), Renewable diesel (HVO), Straight Vegetable Oils (SVO), bioethanol	Biohydrogen, methanol, biogas	Renewable diesel

4. Method

Calculating the external costs of carbon reduction is important to unleash the potential for decarburization of the marine sector. External cost ideas can help you apply full cost accounting. A table containing basic quantitative and qualitative data on world shipping [fleet size, deadweight tonnage (DWT), gross register tonnage, main engine power, commercial ship generator power, etc. I have created a data set in the format. The results are compared to average fuel economy data at key engine loads with MCR = 0.85. For simplicity, average speed and fuel consumption numbers correlate with engine type. Three major marine fuels were considered: heavy oil(HFO), light marine oil (MGO), and liquefied natural gas (LNG).

The data was then entered into an external cost calculator created for the "Eco Bonus" project. The calculator calculates the external cost of shipping compared to vehicle transportation at a specified distance per cargo unit on a running meter. This parameter was related to the carrying capacity of this study. Variable cruising speed, a non-linear function of fuel consumption as a function of speed, standard CO2 emission index for selected fuel type, the standard external cost for sea transport (i.e. € 187.00 / tCO2), and standard external cost for road transport (i.e.). , € 0.10 / km noise, 0.21 € / km accident, 0.19 € / km congestion) belonged to the input data of the computer. CO2 emission costs have been calculated in several modes of transport, starting at 15 knots and ending at 17, 19, and 21 knots, as the most realistic speed of modern sea shipping. According to the author, this calculator uses an expanded fuel consumption index for 217 g / kWh energy efficiency, so there is a serious error. To compensate for the unrealistic speed, the value was replaced with 180 g / kWh (17 per cent lower). Due to the overestimation of gas consumption, the previous figures have inflated external spending. Another drawback is the limited variety of fuels available.

5. Results

➢ Strategic Approach to Low- and Zero-Emission Technology

"Strategy for Smart and Sustainable Development for Social Inclusion" and "White Paper: Plan to Create Harmonious European Transportation Areas-Competitive Energy Efficiency" adopted in March 2010 "Towards a Higher Transportation System" laid the foundation for today's development. European transport policy. It is recognized that promoting the sustainable development of sea shipping involves carbon emissions, with a particular focus on laws and documents related to sea shipping emissions. The International Convention for the Preven+tion of Pollution by Ships-MARPOL 73/78-is in resolving this issue. Decreasing CO2 outflows from ships are tended to in Annex VI of the

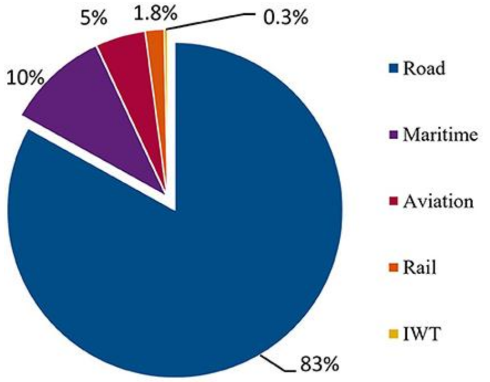
MARPOL Convention. In this way, assuming CO2 discharges are an immediate aftereffect of fuel utilization and are accordingly the sort of innovation and motor utilized in the boat, the pertinent guidelines are connected with the energy productivity of the boat motor for recently planned vessels with more than 400 enrolled weight (RT) and a wide range of drive aside from LNG, EEDI and the useful energy proficiency pointer (EEOI) for vessels currently in assistance. In 2011, guidelines were acquainted that force commitments to take on the executive's proficiency plans energy. EDI is a hypothetical number that shows future effectiveness, and EEOI is a genuine proportion of CO2 outflows evaluated under unambiguous journey and administration conditions for a specific vessel.

