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International Maritime Organization and Decarbonization of Maritime Industry: Mandate and Instruments

*Kristina Yeremenko**

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**LLM, Ukrainian Bar Association (6, Khreshchatyk St., Kyiv, Ukraine) https://orcid.org/0000-0003-1108-3342*

ABSTRACT

The International Maritime Organization (IMO) makes a crucial contribution to the decarbonization of the maritime industry within the United National Framework Convention on Climate Change (UNFCCC) objectives. The IMO's mandate provides for many activities to reduce CO2 emissions from international shipping, including imposing binding and non-binding instruments. The regulations on energy efficiency for ships play a critical role in implementing this IMO strategy. The article examines the conditions of Chapter 4 of the International Convention for the Prevention of Pollution from Ships

(MARPOL) Annex VI. It focuses on the Energy Efficiency Design Index (EEDI) as a non-administrative mechanism and the Ship Energy Efficiency Management Plan (SEEMP) as the operational activity. This article also covers the legal aspects of international cooperation, the dissemination of energy-efficient technologies in the maritime sector, and the IMO's contribution to the Norway GreenVoyage2050 project to promote MARPOL rules in national legislation.

The keywords: *CO2 emissions, Energy Efficient Design Index (EEDI), Ship Energy Efficiency Management Plan (SEEMP), Energy Efficiency Operational Indicator (EEOI), International Energy Efficiency Certificate (IEEC), Energy Efficiency Existing Ship Index (EEXI), Carbon Intensity Indicator (CII) rating, alternative energy sources, GreenVoyage2050.*

Introduction

International shipping is a crucial transport industry, which facilitates over 80% of world trade. Even though international shipping is the most energy-efficient form of freight transport, the sector is reliant on fossil fuels (Wan et al., 2018). According to International Maritime Organization (IMO) data, the greenhouse gas (GHG) emissions– including carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O), expressed in CO2e – of total shipping (international, domestic, and fishing) have increased from 977 million tons in 2012 to 1,076 million tons in 2018 (a 9.6% increase) with the growth of shipping's share in global anthropogenic emissions from 2.76% in 2012 to 2.89% in 2018 (Fourth IMO GHG Study 2020, 2021, p. 1).

Unfortunately, the Kyoto Protocol of the UNFCCC adopted in 1997 (hereinafter, the Kyoto Protocol) did not establish a strategy to set a level for greenhouse gas emissions by the maritime sector. Furthermore, recent research has identified at least seven major challenges for implementing a carbon emission trading scheme in the shipping sector, including (1) geographical coverage; (2) sectoral coverage; (3) free emissions quota percentage, and the carbon trading price; (4) conflict between common but differentiated responsibilities and equal treatment; (5) management difficulties; (6) jurisdiction under international law; and (7) opposition from

the shipping sector (Wu et al., 2022). However, in 2009 the IMO claimed a rulemaking mandate for decarbonizing the industry, stating that its competence to regulate all non-commercial aspects of international shipping included the reduction or limitation of GHG emissions. This mandate appeared uncontroversial given the climate measures that the IMO has enacted since 2011 (Kerr, 2021, p. 123). Hence, the IMO's rulemaking and other actions to decarbonize the maritime industry have become a backbone of implementing the UNFCCC's goals.

This paper traces the development of the IMO's strategies for decarbonizing international shipping and its support of international cooperation in disseminating new energy-efficient and alternative energy technologies in the maritime industry.

Methodology

The article analyses the historical development of the rules governing the energy-efficiency of ships, introduced as part of the IMO strategy to reduce CO2 emissions from international maritime activities. The analyses are based on respective rules and provisions of the Energy Efficiency Design Index (EEDI) for new ships (or significantly re-equipped ships), the Ship Energy Efficiency Management Plan (SEEMP), International Energy Efficiency Certificate (IEE Certificate), etc. The statistical data on GHG emissions illustrates the effectiveness of the strategies and measures in question.

1. The origins of the decarbonization of the maritime industry

The beginning of the historical development of implementing effective solutions to ensure decarbonization within the maritime industry can be found in the International Conference of the Parties to the International Convention on the Prevention of Pollution from Ships (hereinafter, MARPOL) held in 1997.

It was then, decided to include Annex VI to the MARPOL Convention. Annex VI, is entitled "Prevention of Air Pollution from Ships" and it entered into force on May 19, 2005. The aims of the relevant regulations included: minimizing greenhouse gas emissions into the atmosphere from international maritime activities; determining local and global levels of air pollution; and preventing harmful effects on the environment and human health. To ensure the decarbonization of the maritime industry within the framework of the UNFCCC's goals, the IMO focused on the development and implementation of technical, methodological and operational activities that would reduce emissions of ozone-depleting substances, NOx, SOx, VOCs and CO2 (Prevention of Air Pollution from Ships, n.d.).

