INTERNATIONAL MARITIME ORGANIZATION

E

INTERSESSIONAL MEETING OF THE WORKING GROUP ON REDUCTION OF GHG EMISSIONS FROM SHIPS
6th session
Agenda item 2

ISWG-GHG 6/2
21 August 2019
ENGLISH ONLY

FURTHER CONSIDERATION OF CONCRETE PROPOSALS TO IMPROVE THE OPERATIONAL ENERGY EFFICIENCY OF EXISTING SHIPS, WITH A VIEW TO DEVELOPING DRAFT AMENDMENTS TO CHAPTER 4 OF MARPOL ANNEX VI AND ASSOCIATED GUIDELINES, AS APPROPRIATE

Initial impact assessment of the energy efficiency improvement measure on existing ships (EEXI)

Submitted by Japan and Norway

SUMMARY

Executive summary:	This document provides an updated initial impact assessment of the energy efficiency improvement measure on existing ships as submitted by Japan (MEPC 74/7/2) and EEDI for existing ships as submitted by Norway in document ISWG-GHG 5/4, which are built upon fundamentally the same framework ("EEXI" hereafter). The initial impact assessment is conducted in accordance with the procedure set out in MEPC.1/Circ.885, concluding that the proposed EEXI has positive impacts on reduction of GHG emissions and voyage cost, and that the overall transport cost could be reduced and any potential negative impact could be avoided.
Strategic direction, if applicable:	3
Output:	3.2
Action to be taken:	Paragraph 8
Related documents:	MEPC 72/17; MEPC 73/19; MEPC 74/7/2, MEPC 74/INF.23; ISWG-GHG 5/4, ISWG-GHG 5/4/1 and MEPC.1/Circ.885

Introduction

1 The Marine Environment Protection Committee (MEPC), at its seventy-fourth session, considered a number of concrete proposals for candidate short-term measures including proposals on the energy efficiency improvement measure on existing ships as submitted by

Japan (MEPC 74/7/2) and EEDI for existing ships as submitted by Norway in document ISWG-GHG 5/4, which are built upon fundamentally the same framework ("EEXI" hereafter).

2 The Committee further approved the *Procedure for assessing impacts on States of candidate measures* (MEPC.1/Circ.885). According to the procedure, an initial impact assessment of the measure should be submitted as a part of the initial proposal to the Committee for candidate measures.

3 Although documents MEPC 74/7/2 and ISWG-GHG 5/4 provide initial analysis on impacts of the measures, this document includes an updated initial impact assessment of the EEXI in accordance with the procedure set out in MEPC.1/Circ.885.

Initial impact assessment of the EEXI

4 The result of the initial impact assessment of the EEXI is set out in the annex.

5 In summary, the co-sponsors are of the view that the proposed EEXI has positive impacts on reduction of GHG emissions and voyage cost, and that the overall transport cost could be reduced.

6 However, the initial impact assessment does not include quantitative analysis on transport cost or potential economic impacts, since the specific reduction rates have not been proposed yet. Therefore, further quantitative analysis on the detailed breakdown of such potential impact may be conducted in parallel with consideration of the required level of efficiency improvement, before adoption of the measure.

7 Furthermore, in order to avoid any potential disproportionately negative impacts, it is essential to set the required EEXI at an appropriate level for each category of ship type and ship size, rather than applying a fixed/the same reduction rate to all ships. The required EEXI should satisfy both i) contribution to at least 40% carbon intensity reduction target by 2030 and ii) feasibility to be achieved without substantial increase in cost or major technical challenges.

Action requested of the Working Group

8 The Group is invited to consider the initial impact assessment of the energy efficiency improvement measure on existing ships (EEXI) set out in the annex and take action as appropriate.

***

ANNEX

INITIAL IMPACT ASSESSMENT OF THE ENERGY EFFICIENCY IMPROVEMENT MEASURE ON EXISTING SHIPS (EEXI)

1 Impacts on ships and emissions (both positive and negative)

1.1 Impacts on ships

1.1.1 The proposed EEXI requires existing ships to improve energy efficiency performance. Since the measure is goal-based, any option will be allowed to meet the requirement, such as efficiency improvements or the use of alternative fuels, as long as such an option is verifiable.

