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REDUCTION OF GHG EMISSIONS FROM SHIPS

Report of the ad-hoc Expert Workshop on comparative analysis of candidate mid-term GHG reduction measures

Preliminary expert review of the technical and economic elements, and their possible combinations, of the proposals for candidate mid-term GHG reduction measures

Note by the Secretariat

SUMMARY

Executive summary: This document provides a report of the ad-hoc Expert Workshop on comparative analysis of candidate mid-term GHG reduction measures (GHG-EW 3) organized by the Secretariat on 25 and 26 May 2023 upon request of ISWG-GHG 14

Strategic direction, if applicable: 3

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Related documents: GHG EW/3/3; MEPC 80/WP.6, and MEPC 80/INF.39

Introduction

1 As stated in paragraph 10 of document MEPC 80/INF.39, this document presents in annex UNCTAD's preliminary expert review of the technical and economic elements, and their possible combinations, of the proposals for candidate mid-term GHG reduction measures submitted to ISWG-GHG and MEPC.

Action requested of the Committee

2 The Committee is invited to note the information provided in this document in conjunction with the report of the ad-hoc Expert Workshop on comparative analysis of candidate mid-term GHG reduction measure.

ANNEX

**PRELIMINARY EXPERT REVIEW OF THE TECHNICAL AND ECONOMIC ELEMENTS, AND
THEIR POSSIBLE COMBINATIONS, OF THE PROPOSALS FOR CANDIDATE MID-TERM
GHG REDUCTION MEASURES SUBMITTED TO ISWG-GHG AND MEPC**

UNCTAD preliminary expert review
of the technical and economic elements, and their
possible combinations, of the proposals for candidate
mid-term GHG reduction measures submitted to
ISWG-GHG and MEPC

Final report

4 June 2023

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Abbreviations and Acronyms

CAPEX	Capital Expenditure	IPCC	Inter-governmental Panel on Climate Change
CBA	Cost Benefit Analysis	KPI	Key Performance Indicators
CBDR-RC	Common but Differentiated Responsibilities and Respective Capabilities	LCA	Life Cycle Assessment
CEA	Cost Effectiveness Analysis	LDCs	Least Developed Countries
CfD	Contract for Difference	LNG	Liquefied Natural Gas
CI	Carbon Intensity	MACC	Marginal Abatement Cost Curve
CIA	Comprehensive Impact Assessment	MARPOL	International Convention for the Prevention of Pollution from Ships
CII	Carbon Intensity Indicator	MBM	Market-Based Measure
CO ₂	Carbon Dioxide	MCA	Multi-Criteria Analysis
CO _{2e}	Carbon Dioxide Equivalent	MEPC	Marine Environment Protection Committee (of IMO)
DCS	IMO Fuel Oil Consumption Data Collection System	MJ	Megajoule
DU	Deficit Unit	Nm	nautical mile(s)
DWT	Deadweight Tonnage	O/D	Origin / Destination
ECTS	Emissions Cap and Trade System	R&D	Research and Development
EEDI	Energy Efficiency Design Index (for Ships)	RD&D	Research, Development, and Deployment
EEXI	Energy Efficiency Existing Ship Index	SEEMP	Ship Energy Efficiency Management Plan
EPL	Engine Power Limitation	SHA	Stakeholders' Analysis
ETS	Emissions Trading System	SIDS	Small Island Developing States
EU	European Union	SoC	Statement of Compliance
FCM	Flexibility Compliance Mechanism	SRU	Surplus Reward Unit
FCU	Flexible Compliance Unit	SSF	Sustainable Shipping Fund
GDP	Gross Domestic Product	TEU	Twenty-foot Equivalent Unit
GHG	Greenhouse Gas	TJ	Terajoule
GIS	Geographical Information Systems	TtW	Tank-to-Well
GFI	GHG Fuel Intensity	UNCTAD	United Nations Conference on Trade and Development
GFS	Greenhouse Gas Fuel Standard	UNFCCC	United Nations Framework Convention on Climate Change
GJ	Gigajoule	WtT	Well-to-Tank
GRUs	GHG Remedial Units	WtW	Well-to-Wake
GT	Gross Tonnage	ZESIS	Zero-Emission Shipping Incentive Scheme
ICS	International Chamber of Shipping	ZEVs	Zero Emission Vessels
IMO	International Maritime Organization		
IMSF&F	International Maritime Sustainable Fuels and Fund		
IMSF&R	International Maritime Sustainability Funding and Reward		

1 Background and Introduction

Maritime transport is a strategic economic sector that enables growth and determines countries' trade competitiveness and ability to integrate effectively into the global marketplace. With more than 80% of world merchandise trade by volume estimated to be carried by sea, maritime transport shapes the degree of participation or marginalization of countries in the global trading system (UNCTAD, 2022). In addition to its role as a trade enabler and supply chain connector, maritime transport is an economic sector in its own right that creates jobs, generates wealth and value, and contributes to national economic output and social well-being.

The shipping sector is currently at the centre stage of the debate on sustainability. Like other economic sectors, shipping generates greenhouse gas (GHG) emissions and must take action to reduce its carbon footprint as soon as possible. According to the Fourth IMO GHG Study 2020, without further action, carbon dioxide (CO₂) emissions from international shipping are projected to increase from about 90% of 2008 emissions in 2018 to 90-130% of 2008 emissions by 2050 for a range of plausible long-term economic and energy scenarios. For this highly strategic sector not to erode its own benefits, particularly as demand for shipping has grown faster than fuel efficiency improvements over the years, mainstreaming the sustainability principles in maritime transport and decarbonizing shipping is now a pressing imperative.

The IMO, as the specialized United Nations agency with responsibility for regulating the safety and security of shipping and the prevention of marine and air pollution by ships, has over recent years accelerated its work on regulating air emissions from ships, including air pollutants and GHGs. In 2011, IMO adopted mandatory measures to reduce emissions of GHGs from international shipping under IMO's pollution prevention convention (MARPOL). Measures adopted included the Energy Efficiency Design Index (EEDI) mandatory for new ships, and the Ship Energy Efficiency Management Plan (SEEMP).

The 72nd session of IMO's Marine Environment Protection Committee (MEPC) held in April 2018, adopted resolution MEPC.304(72) on the Initial IMO Strategy on reduction of GHG emissions from ships (the Initial Strategy). The Strategy features a series of candidate short-, mid- and long-term measures aimed at reducing the carbon footprint of international shipping. The "short-term GHG reduction measures" were adopted at MEPC 76 in June 2021 and included the Energy Efficiency Existing Ships Index (EEXI), the Carbon Intensity Indicator (CII) and a strengthened Ship Energy Efficiency Management Plan (SEEMP).

In addition to leveraging more efficient ship design, energy saving technologies and operational measures, achieving GHG reduction targets in shipping requires a fuel switch and the uptake of lower or zero carbon fuel alternatives. To this end, shipping requires an enabling policy framework that can promote the availability of low and zero-carbon bunker fuels and technologies and ensure their cost-competitiveness compared to fossil-based fuels and technologies while, at the same time, providing safeguards that pave the way to a just and equitable transition for States. Based on the timeline foreseen by the Initial IMO GHG Strategy and a Work plan for the development of mid- and long-term measures, IMO negotiations are currently focusing on the

development of a basket of mid-term GHG reduction measures, and their impact assessments in accordance with the revised procedure for assessing impacts on States of candidate measures (MEPC.1/Circ.885/Rev.1).