Activities aimed at improving the level of energy-efficient of ships occupy a key place in the IMO strategy for reducing CO2 emissions. The first attempt to resolve the issue of CO2 was Resolution 8, "CO2 emissions from ships" agreed at the 1997 International Conference of the Parties (Prevention of air pollution from ships, 2009, p. 10).

In this resolution, the Marine Environment Protection Committee (hereinafter, MEPC) was invited to consider what strategies could be implemented given the relationship between CO2 and other kinds of pollutants in the atmosphere and the sea, and it was also proposed that the IMO, in cooperation with the UNFCCC, conduct a study of CO2 emissions from ships as part of the global process of inventorying CO2 emissions.

The presentation of the results took place at the 45th session of the MEPC in June 2000 (Prevention of air pollution from ships, 2009, p. 10). According to the first IMO study published (2000) on greenhouse gas emissions from ships, in 1996, because of international maritime activities, CO2 emissions from navigation account for 1.8% of the total anthropogenic CO2 emissions in the world (Prevention of air pollution from ships, 2009, p. 9)

Given the relatively low level of greenhouse gas emissions from shipping when compared to other modes of transport (When transporting 1 ton of cargo per 1 km, CO2 emissions are: maritime transport – about 9 gram., road transport—about 80 gram., aviation – over 600 gram.) (Devyatova, 2020) at first, the IMO did not plan to introduce specific, legally binding rules that would strengthen the requirements for reducing greenhouse gas emissions from ships. However, at the request of the UNFCCC, IMO Resolution A.963 (23) "IMO Policies and practices related to the reduction of greenhouse gas emissions from ships" was adopted in December 2003 with the help of the IMO. This represented part of the IMO's response to global environmental problems (Frolov, 2012, p. 15).

The relevant Resolution called on the MEPC to take effective technical and operational action to respond to modern environmental problems by decarbonizing the maritime industry. The MEPC, in accordance with its responsibilities and to implement the provisions of Resolution A. 963 (23), focused on CO2 emissions. By the next session MEPC, a draft work plan on the recognition and development of mechanisms for implementing the goals set by the IMO Assembly was presented for consideration (Oceans and maritime law, 2006, p. 29–30).

According to the second IMO study on greenhouse gases, the amount emitted by international shipping as of 2007 is 880 million tons, about 2.7% of the total anthropogenic CO2 emissions in the world. Compared with 1996, the level of CO2 emissions from international maritime activities had increased by almost 1%, although some scientists argue that it had increased by 1.5%. Scientists have predicted that in the absence of regulations and sanctions aiming to reduce greenhouse gas emissions, by 2050 the level of greenhouse gas emissions due to increased freight traffic will have grow by 150–200% compared to 2007 (Prevention of air pollution from ships, 2009, p. 9).

The main activities highlighted at the MEPC's 59th session where an annual inventory of CO2 emissions; an analysis of prospects in reducing emissions from shipping; an analysis of technical and operational activities to reduce emissions; an analysis of strategic directions for emission reductions and plans for further actions; a study of the impact of CO2 emissions from shipping on the process of global warming; and a comparison of the energy efficiency of ships and the intensity of CO2 emissions depending on the type of ship (Ivanchenko et al., 2014, p. 107–108). The international community recognized that by increasing the energy efficiency of ships, it would be possible to reduce the number of anthropogenic emissions by 25–75% compared to the level recorded in 2007 (Prevention of air pollution from ships, 2009, p. 9).

Further monitoring of CO2 emissions continues and as of 2022, under the auspices of the IMO, four studies on CO2 emissions from international maritime activities have been conducted. They directly affect the development of the IMO strategy for decarbonizing the maritime sector.

2. IMO Strategy for Improving the Energy Efficiency of Ships

In 2010, with the 60th session of the MEPC, a new stage in global shipbuilding began. In resulted from the Committee's agenda to develop and implement effective and practical activities to improve the energy efficiency of ships. The main achievements of the 60th session of the MEPC were the preparation of the draft Energy Efficiency Design Indicator (hereinafter, the EEDI) for new ships (or significantly re-equipped ships), and the Ship Energy Efficiency Management Plan (hereinafter, the SEEMP) for all operating ships. It was proposed that they could form part of the Judicial Security Management System.

As the draft rules for improving ships energy efficiency required improvement to text in matters related to, issues concerning ship size, target dates and reduction rate in relation to the EEDI the guidelines for calculating the basic indicators that already existed in the Lloyd Register Fairplay (Marine Environment Protection Committee (MEPC) – 60th session, 2010, paras. 3, 4) database were used to prepare the text of the subsequent EEDI project. Finally, in July 2011, at the 62nd session of the MEPC, mandatory rules were adopted to improve the energy efficiency of international maritime transport, which is the first global energy-efficient standard for the entire international maritime industry (Energy Efficiency Measures, n.d., para. 1).