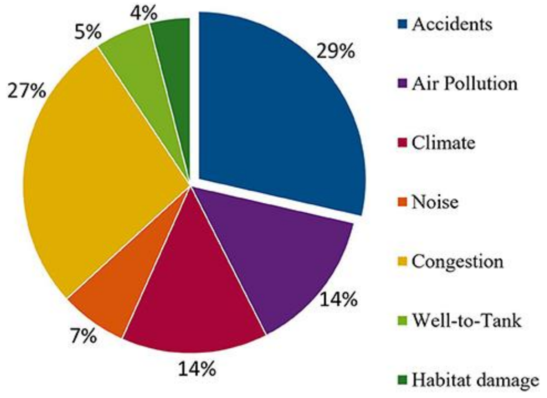
The viability of EEDI techniques is a disputed matter. As indicated by Ani and Estan's (2015) research, diminishing CO2 through these methodologies will be more straightforward than anticipated, suggesting that the degree of the decrease would almost certainly outperform expectations. Other examination stirs up misgivings about the chance of additional CO2 decreases, especially in Unpowered ships, since boats now under development with this drive will be moved by a double fuel motor that will consent to the EEDI limitations. Without a doubt, the IMO goal expresses that just executing the EEDI, and in this way other boat administration boundary pointers, wouldn't do the trick and that it will be important to advertise the training (i.e., align it with transportation practice) and, undeniably, mechanical limit. The IMO's long-term objectives are illustrated in the review "Introductory system on decreasing GHG outflows from ships," which was recently distributed. IMO Resolution MEPC.304 (72), which laid out EEDI as a device for decreasing ozone-depleting substance emanations from global transportation, was the primary worldwide regulation ordered after the United Nations on Climate Change was approved. It is important. Accordingly, the transportation business should be visible as attempting to accomplish the Sustainable Development Goals and lessen ozone harming substance emanations.

- **Estimation of External Costs in EU Transport**

Concerns about the environmental implications of maritime transportation have grown in the previous decade. This is because the predicted increase in the volume of ship movements will surpass the total impacts despite the higher environmental performance. The discrepancy between societal and private transportation expenditures is external transportation costs. Those expenses are caused when one gathering's social or financial exercises affect another gathering, and the effect isn't represented or repaid by the primary gathering. This is because of an absence of market motivators for transportation clients to consider outside costs while pursuing transportation choices. Outer expenses have been the focal point of transportation research starting around 1995. This trend in Europe corresponds to the tendency of politicians to internalize externalities in the price regulation of transportation. The updated External Transportation Costs Guide has calculated the total external transportation costs for the EU Member States (MS) in 2016.

External costs for road, rail, inland waterways, air and sea shipping (excluding congestion costs not assessed in all modes of transport) total € 71 billion, or 4.8% of the GDP of member countries. Very few airports and ports calculate the external costs of air and sea shipping in detail. Sea shipping (50% to origin and 50% to destination) is estimated at € 44 billion for all transport to and from 34 EU ports and with all EU ports. All traffic between them is estimated at € 98 billion. .. Figure 1 shows the percentage of each method and cost category in the total external transportation costs of MS in 2016.