The 2018 Initial Strategy provides that the impacts on States of a measure should be assessed and taken into account, as appropriate, before a measure is adopted. In assessing the impacts, particular attention should be paid to the needs of developing countries, especially small island developing States (SIDS) and least developed countries (LDCs). Disproportionately negative impacts should be assessed and addressed, as appropriate. In 2021, UNCTAD undertook the assessment of the impact on States of the short-term GHG reduction measures as part of the comprehensive impact assessment approved by MEPC 76 before adopting the measures (documents MEPC 76/7/13 and MEPC 76/INF.68 and addendum).

In June 2021, MEPC 76 approved the Work Plan for the development of mid- and long-term GHG reduction measures in line with the Initial IMO Strategy and its Programme of follow-up actions. The Work Plan consists of three main phases:

Phase I (2021– 2022) – Collation and initial consideration of proposals for measures to help understand and compare their main features and implications and identify the key issues to consider in relation to each proposed measure, along with considerations of their potential impacts on States in the application of Circular MEPC.1/Circ.885/Rev.1 on the Procedure for assessing Impacts on States of candidate measures.

Phase II (2022–2023) – Assessment and selection of measure(s) to further develop. Information obtained during Phase I is used to inform the selection of the measure(s) that will be developed as a matter of priority. This selection of the measure (s) will be based on an assessment of the proposed measures, in particular their feasibility, their effectiveness to deliver the long-term levels of ambition of the Initial Strategy and their potential impacts on States. Decisions on measures to develop, as a priority, may be taken in conjunction with the revision of the Initial Strategy.

Phase III – Development of (a) measure(s) to be finalized within (an) agreed target date(s). In the case of amending existing legal instruments, amendments will be prepared, as appropriate. In the case of developing a new legal instrument, a framework for consideration by the MEPC will be prepared to decide on the way forward. Phase III target date(s) are to be agreed in conjunction with the IMO Strategy on Reduction of GHG Emissions from Ships.

The Revised procedure for assessing impacts on States of candidate measures set out in MEPC.1/Circ.885/Rev.1 was approved by MEPC 79 in December 2022. It specifies that the impact assessment should be simple, inclusive, transparent, flexible, evidence-based and measure-specific. It is further noted that the comprehensiveness of any impact assessment should be commensurate to the complexity and nature of the proposed measure. Impact assessments should be undertaken in parallel with the consideration and development of candidate measures.

Four steps underpin the procedure. The first step involves the submission of an Initial Impact Assessment as part of the initial proposal to the MEPC for candidate measures. Bearing in mind

two additional steps that may involve providing comments on the Initial Impact Assessment (Step 2) and revising the initial assessment (Step 3), the modalities stipulate that during the last step (Step 4), a Comprehensive Impact Assessment will be conducted.

According to the set modalities, the Initial Impact Assessment should indicate whether the proposal for the measure provides a description of impacts on ships and emissions as well as identify which impacts should be assessed, including among others the eight criteria outlined in the procedure, as appropriate (geographic remoteness of and connectivity to main markets; cargo value and type; transport dependency; transport costs; food security; disaster response; cost-effectiveness; and socio-economic progress and development). The Initial Impact Assessment should also indicate both positive and negative potential impacts and analyse the extent of the impacts, and whether the measure is likely to result in disproportionately negative impacts and, if so, how these could, as appropriate, be addressed (e.g., avoided, remedied, mitigated). The Initial Impact Assessment should also indicate the methodological tools and data sources used and may indicate the limitations of the analysis.

The future Comprehensive Impact Assessment should consider the issues identified in the previous steps; in the Initial Impact Assessment and, if applicable, the comments received i.e., as set out in Steps 2 and 3 of MEPC.1/Circ.885/Rev.1. The Comprehensive Impact Assessment should consider the guidance on process and methodological elements for the conduct of comprehensive impact assessments and, in addition, pay particular attention to the needs of developing countries, especially SIDS and LDCs.

Against this background and drawing upon a long-standing and fruitful cooperation between the two agencies, UNCTAD has been requested by the IMO Secretariat to carry out an expert preliminary review of the technical and economic elements, and their possible combinations, of the proposals for candidate mid-term measures submitted to ISWG-GHG and MEPC. The present report presents a summary of the findings of the UNCTAD preliminary expert review.

UNCTAD reiterates the view, previously expressed in 2020 and 2021 (UNCTAD 2020, UNCTAD 2021), that the conduct of impact assessments of proposed measures before their adoption and implementation is a useful good practice in regulatory governance. These assessments can help provide valuable input to a future comprehensive impact assessment and help anticipate potential implementation issues or risks that may arise, including negative impacts or unintended effects on relevant actors directly or indirectly subjected to the regulatory measures. Delays in adopting the requisite decarbonization measures and a prolonged regulatory uncertainty are likely to increase the total costs of the transition. Consequently, comprehensive impact assessments should not unduly delay the adoption of the necessary GHG reduction measures at the IMO.

In this context and in compliance with Phase II of the Workplan and in accordance with the terms of reference established by the IMO secretariat and taking into account the Revised procedure for assessing impacts on States of candidate measures set out in MEPC.1/Circ.885/Rev.1, and the available data UNCTAD undertook a preliminary expert review of the proposals containing

candidate mid-term GHG reduction measures submitted to ISWG-GHG and MEPC, including their revised versions and impact assessments, as applicable. In its review, UNCTAD considered the technical and economic elements, and their possible combinations.

This preliminary expert review has considered relevant parameters considered during ISWG-GHG 14, with a particular focus on the feasibility, effectiveness to deliver the levels of ambition and potential impacts on States of the aforesaid technical and economic elements and their possible combinations. The present report of the expert review includes a summary of the initial findings of the preliminary review contained in document GHG-EW 3/3 and presented to the ad-hoc IMO Expert Workshop on comparative analysis of candidate mid-term GHG reduction measures held on 25 and 26 May 2023. As deemed appropriate, feedback received at the workshop has been integrated into the present report. This expert review is expected to help further inform the discussions at the planned ISWG-GHG 15 and MEPC 80.