1.1.2 If a ship chose engine power limit (EPL), the ship should limit its maximum engine power for normal operation in order to meet the requirement. However, as described in document MEPC 74/INF.23 (Japan), EPL does not change the ship's original maximum continuous rating (MCR) which may be utilized in adverse weather conditions.[1] Therefore, EPL does not impact safety or any other performances of the ships except for energy efficiency and maximum power for normal operation.

1.1.3 If a ship chooses to install energy saving devices (e.g. optimally-designed propellers), the ship can maintain its design speed performance with less engine power so as to achieve less fuel consumption. Although the redundant engine power may be limited by EPL in order to avoid the rebound effect (taking advantage of the efficiency improvement by operating at higher speed), the ship can still improve efficiency without any negative consequence to other performances.

1.1.4 If a ship chooses to switch to alternative fuels (e.g. LNG, blending with bio-diesels or co-combustion with hydrogen gas), although this option depends on supply capacity, availability and definition of carbon factors of such alternative fuels, the ship can simply reduce CO_2 emissions so as to improve the EEXI (less CO_2 per transport work) while maintaining the same operational practice.

1.1.5 Under the EEXI, the shipowner is free to choose or combine any option in order to meet the requirement and will therefore be able to take informed decisions based upon the particular ship and its trade.

1.2 Impacts on emissions

1.2.1 The proposed EEXI is a mandatory requirement under MARPOL Annex VI and the applicable ships will fall under the existing survey and certification scheme in a similar manner as for the EEDI requirements. Whatever options the ship chooses, the ship should improve the EEXI at least to the required level.

1.2.2 Unlike operational requirements that can only be enforced through retroactive inspections and where there is no alternative compliance mechanism if a ship does not meet the requirement, the EEXI prevents non-compliant ships to be operated in advance, since it builds upon the existing EEDI framework and the survey and certification scheme.

1 Clear guidelines need to be developed to determine the procedures for overriding the EPL, as proposed in document MEPC 74/5/5 (France et al).

1.2.3 Therefore, the EEXI ensures certain emissions reduction once it enters into force. Quantitative emissions reduction depends on the level of the required EEXI, and it can only be accurately estimated once the level of the required EEXI is agreed.

1.2.4 According to the estimates provided in document ISWG-GHG 5/4, about 22,500 "existing/pre-EEDI ships"[2] falling under the ship types defined in regulation 2 of MARPOL Annex VI and above the size thresholds for required EEDI per regulation 21 were active in 2015. The 22,500 ships emitted about 70% of the total emissions from all ships sailing in 2015. In 2030, these ships are expected to emit about 27% of the total emissions. Very few ships built before 2000 are expected to be in service in 2030.

1.2.5 If the required EEDI was set to the reference line as proposed in document ISWG-GHG 5/4, it is expected to reduce the average EEDI by 10-20%. Assuming that the EEDI reduction would result in the same operational reduction, this measure can contribute to reducing the carbon intensity by around 4% in 2030 if setting the requirement to the reference line. However, the contribution to the 40% carbon intensity reduction target by 2030 will be possible if the scope of application (ship types, size cut-off and age-groups) and the stringency of the measure is sufficiently set. It should also be noted that the EEXI does not necessarily preclude other measures, e.g. a strengthening of SEEMP.

2 Issues to be taken into account

2.1 Geographic remoteness of and connectivity to main markets (see also 2.4)

2.1.1 Fuel cost accounts for nearly two thirds of the voyage cost, although it might differ depending on each ship and its trade pattern. Since an energy efficiency improvement measure directly reduces fuel consumption, ships will reduce their voyage cost by implementing the EEXI (see 2.4.1 and figure 1 extracted from Stopford, M., *Maritime Economics, Third Edition*, 2009).

2.1.2 However, transport cost of shipping depends on various factors such as ship type, ship size, fuel price, market condition and trade patterns. Therefore, it will be useful to analyse impact of the EEXI on transport costs in different shipping routes including both remote areas and non-remote areas based on empirical data. Section 2.4 of this annex provides some initial analysis of transport cost in transpacific routes in this context.

2.2 Cargo value and type (see also 2.5)

2.2.1 Cargo value and type are interlinked and are the primary factors in deciding ship type and ship size. It may also be considered in the context of food security. Therefore, it is important to consider different approaches depending on ship type and ship size, rather than applying the same requirements to all categories of ships.

2.2.2 In light of this, the EEXI can apply different reduction rates based on ship type and ship size, an approach that has already been introduced in the EEDI requirements for new ships.

[2] Delivered from 2000 and onwards and contracted before 1 January 2013.