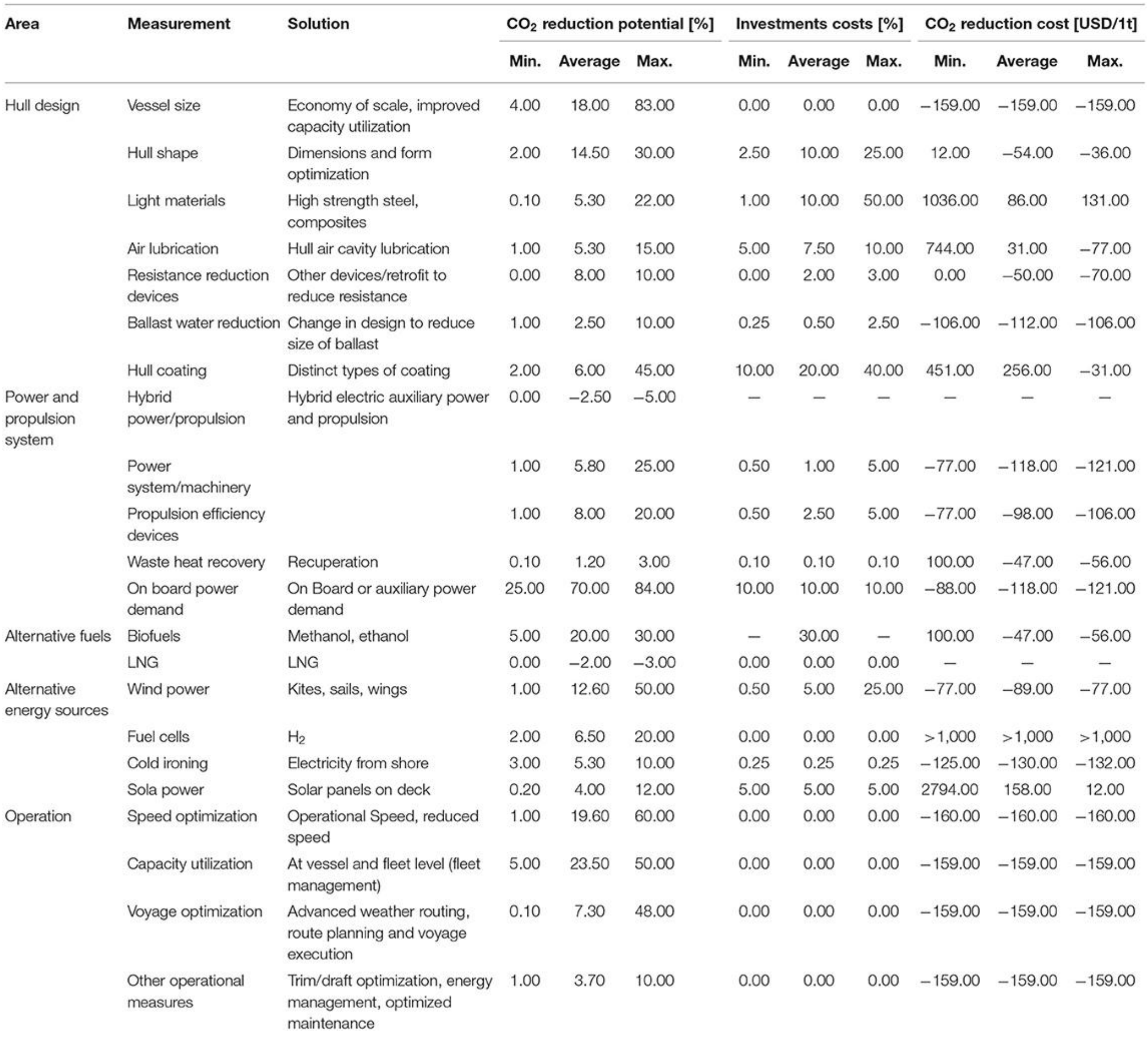


In the most common mode of transport, the external cost is much higher (83% of the total cost). Sea shipping accounts for 10% of the cost, air transport accounts for 5%, rail transportation accounts for 1.8%, and inland waterways account for 0.3%. All outer transportation expenses can be partitioned, with 69% for traveller transportation and 31% for cargo transportation (i.e., including light business vehicles). Mishap costs are the main expense class, representing 29% of all-out costs, trailed by blockage (27%). Environmental change and air contamination costs represent 14% of the aggregate, clamour costs represent 7%, and natural surroundings obliteration represents 4%. Environmental change and air contamination are the two biggest spending areas of ocean delivery. The complete climatic expense of transportation is determined to be € 24 billion in light of transportation execution to guarantee consistency with other transportation modes and cost classifications. The peripheral expense of environmental change must be equivalent to the typical expense. This is because the normal and minimal Environment discharges of vehicles per km are something similar. Since CO2 is disseminated in the climate, the extra kilograms of CO2 transmitted have a similar social (i.e., outer) cost as the normal kilogram of CO2 produced. This cost classification was 0.2 pennies per kilometre, while air contamination costs were 0.4.