The proposals and related impacts assessments covered by the present review are as follows:

1. IMO Maritime Sustainability Fund and Reward (IMSF&R) by ICS

- ISWG-GHG 10/5/2 submitted by ICS and INTERCARGO: *A levy-based MBM, per tonne of CO₂ emissions, to expedite the uptake and deployment of zero-carbon fuels.*
- ISWG-GHG 12/3/8 submitted by ICS: *Initial impact assessment on States of a carbon levy for international shipping.*
- ISWG-GHG 13/4/9 submitted by ICS: *Refinements to IMSF&R (F&R) proposal using a flat rate contribution system, for consideration as a mid-term measure under Phase II of the Work Plan, which combines core elements of proposals submitted under Phase I*
- ISWG-GHG 14/3 submitted by ICS: *Further information about revised IMSF&R proposal and possible draft amendments to MARPOL Annex VI to implement the IMSF&R mechanism and establish an IMO Maritime Sustainability Fund (IMSF)*
- ISWG-GHG 15/3/7 submitted by ICS: *Further information about a basket of measures combining an IMSF&R (Fund and Reward) mechanism (economic measure) and a Global (GHG) Fuel Standard (technical measure)*

2. Zero-Emission Shipping Incentive Scheme (ZESIS) or “feebate mechanism” by Japan

- ISWG-GHG 12/3/17 submitted by Japan: *Proposal on Market-based Measures (MBMs) to incentivize GHG emission reduction and to make equitable transition with an overview of mid- and long-term measures.*
- ISWG-GHG 13/4/6 submitted by Japan: *Refined proposal on Zero-Emission Shipping Incentive Scheme (ZESIS) to incentivize GHG emission reduction and to make an equitable transition.*
- ISWG-GHG 14/3/1 submitted by Japan: *Further proposal on Zero-Emission Shipping Incentive Scheme (ZESIS)*
- ISWG-GHG 15/3 submitted by Japan: *Further proposal on the feebate mechanism.*

3. Emission Cap-and-Trade System (ECTS) by Norway

- ISWG-GHG 12/3/13 submitted by Norway: *Proposal for an Emission Cap-and-Trade System (ECTS)*
- ISWG-GHG 12/3/14 submitted by Norway: *Initial impact assessment of the emission cap-and-trade proposal.*
- ISWG-GHG 12/3/15 submitted by Norway: *The effect on shipowners' decision making of a carbon price and a technical requirement.*
- ISWG-GHG 13/4/1 submitted by Norway: *Further analysis of the Emission Cap-and-Trade System (ECTS).*
- ISWG-GHG 13/4/2 Norway: *Basket of measures for the effective uptake of sustainable low-GHG and zero-GHG fuels and meeting the ambitions for GHG emission reductions.*

4. Greenhouse Gas Fuel Standard (GFS) by Austria et al.

- ISWG-GHG 12/3/3 submitted by Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the European Commission (Austria, EC et al.): *Proposal for a GHG Fuel Standard.*
- ISWG-GHG 12/3/4 submitted by Austria, EC et al.: *Initial impact assessment of a GHG Fuel Standard*
- ISWG-GHG 12/3/5 submitted by Austria, EC et al.: *Consideration of a combination of different types of global market-based measures with technical mid- and long-term measures.*
- ISWG-GHG 13/4/7 submitted by Austria, EC et al.: *Further development of the proposal for a GHG Fuel Standard.*
- ISWG-GHG 13/4/8 submitted by Austria, EC et al.: *Combination of technical and market-based mid-term measures illustrated by combining the GHG Fuel Standard and a levy.*
- ISWG-GHG 15/3/1 submitted by Austria, EC et al.: *Further information on the Greenhouse Gas Fuel Standard (GFS) and associated draft MARPOL amendments.*
- ISWG-GHG 15/3/2 (submitted by Austria, EC et al.: *Elaboration on the proposal of combining the GHG Fuel Standard and a levy.*

5. International Maritime Sustainability Funding and Reward (IMSF&R) mechanism by Argentina et al. and International Maritime Sustainable Fuels and Fund (IMSF&F) by China

- ISWG-GHG 12/3/9 submitted by Argentina, Brazil, China, South Africa, and United Arab Emirates: *Proposal to establish an International Maritime Sustainability Funding and Reward (IMSF&R) mechanism as an integrated mid-term measure.*

- ISWG-GHG 15/3/4 submitted by China: A combination of compatible technical and economic elements as a basket of mid-term measures for further development in Phase III of the Work Plan.

6. GHG levy by Marshall Islands and Solomon Islands

- MEPC 76/7/12 submitted by Marshall Islands and Solomon Islands. Proposal for IMO to establish a universal mandatory greenhouse gas levy.
- MEPC 76/INF.23 submitted by Marshall Islands and Solomon Islands: Initial impact assessment: universal mandatory greenhouse gas levy.
- ISWG-GHG 13/4/11 submitted by Marshall Islands and Solomon Islands: *Proposal for a GHG levy as a component in a basket of measures.*

2 Overview of the Proposals

2.1 IMO Maritime Sustainability Fund and Reward (IMSF&R) by ICS

2.1.1 ISWG-GHG 10/5/2: A levy-based MBM, per tonne of CO₂ emissions, to expedite the uptake and deployment of zero-carbon fuels

The proposal was submitted by ICS and INTERCARGO; it has since been superseded by the ICS IMSF&R proposal set out in ISWG-GHG 14/3. The co-sponsors favour a levy-based market-based measure (MBM), with contributions by ships per tonne of CO₂ emissions being channelled to an IMO fund with the purpose of expediting the uptake and deployment of zero-carbon fuels. The proposal does not provide an explicit carbon price level. A global levy-based mechanism would be least likely to result in distortion of international shipping markets which would interfere with efficient maritime trade. Due to its fixed and stable quantum, a levy would minimize uncertainty with respect to long term investment decisions for zero-carbon technologies. The main objective of the measure is to bridge the price gap between zero-carbon fuels and conventional fuels. The proposal indicates that the revenues from the fuel levy could be used to accelerate Research and Development (R&D) and deployment of new bunkering infrastructure and that the funds contributed to the fund should initially be used to provide support to assist maritime GHG reduction efforts of developing countries, in particular LDCs and SIDS, including deployment of any necessary bunkering infrastructure for the supply of low-carbon and zero-carbon fuels for use by international shipping.

2.1.2 ISWG-GHG 12/3/8: Impact Assessment on States of a carbon levy for international shipping

This document contains an initial impact assessment on States of the above ISWG-GHG 10/5/2 proposal for a mandatory levy-based MBM per tonne of CO₂ emitted; the assessment is also relevant to the subsequent IMSF&R proposal set out in document ISWG-GHG 14/3. The initial assessment was prepared with the assistance of Clarksons Research and explores the impact of

various levy quanta ranging from \$25 to \$400 per tonne of CO₂ on a range of trades involving developing countries, including those which are geographically remote from their markets. The commentary suggests that a flat rate (levy-based) contribution system would allow MEPC to have full control over the quantum of the contribution the timing of any subsequent increases, thereby providing greater certainty about the likely economic impact of the measure on States. In comparison, assessing proposals for alternative MBMs under which the cost of emission allowances is variable, or which use more complex metrics such as transport work, allows for less certainty and clarity about the likely economic impact on States.

The proposal suggests that a simple levy per tonne of CO₂ emitted will also provide greater certainty about the amount of money that will be generated to help expedite the transition by international shipping. The proponents do not draw firm conclusions as to whether any of the impacts on States identified for different levy quanta should be regarded as disproportionately negative, as this is a matter which will need to be determined by MEPC when weighed against the positive impacts of adopting an MBM.

The assessment suggests that setting an initial levy quantum at less than about \$100/tCO₂ might potentially be regarded as not having any disproportionately negative impacts on States when compared both to average freight rate and bunker cost volatility over the past 10 years and the variation in freight rates and bunker costs over same period. When assessed in terms of their impact on the price of delivered cargoes, the various levy quantum analysed in this assessment generally seemed to fall within the average monthly volatility in the price of delivered cargo during 2021.