2.3 Transport dependency (see also 2.4)

2.3.1 If a State is heavily dependent on international seaborne transport, its economy might benefit more from the EEXI measure than the other States, as the EEXI reduces fuel oil consumption and therefore the voyage costs, a substantial part of the total transport costs (see 2.4).

2.4 Transport costs

2.4.1 The EEXI can reduce the overall transport costs if the savings from the reduced fuel oil consumption exceeds other costs (e.g. operating and capital costs). In general, the cost of running a ship consists of i) operating costs; ii) periodic maintenance; iii) voyage costs; iv) cargo-handling costs; and v) capital costs. Among these costs, voyage costs mainly consist of fuel cost and, together with capital costs, these are the major factors that will have an impact on transport costs in international shipping (see figure 1).

Voyage cost

2.4.2 The EEXI reduces voyage cost by reducing fuel consumption. Since it mandates energy efficiency improvement for each ship, complying with the requirement results in reduction of fuel consumption per transport work. The volume of fuel saving depends on the level of the required EEXI (X% of efficiency improvement equals X% of fuel saving, if transport work was the same). Therefore, once the level of the required EEXI is set, the level of voyage cost reduction can be estimated.

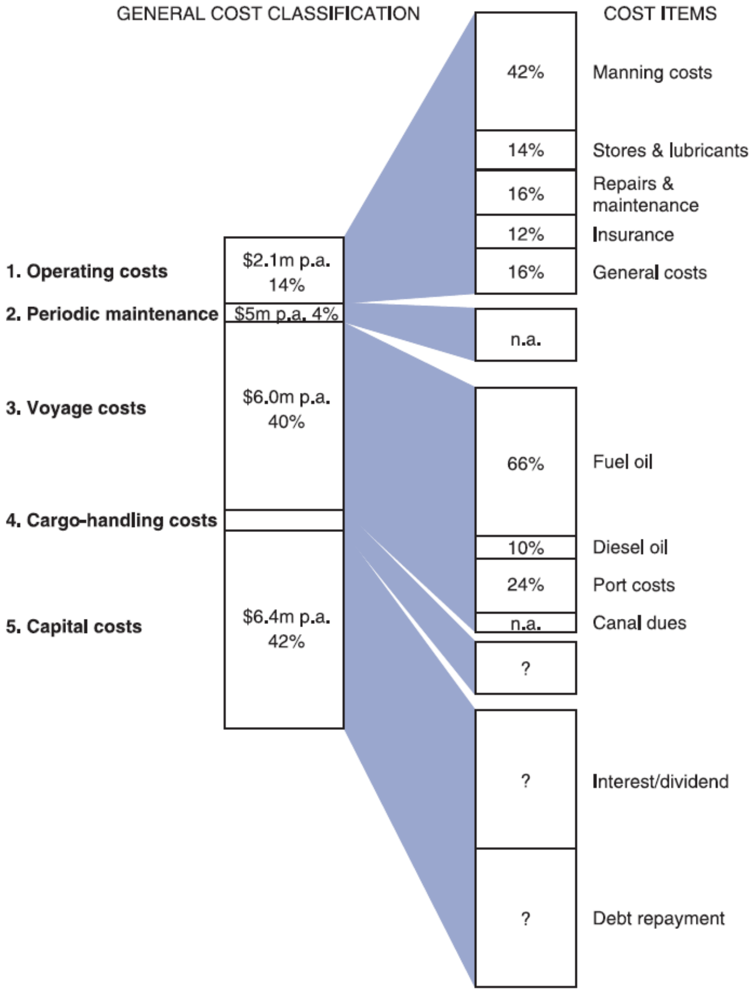

Figure 1. Analysis of the major costs of running a bulk carrier.
Extracted from *Maritime Economics, Third Edition* (Stopford, 2009)

Capital cost

2.4.3 In general, improving a ship's energy efficiency performance might increase the capital cost associated with the ship. For example, retrofitting an energy saving device will require capital investments, although such investment may be recovered by fuel cost savings.

2.4.4 The EEXI allows multiple options to improve energy efficiency and it will be the shipowner's decision on what options are optimal for a specific ship and trade. For example, if a shipowner could not afford to bear substantial capital investment for fuel change or retrofitting, engine power limit (EPL) could be chosen as an option without substantial cost.