➢ Description of Low- to Zero-Emission Technology in Maritime Transport

Sea shipping uses various efficient and often creative techniques to reduce fuel consumption in marine engines. From this perspective, shipowners' clear path of community initiative is in line with sustainable development goals to reduce ship emissions. There are numerous classification methods and assessments in the literature for locations that can reduce vessel emissions. B. Use of emission reduction technology as a standard. Therefore, three areas of potential decrease have been recognized. It is the marine motor, fuel quality, and fuel utilization. Another grouping utilizes discharge control innovation as the principal basis and partitions it into five phases: Time for (1) plan, (2) modernization of existing drive frameworks, (3) changes, (4) elective energizes, or extra in-vehicle gear for elective energy sources, and (5) business administrations. The most generally utilized outflow decrease advancements in corporate structure configuration, power and impetus frameworks, elective energizes, elective energy sources and activities (Table 1).

Table.1.Specification of selected technologies and solutions exploiting ships' potential for reducing CO_2 emissions.



Area	Measurement	Solution	CO_2 reduction potential [%]			Investments costs [%]			CO_2 reduction cost [USD/1t]		
			Min.	Average	Max.	Min.	Average	Max.	Min.	Average	Max.
Hull design	Vessel size	Economy of scale, improved capacity utilization	4.00	18.00	83.00	0.00	0.00	0.00	−159.00	−159.00	−159.00
	Hull shape	Dimensions and form optimization	2.00	14.50	30.00	2.50	10.00	25.00	12.00	−54.00	−36.00
	Light materials	High strength steel, composites	0.10	5.30	22.00	1.00	10.00	50.00	1036.00	86.00	131.00
	Air lubrication	Hull air cavity lubrication	1.00	5.30	15.00	5.00	7.50	10.00	744.00	31.00	−77.00
	Resistance reduction devices	Other devices/retrofit to reduce resistance	0.00	8.00	10.00	0.00	2.00	3.00	0.00	−50.00	−70.00
	Ballast water reduction	Change in design to reduce size of ballast	1.00	2.50	10.00	0.25	0.50	2.50	−106.00	−112.00	−106.00
	Hull coating	Distinct types of coating	2.00	6.00	45.00	10.00	20.00	40.00	451.00	256.00	−31.00
Power and propulsion system	Hybrid power/propulsion	Hybrid electric auxiliary power and propulsion	0.00	−2.50	−5.00	–	–	–	–	–	–
	Power system/machinery		1.00	5.80	25.00	0.50	1.00	5.00	−77.00	−118.00	−121.00
	Propulsion efficiency devices		1.00	8.00	20.00	0.50	2.50	5.00	−77.00	−98.00	−106.00
	Waste heat recovery	Recuperation	0.10	1.20	3.00	0.10	0.10	0.10	100.00	−47.00	−56.00
	On board power demand	On Board or auxiliary power demand	25.00	70.00	84.00	10.00	10.00	10.00	−88.00	−118.00	−121.00
Alternative fuels	Biofuels	Methanol, ethanol	5.00	20.00	30.00	–	30.00	–	100.00	−47.00	−56.00
	LNG	LNG	0.00	−2.00	−3.00	0.00	0.00	0.00	–	–	–
Alternative energy sources	Wind power	Kites, sails, wings	1.00	12.60	50.00	0.50	5.00	25.00	−77.00	−89.00	−77.00
	Fuel cells	H_2	2.00	6.50	20.00	0.00	0.00	0.00	>1,000	>1,000	>1,000
	Cold ironing	Electricity from shore	3.00	5.30	10.00	0.25	0.25	0.25	−125.00	−130.00	−132.00
	Sola power	Solar panels on deck	0.20	4.00	12.00	5.00	5.00	5.00	2794.00	158.00	12.00
Operation	Speed optimization	Operational Speed, reduced speed	1.00	19.60	60.00	0.00	0.00	0.00	−160.00	−160.00	−160.00
	Capacity utilization	At vessel and fleet level (fleet management)	5.00	23.50	50.00	0.00	0.00	0.00	−159.00	−159.00	−159.00
	Voyage optimization	Advanced weather routing, route planning and voyage execution	0.10	7.30	48.00	0.00	0.00	0.00	−159.00	−159.00	−159.00
	Other operational measures	Trim/draft optimization, energy management, optimized maintenance	1.00	3.70	10.00	0.00	0.00	0.00	−159.00	−159.00	−159.00

The fuel quality is at the heart of the strategies being developed and implemented to reduce ship-related emissions. The ensuing savings are possible thanks to technological advancements prompted, on the one hand, by ship owners` need for more fuel-efficient solutions. Standards and regulations in international law, on the other hand, are becoming considerably more stringent, imposing increasingly harsh limitations on emissions from ships during sea voyages and port stops. There are four steps to this emission control method (Table 2). Shipowners can move through these stages by placing new shipbuilding orders first and then modernizing their existing fleet. Below is a complete description of the procedure.