2.1.3 ISWG-GHG 13/4/9: Refinements to IMSF&R (F&R) proposal using a flat rate contribution system, for consideration as a mid-term measure under Phase II of the Work Plan

The proposal combines core elements of proposals submitted under Phase I and aims to facilitate consensus as regards their combining. However, it is based on a flat rate contribution by ships rather than using the CII framework for setting boundaries for contribution/reward benchmarks. The submission proposes that all ships to which the measure will apply would make a flat rate contribution per tonne of CO₂ emitted to an IMO Maritime Sustainability Fund (IMSF) and that rewards should be limited to ships which use "eligible alternative fuels" calculated based on the CO₂ emissions prevented using such fuels.

The proposal considers the immediate need to ensure that 5% of the energy used by shipping in 2030 is produced from alternative fuels by narrowing the price gap with conventional fuels via a rewards program for CO₂ emissions that had been prevented by ships using "eligible alternative fuels" (whose definition can be decided in Phase III). This would accelerate shipping's transition to new fuels to reach a 'take off' point on a pathway to full decarbonization, while allowing the proposed contribution per tonne of CO₂ emitted to be set at a quantum which prevents disproportionately negative impacts on States. For the first five years, contributions and rewards should be calculated as CO₂ emitted/prevented on a Tank-to-Wake (TtW) basis whilst also taking

account of upstream Well-to-Tank emissions, subject to the LCA Guidelines and GHG conversion factors to be adopted at MEPC 80. The aim should be to narrow the price gap between zero-carbon and conventional fuels, support a fair and equitable transition by supporting developing countries, especially SIDS and LDCs, and fund R&D.

The flat rate contribution system per tonne of CO₂ is the easiest mechanism and should be administered using the existing IMO Fuel Oil Data Collection System (DCS), with rewards limited to eligible alternative fuels. Governance will be ensured by IMO Member States through MEPC. The funds contributed to the IMSF will be disbursed for the following purposes:

- To expedite the development and uptake of "eligible alternative fuels",
- Capacity-building and negative impact mitigation in developing countries,
- Funding for R&D programmes of alternative fuels and technologies; and
- Administration of the IMSF.

2.1.4 ISWG-GHG 14/3: Further information about revised IMSF&R proposal and possible draft amendments to MARPOL Annex VI to implement the IMSF&R mechanism and establish an IMO Maritime Sustainability Fund (IMSF)

The proposal reiterates the core elements of the mechanism that need to be finalized and the variables that will determine the quantum of the contribution by ships and suggests recommendations that the Group might offer to MEPC 80. It states that a flat rate contribution by ships to the IMSF up to and above \$50 per tonne of CO₂ will not imply disproportionate negative impacts and that the initial contribution could therefore be set at a quantum at somewhat more than 5% of the average global price of conventional fuels during the preceding five-year period, without a likely need for mitigation. However, the concern about the potential need to mitigate trade impacts could become more relevant should the quantum of the contribution be increased five years after implementation following a review. Furthermore, the proposal provides additional information, including possible draft amendments to MARPOL Annex VI, plus detailed draft guidelines to implement the measure, to assist a decision at MEPC 80 about the measures to be prioritized for development in Phase III and expedite approval by Parties of the necessary amendments in 2024.

The majority of the funds collected annually would be used by the IMSF to fund a rewards programme for first movers based on the emissions prevented by the use of eligible low and zero GHG fuels, with the surplus to be directed to a separate International Maritime Sustainability Board (IMSB) to support GHG reduction efforts by developing countries, including generation of alternative fuels and bunkering infrastructure in ports (plus a smaller allocation for R&D).

2.1.5 ISWG-GHG 15/3/XX: Further information about a basket of measures combining an IMSF&R (Fund and Reward) mechanism (economic measure) and a Global (GHG) Fuel Standard (technical measure)

The submission provides further information about the suggested basket of measures combining both an IMSF&R (Fund and Reward) mechanism (economic measure) and a Global (GHG) Fuel Standard (GFS) (technical measure). The document reiterates the vital and urgent need for the adoption of both sets of measures and examines the economic impacts on States of both measures being adopted at the same time and implemented in parallel to assist a comprehensive impact assessment.

The submission highlights that while the objective of the GFS is to expedite the production and adoption of low and zero carbon fuels this will only be achieved if the GFS is complemented by an economic measure that will provide the necessary incentives to produce sufficient quantities of such fuels and make the necessary GHG reductions. Furthermore, the submission states that a comprehensive impact assessment should focus on the economic impacts on States at least until 2030 because it will be hard to estimate the costs of low and zero GHG fuels compared to conventional fuels after 2030, subject to availability of these fuels, improvements in Technology Readiness Level and political/economic developments which may be impossible to anticipate. ICS continues to take no view on the level of the contribution but states that a \$12.5 per metric tonne of CO₂ (or CO_{2e}), which might raise total funds of about \$10 billion per year, could be sufficient to achieve the objective of the economic measure (incentivize first movers to increase the production and uptake of low and zero GHG fuels) and provide support to maritime GHG reduction efforts by developing countries.

2.2 Zero-Emission Shipping Incentive Scheme (ZESIS) or “feebate mechanism” by Japan

2.2.1 ISWG-GHG 12/3/17: Market-based Measures (MBMs) to incentivize GHG emission reduction and to make equitable transition with an overview of mid- and long-term measures

The proposal introduces a Zero Emission Vessels (ZEVs) Incentive Scheme to promote investments that would enable an effective deployment of zero-emission fuels and provide the necessary support for States, in particular SIDS and LDCs, and thereby, contribute to an equitable transition. The document proposes a feebate measure, where ship owners pay a levy or a combination of a levy/emission trading scheme where revenues are recycled as a subsidy to bridge the price gap for zero emission fuels. The levy is set to finance the subsidy. The proposal is based on TtW.

2.2.2 ISWG-GHG 13/4/6: Refined proposal on Zero-Emission Shipping Incentive Scheme (ZESIS) to incentivize GHG emission reduction and to make an equitable transition

The proposal introduces a Zero Emission Vessels (ZEVs) Incentive Scheme to provide incentives to promote investments to enable an effective deployment of zero-emission fuels and provide the

necessary support for States, in particular SIDS and LDCs, and thereby contribute to an equitable transition.

The Zero-Emission Shipping Incentive Scheme (ZESIS) aims to provide incentives for first movers adopting ZEVs. It would help increase the demand of ZEVs and ZEFs and improve technical maturity. The proposed ZESIS would apply to ships of 5,000 GT and above engaged in international voyages. This scheme would be a rewards program which should be terminated in 2040, but the mandatory contribution will be continued after 2040. A zero-emission shipping fund would be created and would be responsible for collecting contributions, payment of rewards and assistance for developing countries. A fuel standard should be adopted at the same time to support decarbonization. Eligible fuels should be determined based on TtW CO₂ emissions instead of TtW GHG emissions. Each ship's reward should be based on its consumption of eligible zero-emission fuel. Fossil-derived ammonia/hydrogen should qualify since there is a need to stimulate demand alternative fuels. However, other fuels with higher WtW emissions are excluded from the reward.

The Fuel Lifecycle Label could be used for the scheme. Reward rates should be set to fill the price gap between eligible and conventional fuels. Reward amounts should be between \$30/GJ and \$15/GJ. Part of the revenues raised should be used to help SIDS and LDCs to decarbonize.