Because of the package of technical activities adopted by the MEPC to reduce greenhouse gas emissions and increase the energy efficiency of ships, a new Chapter 4 was added to Annex VI of MARPOL. It was called "Energy Efficiency Regulations" and it entered into force on January 1, 2013. It applies to all new vessels with a gross capacity of 400 GT or more, with the following exceptions:

- vessels operating only in the waters of a state under the sovereignty, jurisdiction, or whose flag the ship may fly (but with the greatest possible adoption of measures to ensure the implementation of Chapter 4 of MARPOL);
- the regulations 20 and 21 of MARPOL Annex VI (EEDI regulations) do not apply to vessels with diesel, turbine, or hybrid rowing installations; and
- administrations have been granted permission to exempt vessels of 400 gross tonnage or more from compliance with regulations 20 and 21 of MARPOL Annex VI (about which the administration must notify the IMO, while for further informing the parties of MARPOL) except where the contract for the construction of the vessel was concluded on January 1, 2017, or after this date, or in the absence of a contract for the construction of a vessel

whose keel was laid or which is in a similar stage of construction from July 1, 2017, or after this date, in the event of major changes of a new or an existing vessel, as defined in Rule 2.24 of Annex VI MARPOL, from 1 January 2017, as well as in the way of application of regulations 5.4.2 and 5.4.3 of Chapter 2 of Annex VI MARPOL.

Regulation 2.24 explains the meaning of the term "a major modification" in the context of ship. According to the regulation vessel will be considered significantly re-equipped if: the vessel significantly changes in size, load capacity, or engine power; the vessel changes its type; the vessel's life, in the opinion of the Administration, is significantly extended; the vessel changes in such a way that, if it were a new vessel, it would be subject to the relevant provisions of MARPOL, which do not apply to it as an existing vessel; or if the energy performance of the vessel is significantly altered, in such a way that modifications may cause the required EEDI level to be exceeded (R 21). Rules 5.4.2. and 5.4.3 determine the need for a general or partial inspection (with mandatory certification) to meet the requirements of MARPOL Annex VI, Rules 20, 21, and 22.

EEDI, meanwhile, is the most important technological instrument to promote the use of more energy-efficient (less polluting) equipment and engines for new vessels. We expect that EEDI will encourage further innovation and the technical development of all components that affect the fuel efficiency of the vessel, even at the beginning of the design process. EEDI is a non-regulatory, efficiency-based mechanism that leaves the industry with a choice of technologies to use in a particular ship's design as long as the essential level of energy efficiency is achieved. Naval architects and shipwrights use the most cost-effective solutions for ships, provided that the regulations are followed. EEDI regulations require achieving a minimum level of energy efficiency per mile while under way for different classifications of vessels (i.e., of

different types and sizes). From January 1, 2013, newly designed ships had to meet the reference level for their class (Energy Efficiency Measures, n.d., para.2).

Further work by the Committee on improving the energy efficiency of ships was aimed at expanding the number and types of ships that must comply with the EEDI regulations and refining technical and practical measures for implementing the stages of the EEDI regulatory framework. The EEDI regulations allow for the application of energy efficiency mechanisms to ships in three Phases: Phase 1 began on January 1, 2015; Phase 2 – began on January 1, 2020; and Phase 3 – will begin on 2025 and beyond.

To ensure the quality of the implementation of the stages of the EEDI regulatory framework, the Committee adopted amendments to the 2013 interim guidelines to determine the minimum propulsion power to maintain the maneuverability of ships in adverse conditions, while adhering to the guidelines for the application of Phase 1 of the EEDI. The Committee also established a group to analyze the state of technical developments related to implementing Phase 2 (Marine Environment Protection Committee (MEPC), 67th session, 2014, para. 9). Regulation 21.6 of MARPOL Annex VI requires the organization to "review the status of technological developments at the beginning of Phase 1 and in the middle of Phase 2 and change the periods, baseline parameters of the EEDI for the appropriate ships...".

Based on the results reported by that group, the 70th session of the MEPC presented an analysis of technical developments regarding the implementation of Phase 2 of the EEDI requirements from 2020. The Committee agreed to maintain the requirements of Phase 2 (except for the provisions on cargo and passenger Ro-Ro vessels) and noted the need analysis of the requirements for Phase 3 (which provides for the construction of new vessels 30% more energy efficient than the baseline), including consideration of

the possibility of creating a fourth Phase (Marine Environment Protection Committee (MEPC), 70th session, 2016, paras. 6, 7).

The 71st session of the Marine Environment Protection Committee established a group to review the EEDI after Phase 2; they presented their report at the 73rd Session of the Committee. They discussed the possibility of bringing forward the requirements of Phase 3 from 2025 to 2022 for some vessels, and put forward a proposal to increase the energy efficiency level of container ships to 40% (Marine Environment Protection Committee (MEPC), 73rd session, 2018, para. 4).