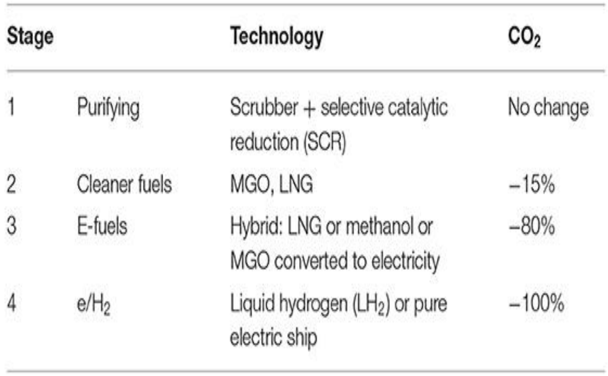
1. Exhaust gas treatment—Various ways to match traditional marine fuel emissions levels to legal limits. Note that these do not eliminate exhaust fumes.

2. Cleaner fuels— technologies that allow cleaner fossil fuels, such as LNG and MGO, to meet emission limits. LNG reduces CO2 emissions by 15%, whereas MGO, a more energy-dense fuel than HFO, increases emissions by 1.3 per cent.

3. E-fuels—All renewable energy sources are incorporated into cutting-edge systems that use fuels for onboard power generation and allow ships to be driven by electrical energy.

4. e/H2-one of the two innovations that take into account zero-discharges transporting today (beside sustainable power sources on electrically impelled ships), utilizes environmentally friendly power sources to give capacity to hydrogen creation or to charge the boat's batteries.

Table.2. Four stages of effective CO2 reduction.



Stage		Technology	CO_2
1	Purifying	Scrubber + selective catalytic reduction (SCR)	No change
2	Cleaner fuels	MGO, LNG	−15%
3	E-fuels	Hybrid: LNG or methanol or MGO converted to electricity	−80%
4	e/H_2	Liquid hydrogen (LH_2) or pure electric ship	−100%

Currently, no fossil fuel technologies are available that meet the MARPOL standards for CO2 and other pollutant emissions. As a result, the first stage should be strengthened by technological advances and further streamlined low to zero emissivity technologies.

- **Assessment Potential of Decarbonization in Maritime Shipping**

The computation yields the last gauge of the outside cost of CO2 outflows as a sign of the potential for future decreases in sea traffic contrasted with momentum conditions. The computations were made utilizing the "Eco Bonus" project mini-computer, which depends on street transport emanations as an option in contrast to transportation. This mini-computer was made to work with the EU's Sea Motorways (MoS) drive. It is important to consider the quantitative decrease of outside costs displayed in US dollars and the recently resolved CO2 discharges from the worldwide guard. Primary database data was initially used to determine fuel consumption for ships of various fleet types. After that, their consumption was converted into CO2 emissions. Table 3 summarizes the results.

Table.3.Estimated fuel consumption and CO2 emissions in global shipping in 2018

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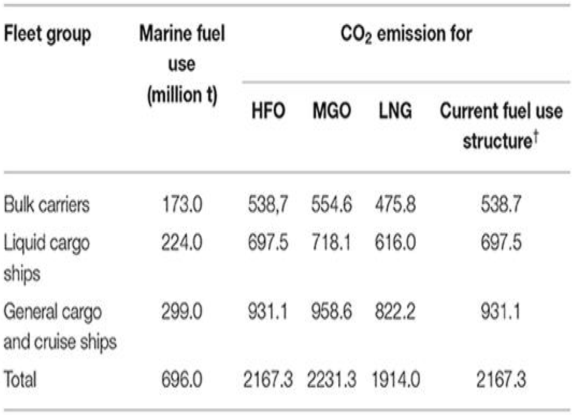