In its impact assessment, Japan's analysis shows that average increase in shipping costs will vary with variations in the unit cost of carbon as follows: +3.8% for \$25/CO₂ tonne, +7.6% for \$50/ CO₂ tonne, +15.3% for \$100/ CO₂ tonne, and +30.5% for \$200/ CO₂ tonne. The analysis conducted shows that necessary revenues could be secured while keeping the contribution rate well below \$100/CO₂ tonne, at least in the initial phase. Part of the revenues of ZESIS will be used for decarbonizing the international shipping sector and mitigating disproportionately negative impacts on developing States. The analysis assumes that payment is made by all ships and does not account for the changing fleet composition of fossil-fuelled ships and ZEVs. In other words, deployment of ZEVs which do not need to pay a mandatory GHG contribution is not considered in the model (Paragraph 22, ISWG-GHG 13/4/6).

2.2.3 ISWG-GHG 14/3/1: Further proposal on Zero-Emission Shipping Incentive Scheme (ZESIS)

This submission supplements and adds more clarity to proposal 13/4/6. According to the submission, MBMs should ensure that incentives are provided to first movers adopting zero-emission fuels and ships in the early stage of transition, promote GHG reduction not only carbon dioxide, treat all ships covered by the measure equally, irrespective of flag, route, etc., with the aim to encouraging fuels and technologies, minimize impacts of mandatory contributions on trade and States, assist developing countries to address climate change, in terms of contributing to an equitable transition and addressing disproportionately negative impacts on States, as appropriate; and raise revenues by mandatory contribution to at least a sufficient amount to meet the purpose of the scheme, which would be managed in a transparent and robust manner for its proper usage.

The submission proposes that all GHGs be covered but does not specify whether a phased approach is advocated. The scope of the rewards should be decided so that low or zero WtW fuels and ships that deploy these fuels are incentivized. Revenues from the contribution should primarily be used for rewards offered to eligible fuels and ships and to assist developing countries. The contribution rate should be determined appropriately to avoid excess or deficit in revenues. It is proposed that the contribution rate be determined by the annual budget necessary to cover both the payment of rewards based on the actual consumption of eligible fuels and to fund projects to assist developing countries. However, if set too high it may bring negative impacts on trade by inducing higher freight rates and alternatively. If the rate is fixed for a longer period, or a ceiling is set, it may lead to insufficient revenues for the scheme.

Assistance should cover initiatives to support enhancement of zero-emission shipping in developing countries (capacity-building, development of infrastructure for production and supply of zero-emission fuels, research and development, etc.); and other projects or initiatives in developing countries to address disproportionately negative impacts. The screening of such projects should be transparent, robust, credible and feasible screening process and criteria must be developed.

2.2.4 ISWG-GHG 15/3: Further proposal on the feebate mechanism

The proposal elaborates on the effectiveness and feasibility of the feebate mechanism or Zero-Emission Shipping Incentive Scheme (ZESIS). A case study is presented to show the effect of a feebate approach on shipowners' investment decisions relating to zero-emission vessels. The proposals also addressed the uncertainty of price and availability of carbon-neutral fuel faced by shipowners and examined the required investments onboard ships and the need to achieve the 2050 emission ambitions which will require that zero-emission vessels be phased in before 2030.

The submission examines how a feebate mechanism can support such investment decisions and the results showed that there is a need for a price signal to avoid huge cost difference between conventional and zero emission vessels. A WtW GHG levy without reward would assist in reducing this cost difference and incentivize the shipowners. Meanwhile, conventional vessels would likely incur significant additional costs, which may lead to higher negative impacts on States or trade. The feebate mechanism can reduce the cost difference while minimizing cost increases for conventional vessels. The proposal also presents a long-term reduction pathway that could be achieved by the mechanism and elaborates on how the mechanism could work in combination with the GHG Fuel Standard (GFS) to further incentivize GHG reduction. Possible draft amendments to MARPOL Annex VI to establish the mechanism are also annexed to the document.

2.3 Emission Cap-and-Trade System (ECTS) by Norway

2.3.1 ISWG-GHG 12/3/13: Proposal for an Emission Cap-and-Trade System (ECTS)

The proposal sets out key features and options that need further discussion and outlines a legal text for illustrative purposes. The document is a more comprehensive version of the proposal on

an ECTS which was presented at ISWG-GHG 10. The document outlines the basic elements of the ECTS, including defining the cap, requirements for ships, distribution and trading of Ship Emission Units (SEUs), roles and responsibilities of international bodies, and financial flows. It also presents various options for designing the mechanism and highlights that adjustments should not compromise agreed ambition levels.

The proposal seeks to ensure a fair global transition by channelling funds generated through the proposed ECTS to developing countries, especially SIDS and LDCs. A new element introduced in the proposal is a possible price control. It is suggested to start with a TtW approach until a WtW methodology is in place and revenue distribution could use the architecture of the Green Climate Fund under the UNFCCC. Proposes a closed ECTS applicable to all ships of 400 GT and above subject to MARPOL Annex VI, Chapter 4. The cap will be determined based on the revised GHG Strategy. Revenues should be used to address potential disproportionate impacts on States, accelerate the uptake of low- and zero-carbon fuels and ensure a global and fair transition.

2.3.2 ISWG-GHG 12/3/14: Impact Assessment

The submission contains an initial impact assessment of the ISWG-GHG 12/3/13 proposal. The ECTS is likely to create net negative economic impacts. The assessment analyses the impacts on ships and emissions using a simplified approach to model a cap-and-trade system, estimating the abatement costs and carbon prices using marginal abatement cost curves (MACC).

Increased transport costs could reduce shipping and economic activity while increasing shipping services prices. In the short term, it is likely that the shipowners will bear a larger proportion of the costs. In the medium and long term, these costs will – to some extent – be transferred to the consumers and users of the produced and transported goods. Smaller States with high reliance on shipping for importing goods, including SIDS, are likely to be more affected relative to other States. Depending on the design of the ECTS, substantial revenues from ship emission unit sales could be generated to compensate for disproportionately negative impacts.

2.3.3 ISWG-GHG 12/3/15: The effect on shipowners' decision making of a carbon price and a technical requirement

The document discusses through case studies the effect of a carbon price, a technical requirement and a combination of both on shipowners' decision making. The document also highlights that a carbon price mechanism alone only incentivizes a fuel switch and reduces emissions once the cost of fuel is lower for the carbon-neutral fuel alternative than for the fossil fuel option, including a carbon price.

The case studies presented in this document are simplified and illustrate how technical requirements, such as those from a GFS, and a carbon price imposed through an emission cap-and-trade system impact shipowners' decision. The findings of the case study underpin the arguments made in ISWG-GHG 10/5/6 (Norway) that a GFS and an emission cap-and-trade system establishing a credible carbon price will work best when combined as they will help ensure the effective uptake of sustainable low-carbon and zero-carbon fuels.