Engine power limit and net transport cost

2.4.5 If a ship chose engine power limit (EPL) as an option to comply with the EEXI requirements, the ship might operate at a lower speed than those who chose other alternatives in order to meet the requirements. Slowing down reduces fuel consumption, but at the same time it results in longer shipping time, which will increase inventory cost of goods, capital cost for fleet increase and other costs associated with the operation. There are several studies on the effect of ship speed and transport cost:

.1 National Maritime Research Institute of Japan (NMRI),[3] using the ship movement database by Lloyd's List Intelligence, finds that ship speed has been continuously decreasing since 2010 for most ship types.

Type	Size	Average sea speed(knots)							Annual reduction rate
		3rd. IMO GHG Study						Estimation	2008-2018(e)
		2007	2008	2009	2010	2011	2012	2018(e)	
Container	0-999 teu	13.3	13.2	13.2	12.7	12.6	12.4	12.0	**-1.0%**
	1,000-1,999 teu	15.2	15.2	15.1	14.5	14.4	13.9	13.4	**-1.2%**
	2,000-2,999 teu	16.8	16.7	16.8	16.2	16.0	15.0	14.2	**-1.6%**
	3,000-4,999 teu	18.6	18.1	17.6	17.2	16.9	16.1	14.9	**-2.0%**
	5,000-7,999 teu	20.6	19.7	19.2	17.5	17.2	16.3	15.1	**-2.6%**
	8,000-11,999 teu	21.3	20.3	19.9	17.9	17.4	16.3	15.1	**-2.9%**
	12,000-14,499 teu	20.6	19.2	17.4	17.0	16.9	16.1	15.2	**-2.3%**
	14,500-+ teu	-	-	-	-	-	14.8	15.2	**-**
General cargo	0-4,999 dwt	9.3	9.2	9.2	8.8	8.8	8.7	8.8	**-0.5%**
	5,000-9,999 dwt	11.4	11.3	10.9	10.4	10.3	10.1	9.8	**-1.4%**
	10,000-+ dwt	12.9	12.9	12.6	12.2	12.1	12.0	11.4	**-1.2%**
Refrigerated cargo	All sizes	13.6	13.7	13.6	13.7	13.6	13.4	13.0	**-0.6%**

2018(e): NMRI estimation based on LLI vessel movement data

Table 1. Estimate of ship speed (2008-2018)

Using data from the United States Census Bureau[4] and Datamyne,[5] it further analysed the trend of transport cost in different shipping routes (from Japan/China/South Korea/Chile to North America), with a ratio to the price of goods imported to North America by these shipping routes (see figure 2).

Although further analysis might be needed to derive causal effect of ship speed on transport cost in different shipping routes and cargos, the result by NMRI implies that slow-steaming since 2010 did not result in an increase in transport cost.

3 Kosaka (2019), *Analysis on impact of slow-steaming on international trade costs*, National Maritime Research Institute (Original in Japanese).

4 United States Census Bureau, USA Trade Online, https://usatrade.census.gov

5 DESCARTES, Datamyne, http://www.datamyne.com/

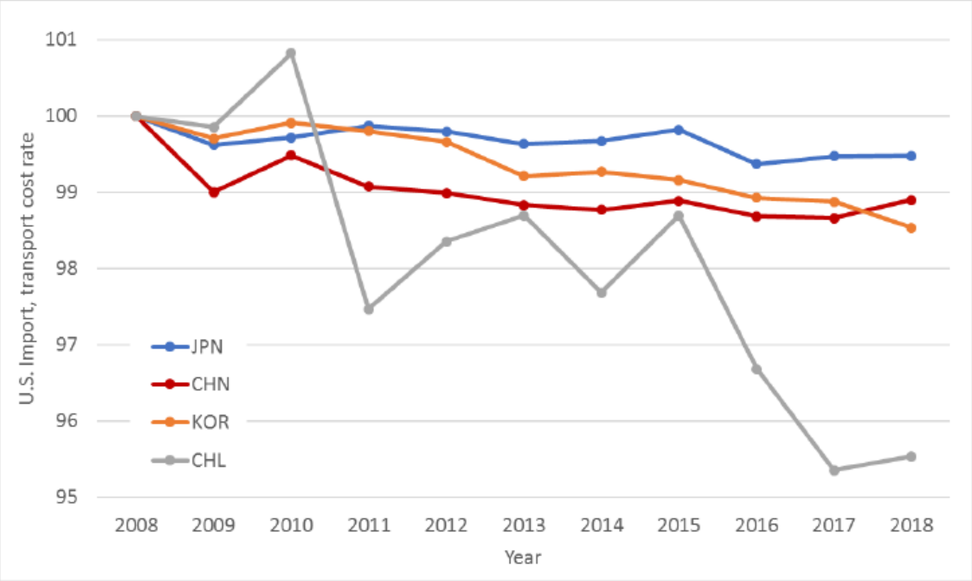

Figure 2. Ratio of transport cost to import cost (2008-2018).
The country codes in the examples are as follows: JPN (Japan), CHN (China), KOR (Republic of Korea) and CHL (Chile).