Fleet group	Marine fuel use (million t)	CO_2 emission for			
		HFO	MGO	LNG	Current fuel use structure†
Bulk carriers	173.0	538,7	554.6	475.8	538.7
Liquid cargo ships	224.0	697.5	718.1	616.0	697.5
General cargo and cruise ships	299.0	931.1	958.6	822.2	931.1
Total	696.0	2167.3	2231.3	1914.0	2167.3

According to the existing fuel structure used in world shipping, the total emissions of fleets worldwide are 2,167 million tonnes of CO2, which is interestingly the emissions generated when using only HFOs. Corresponds to. As a result, a 2% contribution from LNG with low CO2 emissions offsets a 26% contribution from MGO with significantly higher CO2 emissions. Expecting that the whole vehicle changes to MGO, a cleaner fuel as far as SOx and NOx emanations, there are 2.23 billion tons of CO2 outflows, a slight increment over the ongoing circumstance. Full Switch's new CO2 outflows to LNG are 1,914 million tons, simply 12.7 per cent, not exactly the current HFO-based form.

The "Eco Bonus" calculator compares the externalities of direct door-to-door roads with MoS options, considering the impact on individual vessel technology, operational profiles, ports of call and port access. Using the output of an external cost calculator for 1 ton of carbon emissions, we were able to calculate the total external cost of carbon emissions in global transport (ie HFO = $ 159.10; MGO = $ 153.44; LNG. = $ 112.40; Various combinations: LNG + SCR = $ 112.40, HFO + Scrubber + SCR = $ 162.28, MGO + SCR = $ 153.44). This is $ 34.91 billion for HFOs, $ 33.57 billion for MGOs and $ 214.37 billion for LNG, which is about 61.4% of the same cost of HFOs. Model errors ranged from $ 8.41 to $ 11.90 per issue unit, and the model's goodness of fit was 0.96. The numbers were calculated using an average traffic speed of 15kn. Similar calculations were performed for higher speeds (17, 19, 21 kn) to highlight the increasing trend of external costs for vessels without exhaust gas cleaning technology, and the results showed stable levels.

6. Discussion & Conclusion

The examinations have affirmed various key realities; however, they ought to be seen with alert. In the first place, because no strategies for surveying outflows in the oceanic vehicle have been concocted, the last outer quotes of 1 ton of CO2 emanations depend on calculating externalities inland transport. Subsequently, a more reasonable appraisal requires more prominent involvement in how outer expenses create sea delivery. Second, utilizing the projected fuel use structure from 2017 for 2018 information is a mix-up (i.e., since no ongoing information is accessible). Electrical, hybrid, and methanol-powered drives are not included in the construction because they only use three marine fuel forms. Plans to use liquid hydrogen would also change the forecasts dramatically. As a result, global statistics on real fuel use for each ship type will need to be closely monitored and updated (i.e., as data become available).

For quite a long time, Europe's vehicle has been an impetus for the monetary turn of events. As of now, it works with trade among the European Union (EU), the Member States and a large part of the remainder of the world. Maritime transport shapes the fundamental pivot of global trade, conveying ~90 per cent of the absolute exchanged weight. In doing so, it bears liability regarding 2.5 per cent of overall ozone harming substance emanations. The endeavours to diminish the negative ecological effect of transport movement are fixated on better modular coordination of the normal vehicle framework, supportability, green innovations in the vehicle area, asset productivity, and fossil fuel byproducts decrease. The International Maritime Organization has entrusted its individuals to accomplish a 70 per cent decrease in CO2 emanations by 2050 or, on the other hand, if conceivable, to dispense with them by and large. From a business end, it is feasible to apply an assortment of advancements to guarantee zero-emanations or, in any event, a sensational decrease of outflows in the delivery area. This paper aims to assess the essential way to deal with the decarbonization interaction in light of EU key reports and low-discharge and zero-outflow innovations utilized and created in the oceanic vehicle. An assessment of outer costs caused by oceanic vehicles will consider the evaluation of advantages because of the use of innovations and elective powers proposed in the arrangements. Based on the acquired outcomes from the outside cost valuation assessing the potential for decarbonization in oceanic transport.

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