Eventually the Committee approved and adopted the draft amendments to Annex VI of MARPOL, significantly strengthening the requirements of Phase 3 of the EEDI. There changed Phase's 3 effective date of entry into force to 2022 for some types of vessels, and included the requirement to increase the energy efficiency of container ships to 40% (Marine Environment Protection Committee (MEPC) 75th session, 2020).

Currently, EEDI regulations apply to the following vessels: bulk carriers, gas carriers, tankers, container ships, general cargo vessels, refrigerated cargo vessels, combined vessels, passenger vessels, ro-ro trucks, ro-ro cargo ships, ro-ro passenger vessels, LNG tankers (using the new calculation method) and cruise passenger ships with non-traditional propulsion systems, which together account for about 85% of total CO2 emissions from international navigation (Energy Efficiency Measures, n.d, para. 3).

Meanwhile, the Ship Energy Efficiency Management Plan (SEEMP), it requires ship-owners to have a plan on board every vessel that will improve the ship's operational efficiency. This can be part of the Judicial Security Management System (MARPOL, Annex VI, 1997, r. 22), the main goal of which is to increase the overall efficiency of ship operation in the long term, by introducing regulations and optimization methods for saving energy and fuel economy (Energy Efficiency Measures, n.d, para. 7).

All ships with a gross tonnage of 400 GT or more involved in international trade must comply with SEEMP, which establishes a mechanism for shipowners and operators for improving the energy efficiency of ships. They should achieve these actions by monitoring the energy efficiency of the vessel's operations and by regularly applying new technologies and practices to improve the energy efficiency of ships (IMO's work to cut GHG emissions from ships, n.d., para. 26). SEEMP is an operational measure that helps to improve the energy efficiency of the ship via cost-effective means, and also provides mechanisms for implementing energy efficiency shipping operations for the ship and (or) ship companies. The SEEMP Guidelines for New and Existing ships include the best practices for ensuring the fuel-conserving operation of vessels (Energy Efficiency Measures, n.d, para. 7).

Among the main methods of improving the energy efficiency of ships are route planning, weather and time planning, optimizing of ship speed, optimizing the power developed by the main engine, optimizing control of the ship, hull maintenance, optimizing both the operation of the ship power plant and its maintenance, optimizing heat recovery, optimizing cargo operations, managing electricity and using alternative fuels (Zhmur & Leonov, 2017, p. 125–126).

Thus, the effectiveness of SEEMP primarily depends on the use of accumulated scientific and practical experience to save fuel, plan effectively and reduce the emission of harmful greenhouse gases. Zhmur and Leonov (2017, p. 125–126) in their analysis of the provisions that resulted in the development of SEEMP suggest that innovative and technical solutions in resource-saving technologies, which are aimed at improving the technical, economic and operational indicators of ship performance, are necessary.

The IMO has also developed an additional monitoring tool for SEEMP called the Energy Efficiency Operational Indicator (EEOI), which is used by operators to assess the energy efficiency of ships

according to CO2 emissions per unit of transport work (as opposed to EEDI, which evaluates the design of a ship) (Lindstad & Bø, 2018, p. 277). These indicators are mandatory and standardize the measurement of energy efficiency enabling improvements in the design and operation of ships.

To legally confirm the ships compliance with the EEDI, SEEMP and EEOI regulations, the IMO has introduced a new certificate for new and existing ships, to which Chapter 4 of Annex VI of MARPOL applies. It is called the International Energy Efficiency Certificate (the IEE Certificate). This IEE Certificate will be issued to new ships at the first inspection before the ship is put into operation, and issued to existing ships with a gross tonnage of 400 GT or more during the intermediate inspection or after significant re-equipping of the ship (MARPOL, Annex VI, 1997, r. 6 p. 4).

The IEE certificate is issued once for every ship and is valid for the ship's entire life, unless it is invalidated by any of the following cases: if the ship is decommissioned or if a new IEE certificate is issued after a significant conversion of the vessel; when a vessel is transferred under the flag of another state (a new certificate will be issued only when the Registrar is fully satisfied that the vessel meets with the requirements of Section 4 of Annex VI to MARPOL); and finally, in the event of a transfer between the Parties, if the request is made within three months of the transfer, the Government of the Party under whose flag the ship was previously entitled to sail shall transmit to the Administration as soon as possible a copy of the certificate available on the vessel before its transfer and copies of the relevant inspection reports (MARPOL, Annex VI, 1997, r. 9 p. 10, p. 11).