2.3.4 ISWG-GHG 13/4/1: Further analysis of the Emission Cap-and-Trade System (ECTS)

The document provides further analysis on the issue of variable CO₂ price under an ECTS that can mitigate the uncertainty surrounding future fuel prices, in particular, the price difference between fossil fuels and carbon-neutral fuels. This can provide greater confidence to shipowners who may have invested in fuel technologies and are using carbon-neutral fuels by ensuring that the ship will not be operating at a disadvantage relative to ships that remain on fossil fuels. As such, the expected volatility and variations of a CO₂ price under an ECTS should be seen as an advantage rather than a barrier. A fixed CO₂ price through a levy may enable a more predictable cost picture for ships running on fossil fuels. However, the ECTS is intended to create certainty for the ships opting for alternative carbon-neutral fuels and fuel systems, so that they can operate and be certain of being competitive relative to ships choosing to operate on fossil fuels. The proposal discusses how a price ceiling might be needed at times. Such a price can be implemented by "borrowing" allowances from future years at a set price, which will ensure that the total emissions are still reduced. Such a mechanism can alleviate concerns over the potential constrained shipping activity.

2.3.5 ISWG-GHG 13/4/2: Basket of measures for the effective uptake of sustainable low-GHG and zero-GHG fuels and meeting the ambitions for GHG emission reductions

The proposal sets out Norway's proposed basket of measures, consisting of an ECTS and a GFS which are supported by National Action Plans, technical cooperation and green corridors. The proposal features a high-level overview as to why it prefers an ECTS instead of a levy (e.g., emission cap). It outlines that national action would benefit from coordination by IMO; green corridors should be addressed in the revised IMO GHG strategy; and enhanced and upgraded technical assistance should be provided to support the implementation of the revised strategy. A future process to develop a basket of measures - including amendments of revised strategy entering into force in 2026 is also outlined.

2.4 Greenhouse Gas Fuel Standard (GFS) by Austria et al

2.4.1 ISWG-GHG 12/3/3: GHG Fuel Standard

The proposal was submitted by Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the European Commission. The document proposes a GFS, a goal-based measure aimed at reducing the GHG intensity of fuels while providing long-term certainty required by shipping companies and fuel producers to help ensure that the demand for low- and zero-GHG fuels from the shipping sector will increase.

The GFS is a technical measure that can be an essential element of a combination of measures aimed at achieving the levels of ambition of both the Initial and the revised IMO Strategy. To allow sufficient time to build the fuel production capacity, the bunkering infrastructure and for the fleet

to adjust to the new fuels, it is important to adopt the GFS before the middle of this decade. The GFS needs to address WtW emissions of fuels and include all relevant GHGs, building on the LCA approach. It can be met by different fuel types and blends and does not prescribe or favour the use of specific fuels. The GFS would require all ships above a certain size limit, e.g., 400 GT or 5,000 GT, to use fuels (or other energy sources) which on average during the compliance period, have a WtW GHG intensity at or below a certain limit value. It is expressed in the mass of GHG emissions per unit of energy used on board a ship, e.g., g CO_{2e}/MJ. The GFS would be strengthened over time, thus ensuring a gradual and predictable phase-in of low- and zero-GHG fuels. The exact stringency of the GFS and the corresponding reduction trajectory would be driven by the goals of the IMO GHG Strategy.

2.4.2 ISWG-GHG 12/3/4: Initial impact assessment of a GHG Fuel Standard

This document accompanies the submission on the GHG Fuel Standard (GFS) contained in ISWG-GHG 12/3/3 and provides an initial impact assessment of the GFS in line with the Procedure for assessing impacts on States of candidate Measure.

The analysis revealed that the proposed measure will initially have a limited increase in transport costs with further expected increases to be mitigated by reduced prices of alternative fuels. The impact on freight rates will vary among sectors, types and direction of cargo. Different States will face different impacts depending on their location, transport dependency, remoteness, and ability to produce renewable fuels.

The gradual uptake of low and zero GHG fuels will have a marginally positive impact on seafarers' employment. It is also expected to increase fleet and equipment investments and R&D. In relation to administrative costs, the GFS will rely on existing reporting requirements in the IMO DCS subject to further improvements in terms of data quality and accessibility.

The impact assessment undertaken by the co-sponsors showed that the impacts of the measure on trade are at least one order of magnitude smaller than the impacts on transport costs, and the impacts on the economy at least two orders of magnitude smaller. In particular, the assessment shows that the impacts of a generalized GHG reducing policy (such as the GFS or others) are typically much less than a tenth of a percent for most countries and regions, although they vary across countries and economies, with net negative impacts observed for some of the regional aggregations of economies including the selected aggregation of SIDS. On the other hand, the results for LDCs are strikingly variable and include the highest net negative and positive impacts, and largest magnitudes of change in investment, imports and exports. The results imply that middle-income economies LDCs and SIDS can be less able to counterbalance the negative impact on their economic sectors.

2.4.3 ISWG-GHG 12/3/5: Consideration of a combination of different types of global market-based measures with technical mid- and long-term measures

This document analyses the main features and implications of a basket of mid- and long-term measures combining a carbon pricing measure in the form of a levy-based scheme or a cap-and-

trade scheme, with a technical measure like the GHG Fuel Standard (GFS). It shows the potential of combining technical measures and economic incentives to facilitate a fair and equitable transition and create an effective, clear and measurable response to the climate emergency in terms of reduced GHG emissions.

Combining a technical fuel standard, with a GHG levy or an emission cap-and-trade scheme would address two distinct types of market failures in the sector: the coordination failure along the fuel supply chain and the generation of sufficient revenues to pave the way for a fair and equitable transition.

Revenues that may be generated could be used to support maritime climate mitigation and adaptation activities, support R&D, incentivize the uptake and improve availability of low- and zero-GHG fuels and solutions as well as to ensure a fair and equitable transition in SIDS and LDCs. A technical GFS addresses the non-pricing barriers to the deployment of alternative fuels by providing a predictable demand from the shipping sector on the use and deployment of alternative fuels that also allows for a gradual transition on both the demand and supply side.

2.4.4 ISWG-GHG 13/4/7: Further development of the proposal for a GHG Fuel Standard

This document presents an elaborated and amended proposal for a GFS as a mid-term measure to address GHG emissions from international shipping. It proposes alternative ways for compliance in the form of a voluntary flexibility mechanism that fosters innovation, incentivizes first movers, and maintains the level playing field; and a remedial action that allows ships that cannot sail on low-GHG fuels to continue to operate. Current data collection for a GHG fuel standard could be based on the current IMO DCS framework - including SEEMP.

The proposed GFS contains a voluntary mechanism (the Surplus Reward System - SRS) designed to foster innovation, reward first movers, and maintain a level playing field while ensuring the environmental integrity of the GFS. Ships with a lower than required GHG intensity of their fuel (GFI) will be granted Surplus Reward Units (SRUs). Ships with a higher than required GFI can use SRUs to make up for their undercompliance. In addition, a GFS Register can sell GFS Remedial Units (GRUs) at a predetermined price to prevent prices of SRUs becoming excessively high.

With this system, ships could comply with the GFS by using fuel lower than GFS; using zero-GHG fuels in one engine and conventional fuel in another; using shoreside electricity; switching between conventional and zero-GHG fuels. Likewise, additional units could be bought or handed in to bridge the gap between GFS and GHG fuel intensity. This system rewards ships that over comply and it allows ships that are unable to use zero-carbon fuels to comply still if they buy extra units. The GFS can be translated into absolute GHG reduction and so can help achieve long-term levels of ambition. Ships that fail to reach the standard can continue to operate through the flexibility mechanism, or by means of acquiring GRUs at a price that deters non-compliance.