.2 Öko-Institut e.V.[6] of Germany, using theoretical models, estimated the impact of ship speed on total transport costs of bulk carriers for different size categories and different fuel prices, identifying main contributors to transport costs (see figure 3).

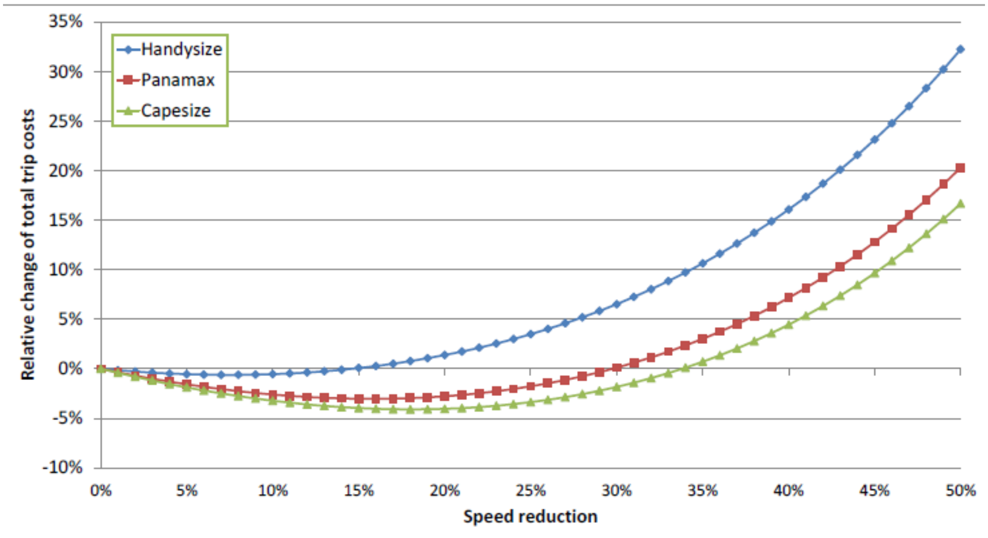

Figure 3. Effect of ship speed on transport cost (Healy and Graichen (2019)).

It identified that adoption of progressively higher speed reductions extended the number of days at sea and this resulted in additional bulk freight costs (i.e. the longer voyages due to the introduction of speed reductions lead to an increase in operational, capital and revenue costs).

6 Healy and Graichen (2019), *Impact of slow steaming for different types of ships carrying bulk cargo*, Öko-Institut e.V. (https://www.oeko.de/en/publications/p-details/impact-of-slow-steaming-for-different-types-of-ships-carrying-bulk-cargo/).

However, it further analysed that these additional bulk freight costs were offset by the lower fuel costs in the majority of the scenarios, unless the fuel price was very low or if a "break-even point" for speed reduction was exceeded where the marginal fuel cost reductions could no longer offset the marginal operational cost increases under slow steaming.

It also identified that maritime transport costs contributed with less than 5% to consumer prices in most cases and that small changes in transport costs in either direction would not have a significant impact.

In summary, it was found that i) slow-steaming would bring lower transport cost for most scenarios, ii) there was a break-even point of speed reduction where net transport cost could no longer be reduced, and iii) small changes in maritime transport cost would not have a significant impact on product prices.

2.4.6 Based on these studies, it is considered that EPL, a possible option to be taken under the EEXI measure, can reduce net transport cost unless the "break-even point" is exceeded.

Summary: net transport cost

2.4.7 The EEXI could reduce the net transport cost, as the EEXI reduces fuel oil consumption and therefore the voyage costs, which are a substantial part of the net transport cost. As this is a goal-based measure where the shipowner can choose the option regarded as optimal for each individual ship and trade, the goal-based EEXI requirement will be met in the most cost-effective manner and have the potential to reduce the net transport costs.