Amendments MARPOL Annex VI on the Energy Efficiency Existing Ship Index (hereinafter, the EEXI), Annual Operational Carbon Intensity Indicator (CII) and CII rating were approved

at the 76th session of the MEPC in June, 2021, in order to improve the energy efficiency of ships and reduce the amount of greenhouse gas emissions. The relevant amendments to MARPOL Annex VI are expected to enter force on 1 January, 2023. The new measures will require all ships to calculate their EEXI following technical means to improve their energy efficiency and to establish their annual operational carbon intensity indicator (CII) and CII rating. The attained EEXI is required to be calculated for ships of 400 GT and above, in accordance with the different values set for ship types and size categories (Reduction of GHG emissions from shipping measures adopted, 2021, paras. 2–4, 6).

The CII determines the annual reduction factor needed to ensure continuous improvement of the ship's operational carbon intensity within a specific rating level. The actual annual operational CII achieved (attained annual operational CII) would be required to be documented and verified against the required annual operational CII. This would enable the operational carbon intensity rating to be determined. The rating falls on a scale – from A to E. The appropriate rating for the ship's carbon production should be recorded in the ship's SEEMP (Further shipping GHG emission reduction measures adopted, 2021).

It should be noted that administrations, port authorities, and other stakeholders are encouraged to create additional incentives for A- or B-rated ships. Shipowners of ships with a D or E rating that has been maintained for several consecutive years are required to submit a corrective action plan to bring the ship to the required level of C or higher. The ship's rating will be positively affected by using of low-carbon fuel, cleaning the hull to reduce drag, speed optimization, installing energy-saving light bulbs, installing solar or wind auxiliary energy sources, etc. (Further shipping GHG emission reduction measures adopted. Further information, 2021).

3. Alternative energy sources as an effective means of increasing the energy efficiency of ships

IMO policy is aimed at implementing operational and technical measures for improving the energy efficiency of ships. Among them, the use of alternative energy sources occupies a key place as their use will ensure the decarbonization of the maritime industry. It is the most effective measure to reduce greenhouse gas emissions from shipping.

Every year, the Royal Institute of Naval Architects (RINA) publishes in Significant Ships a list and summary of what they consider to be the most interesting projects in the shipbuilding industry. The projects collected in Significant Ships are fairly representative and can identify the main trends in the use of various types of technologies (Beletsky & Kuznetsov, 2018, p. 41–42).

Today, alternative energy sources such as liquefied natural gas (LNG) (Royal Academy of Engineering study examines future lower-carbon ship powering option, 2013) and liquefied petroleum gas (LPG) are used as short-term prospects in the maritime industry: while among the most popular technologies, the most effective is using scrubbers (selective catalytic reduction (SCR)), which today is a tested and mature technology for the treatment of greenhouse gas emissions at high exhaust temperatures. As medium and long-term options, scientists focus on biofuels, dimethyl ether, atomic energy, battery technologies, superconducting electric motors, hydrogen, compressed air and liquid nitrogen (Royal Academy of Engineering study examines future lower-carbon ship powering option, 2013), as well as ammonia, methanol, ethane, and various other renewable energy sources (Danish shipping have reconfirmed their support of propulsion & future fuels, 2020, para. 5). There are undoubted obstacles to the introduction and use of these technologies, but the international community and scientists around the world are actively working towards improving the new shipbuilding technologies that contribute to implementing the goals set by the UNFCCC.

Given global trends in green fuels, renewable energy sources require the most long-term attention. They are characterized by inexhaustibility and accessibility in contrast to traditional energy resources, and they cause the least environmental damage. Of course, the practical transition to eco-friendly shipping requires significant technological and investment efforts: the transition from fossil-fueled transport to energy-efficient structures and renewable energy technologies has thus far been quite limited, even though there are optimistic scenarios regarding future uptake. The main obstacles to eco-friendly shipping are technological ignorance and an oversupply of fossil fuels which reduce the extent of financial investment in the development of potentially attractive alternative and renewable energy solutions for the maritime industry. It is necessary to make significant efforts to support green technologies today, in order to increase the role of renewable and alternative energy sources in shipping (Renewable Energy Options for shipping. Technology Brief, 2015, p. 4).

4. International cooperation for the dissemination of energy-efficient technologies in the maritime industry

International maritime activities play a crucial role in enabling world trade. As the most cost-effective and energy-efficient method of mass transportation, shipping contributes significantly to the prosperity of both developed countries and developing countries. However, there are obstacles in the way of the latter implementing energy-efficient technologies, such as technical ignorance and lack of financial support. IMO has adopted several guidelines aimed at promoting the exchange and transfer of innovative technologies that help to improve the energy efficiency of international maritime transport. IMO has also developed practical measures to help find financing for energy-efficient technological solutions for developing and least developed countries.