2.4.5 ISWG-GHG 13/4/8: Combination of technical and market-based mid-term measures illustrated by combining the GHG Fuel Standard and a Levy

This submission identifies the advantages of combining a technical and a market-based measure and suggests some core elements that should be included in a combination proposal. It also analyses how a combination of the GFS, and a levy could be designed to generate sufficient incentives to switch to alternative fuels. The measures must lead to a clear and predictable emission reduction pathway that is consistent with Paris Agreement goals, must facilitate the immediate start of the fuel transition without leading to increased emissions in other sectors and must include an economic incentive. Any levy should apply to all ships above 5,000 GT, with the potential to lower the threshold to 400 GT. It should be based on WtW GHGs, and bunkered fuels should be verified and reported annually. Regional and national pricing systems need to avoid double-counting of emissions.

The main advantages of combining the GFS and a levy include transparent and stable emission pricing providing clear economic incentive; simple administration for both industry and authorities; predictable and stable revenues to meet the core elements; and stable economic incentives for the early uptake of low GHG fuels. Furthermore, the levy does not need to bridge the full price gap which leaves room for a lower levy without compromising the reduction target.

The submission also considers how to allocate revenues and suggests the working arrangements and the structure of an eventual IMO Climate Transition Fund. Revenue should be distributed for shipping-related climate transitions (e.g., improve port and maritime infrastructure and green marine fuels); maritime climate transition and adaptation measures in SIDS/LDCs (e.g., tech cooperation, capacity building); addressing potential disproportionately negative impacts; maritime R&D; administration of the fund. Revenues may be allocated as subsidies, financial instruments or other.

2.4.6 ISWG-GHG 15/3/1: Further information on the Greenhouse Gas Fuel Standard (GFS) and associated draft MARPOL amendments

In this submission, the convergence of views on the development of a basket of measures consisting of both technical and economic elements is noted. As the technical element of the basket of measures, the GFS was extensively discussed and widely supported, this submission addresses the main issues raised during the consideration of the GFS and presents draft MARPOL amendments.

The co-sponsors have decided to rename the Surplus Reward System (SRS) into a “Flexibility Compliance Mechanism” (FCM) to avoid the misperception that the SRS would primarily be a reward for overcompliance or an economic element in a basket of measures, which is neither the purpose nor the function of the flexibility mechanism. The proposal clarifies that the environmental integrity of the GFS would be guaranteed even when ships participate in the FCM, because the emissions below the required GFI (equal to the number of FCUs granted) would be equal to the emissions above the required GFI (equal to the number of FCUs handed in). GFS

Registry would be allowed to provide GRUs at a certain, dissuasive, price to ensure that all ships can always comply with the GFS, regardless of the number of FCUs generated by ships sailing on fuels with a lower GFI than required. This would not undermine the environmental integrity because the revenues of GRU sales would be used to further reduce emissions in the value chain of marine fuels. The price of GRUs would be set by the MEPC at a level that would ensure that the FCUs are the preferred means of compliance and that the use of GRUs remains a last resort compliance option. The proposal addresses the issues of FCM duplication of other measures, double taxation, administrative burden and timing of the implementation.

Some delegations were concerned that companies will concentrate FCUs with early movers hoarding the FCUs they generate rather than making them available to other ships, e.g., with the purpose of enlarging market dominance. However, the co-sponsors believe that this risk is sufficiently mitigated by the design of the system and provide further details.

2.4.7 ISWG-GHG 15/3/2: Elaboration on the proposal of combining the GHG Fuel Standard and a levy

The submission clarifies the proposal contained in ISWG-GHG 13/4/8 (Austria et al.) on the combination of technical and market-based mid-term measures illustrated by combining the GFS and a levy, following comments and concerns raised at ISWG-GHG 13.

The proposal reiterates that, combined with the GFS, the MBM would assist and facilitate the transition by providing economic incentives for the use of low- and zero-GHG fuels, narrowing the price gap between the latter and traditional fuels as well as deploying solutions that improve energy efficiency. For that reason, as explained in ISWG-GHG 13/4/8, when combined with the GFS, “the levy does not need to bridge the full price gap between conventional and near-zero- and zero-GHG fuels”, as it would be the case of a levy as stand-alone measure.

On the size of the levy, the cosponsors do not take a position and state that they were flexible. It must be ensured that the levy is technologically neutral, does not distort competition and is compatible with the goals of the Paris agreement. Generally, costs and benefits should be proportionate, and the administrative burden should be kept minimal. On the size of the revenues, the co-sponsors state that revenues would be large and although primarily a matter for Phase III of the Workplan on mid- and long-term measures, it is pertinent to consider how those revenues could contribute to a just and equitable transition of the shipping sector, with a particular focus SIDS and the LDCs. Those revenues may be used for various purposes, such as research and development (R&D) and projects that make the transition just and equitable.

Links with initiatives devoted to mobilizing innovative sources of finance, in particular for countries vulnerable to climate change, could be explored. In relation to double payment, the cosponsors are of the view that the flexibility mechanism is voluntary; the ships which comply with the required GHG Fuel Intensity (GFI) provided for in the GFS would not need to use it. Ships that choose to voluntarily participate in the flexibility mechanism deliberately opt for that compliance option. The use of the FCM does not necessarily imply financial payments.

The Flexible Compliance Units (FCU) can be exchanged free of charge and/or used by the same ship in another year; and The GFS flexibility compliance mechanism and a levy are complementary because together they close the price gap. In other words, the intrinsic value of a flexible compliance unit is the difference between the cost of direct compliance and the levy. Therefore, the higher the levy, the lower the value of the FCU. Concerning the issue of the GFS and the levy not closing the price gap, it would seem very unlikely that the combined price of the FCU and of the levy will exceed the difference in cost between the use of low- and zero-GHG fuels and of conventional fuels (including necessary technical investment). The co-sponsors propose that both the GFS and the levy use the full life cycle analysis as a basis for calculating the emissions.

2.5 International Maritime Sustainability Funding and Reward (IMSF&R) mechanism by Argentina et al. and International Maritime Sustainable Fuels and Fund (IMSF&F) by China

2.5.1 ISWG-GHG 12/3/9 (Argentina et al.): Proposal to establish an International Maritime Sustainability Funding and Reward (IMSF&R) mechanism as an integrated mid-term measure

The submission proposes an International Maritime Sustainability Funding and Reward (IMSF&R) mechanism as a mid-term measure to reduce GHG emissions from ships. The proposed IMSF&R mechanism could incorporate almost all the goals of other candidate measures (e.g., ambition assurance, first mover impetus, revenue raising for capacity building/impact mitigation and RD&D) while addressing the concerns about unaffordable fuel price, rationing of transport supply and heavy administrative burden.

The submission proposes a fund and reward (feebate) system (IMSF&R mechanism) based on the existing CII measure and based on DCS. It contains elements, e.g., a fund collected based on the benchmark related to the required CII, a compensation (5% more allowances) for ships serving one or more ports of developing countries likely to be negatively impacted and a reward for ships that use alternative low/zero-carbon fuels. The effectiveness of the IMSF&R mechanism relies on the required CII and how it can be strengthened from 2026 onwards. Its basic concept is to set up the upper/lower benchmark CO₂ emissions level for a ship based on its upper/lower "C" rating boundaries as set out in the CII Rating Guidelines in conjunction with its capacity (DWT or GT depending on ship types) and actual distance travelled in a calendar year. A ship with the actual CO₂ emissions above the upper benchmark level needs to pay the fund contributions for its extra emissions and a ship with CO₂ emissions below the lower benchmark level would be rewarded for the emissions reduced. Ships with the actual CO₂ emissions in-between the set boundaries will not pay the fund contribution or be rewarded.