2.5 Food security (see also 2.2, 2.3 and 2.4)

2.5.1 Similarly to the issue on transport dependency and geographic remoteness of and connectivity to main markets, if a State's food supply was heavily dependent on import by ships, its food security might benefit more from the EEXI than the other States, as the EEXI might save transport costs (see 2.4).

2.5.2 However, there could be some food products, such as perishables, for which transport time should be taken into account. Therefore, careful consideration should be given based on type of goods, as well as ship type and ship size.

2.6 Disaster response

2.6.1 The EEXI does not apply to emissions for disaster response falling under regulation 3.1.1 of MARPOL Annex VI, which exempts any emission necessary for the purpose of securing the safety of a ship or saving life at sea from application of the Annex.

2.6.2 In addition, some sea areas may be vulnerable to natural disasters such as typhoons (see figure 4). In such areas, ships may have to expect adverse weather conditions in which extraordinary engine power might be needed in order to maintain manoeuvrability of the ship.

2.6.3 In order to solve the conflict between emissions reduction and safety in case of adverse weather conditions, the EEXI allows "safety power reserve" for ships choosing EPL as an option to meet the requirement. The detailed mechanism and measures to prevent improper use of "safety power reserve" are described in documents MEPC 74/5/5 (France et al.) and MEPC 74/INF.23 (Japan).

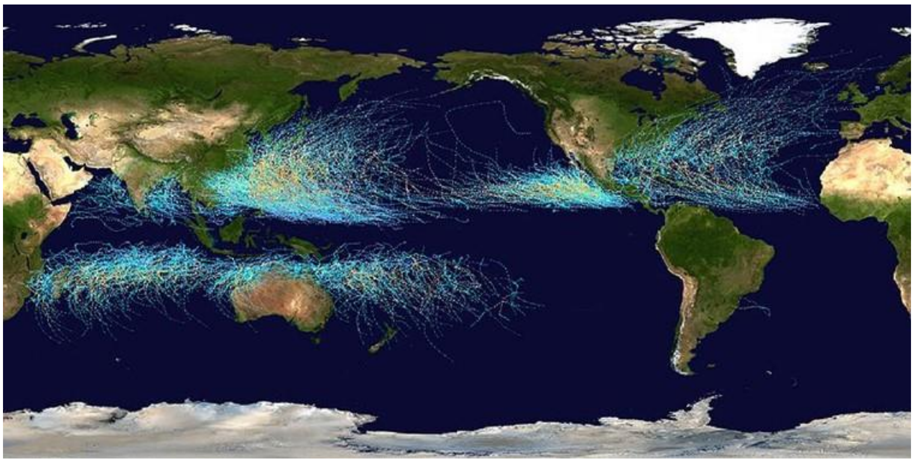

Figure 4. Map of the cumulative tracks of tropical cyclones (1985-2005)[7]

2.7 Cost-effectiveness (see also 1.2 and 2.4)

2.7.1 Cost-effectiveness of the EEXI depends on i) how much GHG emissions could be reduced and ii) how much transport cost will be influenced.

2.7.2 As described in section 1.2, the EEXI can ensure certain emission reductions once it enters into force, though quantitative analysis will be needed based on the specific level of the required EEXI.

2.7.3 Therefore, quantitative cost-effectiveness of the EEXI could be further considered in conjunction with further quantitative analysis on the level of GHG emissions reduction and the transport costs, if necessary.

2.8 Socio-economic progress and development (see also 2.3 and 2.4)

2.8.1 Similarly to the issue on transport dependency, if a State was heavily dependent on international seaborne transport, its economy might benefit more from the EEXI than the other States, as the EEXI measure might save transport costs (see 2.4).

3 Potential disproportionately negative impacts

3.1 In general, as long as the measure is applied and enforced robustly and globally regardless of the flags under the principle of non-discrimination and no more favourable treatment, disproportionately negative impacts may be avoided and a level playing field may be secured. This is what IMO has realized through a number of legally binding requirements on ships for both safety and environmental purposes.

3.2 However, as discussed under section 2 of this annex, there might be cases where disproportionately negative impacts might happen if the required EEXI was improperly set:

.1 if the required EEXI was set flatly regardless of ship type and ship size, the requirement might disproportionately impact specific shipping activities. For example, it might be inappropriate to apply the same requirement on small refrigerated cargo carriers and very large containerships;

[7] Source: NASA (https://www.nasa.gov/mission_pages/hurricanes/features/hurricane_brew.html).