Regulating the international exchange and transfer of technologies that contribute to improving the energy efficiency of sea transportation was raised for the first time in 2012 at the 63rd session of the MEPC. At the 65th session, the MEPC resolution on promoting technical cooperation and technology transfer to improve the energy efficiency of the marine industry was adopted. The committee appealed to the IMO Assembly to take measures to facilitate technical help for participating countries, to ensure cooperation in transferring energy-efficient technologies to developing countries, and to help search for funding for capacity-building, through the Assembly's various programs (Marine Environment Protection Committee (MEPC), 65th session, 2013).

At the 66th session of the MEPC (April 2014), the committee approved the creation of an Ad Hoc Working Group of experts on the facilitation of technology transfer for ships. At its first meeting, the Working Group approved the method and work plan for the exchange and transfer of energy efficiency technologies, which provided for:

– assessment of the potential consequences of implementing the energy efficiency rule in Chapter 4 of Annex VI of MARPOL, in particular in developing countries, to ensure the transfer of technology and financial needs of the latter;

– identification and compilation of a list of energy-efficient technologies for ships;

– identification of obstacles to technology transfer to developing countries, including associated costs and sources of financing;

– providing recommendations, including the development of a model agreement that allows the transfer of financial and technological resources, as well as capacity-building between the Parties, to implement the regulations of energy-efficiency of ships (Marine Environment Protection Committee (MEPC), 66th session, 2014, para. 17).

To ensure the effective implementation of the IMO strategy for the decarbonization of the maritime industry and the adoption of implementing energy efficiency regulations in developing and the least developed countries, the IMO has focused on technical cooperation, capacity-building, and several regional and national workshops (UN Framework Convention on Climate Change. Subsidiary Body for Scientific and Technological Advice Forty-third session, 2015, p. 26).

Because frequent maritime transport is projected significantly increase in the future, the global approach to further improving the IMO strategy for improving the energy efficiency of ships and decarbonizing the maritime industry is considered a necessary condition for the normal existence and development of humanity (UN Framework Convention on Climate Change. Subsidiary Body for Scientific and Technological Advice Forty-third session, 2015, p. 27). This is why IMO's regulatory activities concerning energy-efficient technologies are extremely important for the sustainable development of humanity.

Rule 23 of Annex VI of MARPOL defines the specifics of promoting technical cooperation and technology transfer to improve the energy efficiency of ships. It explains that the administrations of the participating countries, in cooperation with IMO and the other international bodies, must provide help and support personally or through IMO states, especially developing countries and least developed countries that have directly requested technical help or help in implementing measures to comply with the rules of Chapter 4 regarding the authority of the administration. The administrations of participating countries should actively cooperate with other participating countries, within the bounds of their national laws, regulations and policies, to promote the development and transfer of technologies to improve the energy efficiency of ships.

A key role in the process of technological cooperation belongs to financial investments. The IMO emphasizes the importance

of financial support for the development of instruments aimed not only at assisting developing countries but also at facilitating cooperation to reduce greenhouse gas emissions and increase energy efficiency throughout the maritime industry.

Cooperation and the exchange of information within the framework of the initiative to decarbonize the maritime industry are activities gaining more and more traction today. With the support of IMO at the international level, projects have been launched that are aimed directly at sharing information on technical development and capacity-building in developing countries (UN agency pushes forward on shipping emissions reduction, 2019, para. 24). The main issue is the introduction of energy-efficient shipping solutions into the national legislation of developing countries. To date, with the support of IMO, many such countries have created specialized projects aimed at ensuring an appropriate level of decarbonization in the maritime industry. Projects that have been emplaced according to the IMO's strategic directions, include:

1. The IMO-Singapore NextGEN Initiative, which aims to bring together key stakeholders in the maritime industry and develop an initiative to decarbonize and support further cooperation (NextGEN holds first meeting to push maritime decarbonization, 2021, para. 4).

2. The IMO-Norway Greenvoyage2050 project, with supports the transition of the maritime industry to a low-carbon future. The work of the project assists cooperation with individual developing countries, including Small Island Developing States (SIDS), and Least Developed Countries (LDCs). The projects ambition matches the objectives of the IMO Priority Strategy for Greenhouse Gas Emissions from Marine Activities (Technology Groups, n.d., para. 1).

3. The IMO-EU Global MTCC Network (GMN) Project is a global network of centers for cooperation in the field of marine technologies (Maritime Technologies Cooperation Center, or MTCCs), funded by the European Union and implemented by the IMO. The project aims to promote technologies and operations that

increase the energy efficiency of the maritime industry and help to guide LDC countries into the future of low-carbon shipping (About GMN. Energy efficiency in shipping – why it matters, n.d., para. 2).

4. The Global Industry Alliance (Low Carbon GIA) is a public-private partnership established under the IMO-Norway GreenVoyage2050 project, which aims to bring together maritime leaders to support an energy-efficient and low-carbon maritime transport system. Leading shipowners and operators, classification societies, engine and technology manufacturers and suppliers, oil companies, and ports have joined in the Low Carbon GIA project to collectively identify and develop innovative solutions to overcome common obstacles to the introduction and implementation of energy-efficient technologies, best practices and alternative fuels with low or zero sulfur content (Technology Groups, n.d, para. 1).

5. The GEF-UNDP-IMO GloFouling Partnerships Project, aimed at solving the problem of ships' hull fouling, which increases hydrodynamic drag, fuel consumption and overall greenhouse gas emissions (Biofouling and greenhouse gas (GHG) emissions from ships, n.d., para. 1).

6. The IMO-Republic of Korea GHG SMART Project is a sustainable maritime transport training program to support developing countries in reducing greenhouse gas emissions from shipping. The project will contribute to implementing IMO measures and developing of national strategies to reduce greenhouse gas emissions in the maritime and port sectors. The training program is focused on LDCs and SIDS (IMO and Republic of Korea partner to address ships' GHG emissions, 2020, para. 2).

7. The IMO-EBRD-World Bank FIN-SMART roundtable is a platform for regular dialogue between key stakeholders in the maritime industry, to support accelerating financial flows (especially in developing countries) to decarbonize the maritime industry (IMO's work to cut GHG emissions from ships, n.d.).

8. The IMO-Germany project will attempt to cut maritime transport emissions in Asia (IMO's work to cut GHG emissions from ships, n.d.).

9. The Maritime Innovation Forum on Zero and Low Emissions is a forum co-organized by the IMO and the United Nations Environment Program (UNEP), with Norwegian support the relevant forum was in September 2021. The objective was to gather all stakeholders to show the latest developments in research and development that support the decarbonization of the maritime industry in line with the IMO's Priority Strategy for Greenhouse Gas Emissions (IMO and UNEP to host 2021 Maritime Zero-Low Carbon Innovation Forum, 2020).

When analyzing the relevant projects, initiatives, forums and roundtables aimed at decarbonizing the maritime industry, it is worth noting their significant contribution to the practical implementation of IMO strategic directions for reducing greenhouse gas emissions.

Of particular note are the financial contributions made by Norway and the GreenVoyage2050 project (IMO's work to cut GHG emissions from ships, n.d.), which has developed the most cost-effective measures to meet the aid needs of states and support the transfer of energy-efficient technologies, contributing to the introduction of green technologies throughout the maritime industry. GreenVoyage2050 has combined existing and possible measures to increase the energy efficiency of ships; it has also created technology groups to determine the level of the technologies maturity and assess the extent of proven technologies' and principles' distribution throughout the maritime industry. Mature technologies are new or existing technologies or principles that are proven and widely used in the maritime industry. Semi-mature – technologies are new or existing technologies or principles that are proven but in limited use in the maritime industry. Immature technologies are new, untested, unproven

technologies or principles, characterized by a relatively low level of installation in the industry and for which there is virtually no experience. Maturity analysis was performed among the following technological groups: machine technology, improvement of the engine and hull, energy consumption on the ship, the use of renewable energy and technological solutions to optimize the operation of the vessel (Technology Groups, n.d.).

The relevant analysis allows interested parties choose the most energy-efficient solutions for practical application, or to identify attractive technologies for potential technical development to decarbonize the maritime industry.

It is also worth noting the work of GreenVoyage2050 to simplify incorporating Annex VI of MARPOL in the national legislation of interested parties. The relevant project website provides an Article-by-Article analysis of Annex VI of MARPOL in 6 languages (Clause by clause analysis of MARPOL Annex VI, 2018), including Russian, showing the level of mandatory or recommended implementation of the rules of Annex VI in the national legislations of the countries concerned.

An important aspect of this project is the development of a Guide to Ship-Port Interaction with Practical Measures to Reduce Greenhouse Gas Emissions (Ship-Port Interface Guide. Practical Measures to Reduce GHG Emissions, 2021, p. 1). This guide can be applied today with limited or low capital and operational investments. The recommended practical measures are relatively quick and easy to implement and have the potential to reduce greenhouse gas emissions, while offering additional benefits. Among the practical measures recommended for implementation with limited capital, are: promoting of immobilization in ports; help in cleaning the hull and screw in ports; facilitating simultaneous operations (SIMOPS) in ports; optimizing port stays in the port by pre-cleaning; improving the planning of the movement of ships entering several berths in one port; improving the compatibility

of the ship and the berth by improving the basic data of the port; enabling the optimization of the deadweight of the vessel by improving the basic data of the port; and optimizing transit speeds between ports (Ship-Port Interface Guide. Practical Measures to Reduce GHG Emissions, 2021, p. 11). The guide explains each of the eight measures and provides practical recommendations for their implementation.