.2 if the required EEXI was set at a level beyond the "break-even point", the requirement might raise total transport costs; and

.3 if the required EEXI did not take into account manoeuvrability of ships in adverse weather conditions, the shipping activities in specific sea areas in which natural disasters frequently occur will be impacted.

4 Potential measures to address potential impacts

4.1 In order to avoid aforementioned potential impacts, it is essential to set the required EEXI at an appropriate level for each category of ship type and ship size. The requirements the EEXI should satisfy are both i) contribution to at least 40% carbon intensity reduction target by 2030 and ii) feasibility to be achieved without substantial cost and technical challenges.

4.2 In terms of safety in case of adverse weather conditions, "safety power reserve" should be allowed for ships choosing EPL as an option to meet the requirement. At the same time, appropriate measures to prevent improper use of "safety power reserve" should be developed in accordance with documents MEPC 74/5/5 (France et al.) and/or MEPC 74/INF.23 (Japan).

4.3 In particular for specific categories/groups of ships, exemption or mitigation of the measure could be considered. For example, the EEDI phase 2 requirements apply relatively relaxed reduction rates for some ship types such as refrigerated cargo carriers and ro-ro ships. The EEDI phase 3 requirements apply different levels of reduction rate for containerships by ship size. Furthermore, for all ship types, small ships are exempt from application of the EEDI requirements. A similar approach could be considered under the EEXI requirements as well.

4.4 Furthermore, as a safeguard to allow flexibility under the responsibility of the Administration, a waiver clause with specific conditions under the Convention could be considered. For example, regulation 19.4 of MARPOL Annex VI had allowed the Administration to waive the EEDI requirement up to 1 July 2019, subject to notification to IMO and circulation to the other Parties by IMO. A similar framework within some grace period could be considered, if needed.

5 Limitations

5.1 The initial impact assessment does not include quantitative analysis on transport cost or potential economic impacts, since a specific reduction rate has not been proposed yet. Therefore, further quantitative analysis on a detailed breakdown of such a potential impact may be conducted in parallel with consideration of a level of efficiency requirement, before adoption of the measure.

APPENDIX

SUMMARY TABLE OF INITIAL IMPACT ASSESSMENT OF THE ENERGY EFFICIENCY IMPROVEMENT MEASURE ON EXISTING SHIPS (EEXI)

1 Impact on ships and emissions

Section	Impact on:	Positive impact	Negative impact
1.1	Ships	- Better energy efficiency	- Reduced maximum speed (in case of EPL only)
1.2	Emissions	- Less CO_2 emissions	- NA

2 Issues to be taken into account

Section	Issues	Description
2.1	Geographic remoteness of and connectivity to main markets	- To be considered in the context of transport cost. (See also 2.4)
2.2	Cargo value and type	- Primary factor to decide ship type and size. - Different levels of the required EEXI by ship type and size are needed.
2.3	Transport dependency	- To be considered in the context of transport cost. (See also 2.4)
2.4	Transport costs	- Voyage cost can be reduced. - Capital cost and other costs associated with operation may increase, but net transport cost might be reduced.
2.5	Food security	- To be considered in the context of transport cost. (See also 2.4) - Consideration should be given based on type of goods, as well as ship type and ship size.
2.6	Disaster response	- "Safety power reserve" to maintain the manoeuvrability of the ship should be allowed. - Appropriate measures to prevent improper use of "safety power reserve" should be developed.
2.7	Cost-effectiveness	- Positive. Quantitative cost-effectiveness could be further considered in conjunction with further quantitative analysis on the level of GHG emissions reduction and the transport costs, if necessary. (See also 1.2 and 2.4)
2.8	Socio-economic progress and development	- To be considered in the context of transport cost. (See also 2.4)

3 Potential disproportionately negative impacts and measures to address them

Section	Potential disproportionately negative impacts	Measures
3.2.1	Impact on shipping activities	- Different levels of the required EEXI by ship type and size are needed. - Exemption/mitigation for specific categories/groups of ships could be considered. - Waiver by the Administration could be considered.
3.2.2	Impact on transport cost	- Technically feasible levels of the required EEXI are needed.
3.2.3	Impact on disaster response	- "Safety power reserve" to maintain the manoeuvrability of the ship should be allowed. - Appropriate measures to prevent improper use of "safety power reserve" should be developed.

___