Summing up the work of the IMO Project – Norway GreenVoyage2050 requires noting its significant contribution to the process of decarbonizing the maritime industry and promoting the regulations on energy efficiency at the international level. Most of the guidelines and recommendations suggested by this project have the potential to be implemented by any state.

Conclusions

The process of decarbonization of the maritime industry will be long and complex, and it requires the creation of specialized mandatory legislation not only at the international level but also in the form of national standards. However, the full legal implementation of international regulations into national law will not lead to the desired results, because without technical awareness and financial support, the decarbonization of the maritime industry may be difficult to impossible, especially for developing countries. The advanced methods of improving the energy efficiency of ships, as developed, and implemented by the IMO, are currently quite promising for their practical implementation. The EEDI and SEEMP rules are the first universally binding global energy efficiency standards for the entire international maritime industry. Thanks to their implementation the maritime industry today is 5–20 % more eco-friendly than it was before their adoption. The operational efficiency indicator, which measures a vessel's carbon intensity over time, has also been implemented and it serves as a good

example of the symbiosis of the imperative and dispositive methods of incentivization to increase vessels' energy efficiency.

As part of the IMO strategy to decarbonize the maritime industry and increase the energy efficiency of ships, scientists have identified short-term, medium-term, and long-term solutions. Among them, alternative energy sources occupy an important place. Thanks to the GreenVoyage2050 project, which sorts possible energy-efficient solutions into technology groups (mature, semi-mature and immature), the implementation of green technologies is becoming more accessible and understandable, especially for developing and least developed countries.

Finally, the IMO has been active in ensuring international cooperation and the exchange of energy-efficient technologies. Specialized projects have been created to increase global maritime actors' awareness and to implement the UNFCCC's goal of mitigating climate change by decarbonizing the maritime industry, especially in developing and least-developed countries.

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Єременко К. Міжнародна морська організація та декарбонізація морської галузі: мандат та інструменти. – Стаття.

Міжнародна морська організація (IMO) робить вирішальний внесок у декарбонізацію морської галузі у рамках цілей Національної рамкової конвенції Організації Об'єднаних Націй про зміну клімату (РКЗК ООН). Мандат IMO передбачає безліч заходів щодо скорочення викидів CO2 від міжнародного судноплавства, включаючи введення обов'язкових та необов'язкових інструментів. Положення про енергоефективність суден відіграють вирішальну роль у реалізації цієї стратегії IMO. У статті розглядаються умови глави 4 Міжнародної конвенції щодо запобігання забрудненню з суден (МАРПОЛ), Додаток VI. Основна увага приділяється Проектному індексу енергоефективності (EEDI) як неадміністративному механізму та Плану управління енергоефективністю суден (SEEMP) як операційній діяльності. У цій статті також розглядаються правові аспекти міжнародного співробітництва, поширення енергоефективних технологій у морському секторі та внесок IMO у проект Norway GreenVoyage2050 щодо просування правил МАРПОЛ у національному законодавстві.

Ключові слова: викиди CO2, індекс енергоефективності конструкції (EEDI), план управління енергоефективністю судна (SEEMP), експлуатаційний показник енергоефективності (EEOI), міжнародний сертифікат енергоефективності (IEEC), індекс енергоефективності існуючих суден (EEXI), показник вуглецевомісткості (CII), альтернативні джерела енергії, GreenVoyage2050.

Еременко К. Международная морская организация и декарбонизация морской отрасли: мандат и инструменты. – Статья.

Международная морская организация (ИМО) вносит решающий вклад в декарбонизацию морской отрасли в рамках целей Национальной рамочной конвенции Организации Объединенных Наций об изменении климата (РКИК ООН). Мандат ИМО предусматривает множество мероприятий по сокращению выбросов CO2 от международного судоходства, включая введение обязательных и необязательных инструментов. Положения об энергоэффективности судов играют решающую роль в реализации этой стратегии ИМО. В статье рассматриваются условия главы 4 Международной конвенции по предотвращению загрязнения с судов (МАРПОЛ), Приложение VI.

Основное внимание в нем уделяется Проектному индексу энергоэффективности (EEDI) как неадминистративному механизму и Плану управления энергоэффективностью судов (SEEMP) как операционной деятельности. В этой статье также рассматриваются правовые аспекты международного сотрудничества, распространение энергоэффективных технологий в морском секторе и вклад ИМО в проект Norway GreenVoyage2050 по продвижению правил МАРПОЛ в национальном законодательстве.

Ключевые слова: выбросы CO2, индекс энергоэффективности конструкции (EEDI), план управления энергоэффективностью судна (SEEMP), эксплуатационный показатель энергоэффективности (EEOI), международный сертификат энергоэффективности (IEEC), индекс энергоэффективности существующих судов (EEXI), показатель углеродоемкости (CII) рейтинг, альтернативные источники энергии, GreenVoyage2050.