Among the total annual funding contributions, the proposal suggests allocating [40%] to reward superior players with actual carbon emissions below the reward benchmark level, [30%] for capacity building and negative impact mitigation in developing countries. The contributions allocated to capacity building and impact mitigation may be transmitted to IMO's Multi-donor

GHG Trust Fund to provide an enhanced financial support for technical cooperation and capacity-building activities to support the implementation of the (Initial) IMO GHG Strategy. For the rest, [20%] is proposed to be allocated for RD&D and technology transfer and [10%] for administrative costs.

2.5.2 ISWG-GHG 15/3/4 (China); A combination of compatible technical and economic elements as a basket of mid-term measures for further development in Phase III of the Work Plan

This proposal has not been developed to replace or withdraw the original IMF&R mechanism (ISWG-GHG12/3/9). Instead, it is intended to be a step forward to design a combination of a basket of mid-term measures, consisting of both technical and economic elements.

The IMSF&F mechanism is developed based on the original IMSF&R mechanism (ISWG-GHG 12/3/9) and has incorporated other compatible technical and economic elements from various proposals like the GFS, incentives for first movers and revenue raising/disbursement issues. The CII metric has been replaced by the GHG intensity of fuels/energy in the updated version, which is also a compromise to bridge the divergence between difference proposals.

In addition, a sustainability framework is introduced to set quantitative and/or qualitative thresholds, where appropriate, for the lifecycle GHG emissions and other sustainability aspects of sustainable marine fuels/energy. The IMSF&F mechanism will be implemented on an annual basis. The basic idea of the ISMF&F is to first set up a limit to the GHG intensity indicator of fuels/energy used on board ships (required GFI, in g CO_{2e} /MJ). The benchmark of the GHG emissions level (in t CO_{2e}) for a ship can be calculated by multiplying the required GFI with its actual annual fuels/energy consumption (in TJ). The actual GHG emissions of a ship can be calculated by multiplying the actual GFI with the actual annual fuels/energy consumption (in TJ).

To comply with the required GFI, the actual GHG emissions of a ship should not be higher than the benchmark level. Like the flexible compliance options designed in the GHG Fuel Standard (GFS) proposal (ISWG-GHG 13/4/7), when ships have emitted less GHGs than the benchmark (equivalent to an attained annual GFI lower/better than the required GFI), they can be granted Surplus Reward Units (SRUs, expressed in t CO_{2e}). The amount of SRUs is equal to the difference between the actual GHG emissions from the ship and the benchmark level. The Surplus Reward Units (SRUs) can be transferred between ships of the same company, or between ships of different companies at a price agreed between the two companies. The Surplus Reward Units (SRUs) can also be kept by ships for use in the following calendar year. On the contrary, when ships have emitted more GHGs than the benchmark (equivalent to an attained annual GFI higher/worse than the required GFI), the gap between the actual GHG emissions and the benchmark level is recorded as Deficit Units (DUs).

For compliance purposes, ships with DUs need to obtain equivalent amount of Surplus SRUs from other ships or equivalent number of Remedial Units (RUs) from the Sustainable Shipping Fund (SSF), or the mixture of both, to offset the DUs. To provide sufficient incentives to first movers,

the price for RUs should be determined by the Committee before the compliance period and should be set at a level that could bridge the cost gap between compliant and non-compliant ships.

Despite the goal of encouraging first movers to uptake sustainable fuels/energy, this proposal does not intend to close the price gap with low and zero carbon fuels completely, as existence of a smaller price gap after the transfer of SRUs or the payment for the RUs is necessary in order to encourage the scaling up of the production of sustainable fuels while reducing the cost of production. To avoid double payment and double reward, the proposal suggests that there is no need to further introduce an additional independent levy to address the price gap, or any other revenue raising mechanisms to further reward or rebate the first movers.

The proposal suggests that since the Sustainable Shipping Fund would be used to support capacity building, negative impact mitigation, as well as R&D, there is no need to further introduce other independent revenue raising mechanisms for these purposes as well.

2.6 GHG levy by Marshall Islands and Solomon Islands

2.6.1 MEPC 76/7/12: Proposal for IMO to establish a universal mandatory greenhouse gas levy

The proposal introduces a universal mandatory GHG levy. It focuses on using the GHG price to drive mitigation investment, with most revenues being used to support an equitable transition, and some share for use in-sector including for RD&D, which could include a “feebate” or similar mechanism to reward first movers and innovators. The proposal calls for a ‘credible’ price signal and the necessity of using revenues to enable an equitable transition.

The co-sponsors proposed an entry level of \$100 per tonne of CO₂ equivalent by 2025 with upward ratchets on a 5-yearly review cycle. Even though initially below the necessary \$250-300 tonne price, it would still enable take-up, if some portion of revenues raised are reinvested to benefit the sector’s decarbonization and used in subsidizing research, development and deployment (RD&D). The first review would coincide with the introduction of long-term measures under the IMO Initial Strategy, allowing for the deployment of a strong command-and-control regulatory framework (e.g., regulation on the carbon content of fuel used) by 2030 should the market not demonstrate sufficient reaction to the levy.

2.6.2 MEPC 76/INF.23: Initial impact assessment: universal mandatory greenhouse gas levy

This document contains the initial impact assessment of the proposal contained in document MEPC 76/7/1 and setting out a universal mandatory GHG levy as a relevant measure. The analysis highlights that the main impact arising from a GHG levy will be the positive impact of minimizing the multiple severe, and in some cases, existential damages attributed to the impacts of climate change. Negative impacts are likely to arise from the increase in the transport cost created by the GHG levy with the transport cost increases varying by Member States. In most cases it is likely to

remain within the limits of recently experienced historical transport cost fluctuations (e.g., high freight rates or high oil prices). The severity and disproportionality of the impacts will likely vary depending on the specifics of the country. In this respect, further analysis can be beneficial. The levy is designed to be inclusive of a significant revenue deployment to assist in addressing disproportionate negative impacts that may arise. States that are remote and poorly connected to main markets can expect to see an improved connectivity through a GHG levy as revenues raised can be reinvested to offset the increase in transport cost associated with the levy price and/or higher fuel costs, particularly for SIDS and LDCs. Without measures such as a GHG levy that could incentivize investment in zero- and low-carbon ship technologies, supply chains may become increasingly stranded and uncompetitive. As lower value cargoes can have a higher proportion of their total costs associated with transport, there may be differences in the impacts experienced by States that are particularly reliant on the import/export of low value cargoes. This, however, will also depend on the nature of the supply chains and substitution options for this trade. The measure can address negative impacts relating to transport dependency. The application of a levy can increase transport costs in the short term (e.g., during the transition to increasing the use of zero carbon fuel and energy sources). The way in which costs increase depends partly on the level of competition on the trade routes servicing a route, as well as the response created by the levy. In the longer-term, a levy needs not be associated with any greater transport cost increase than is already anticipated to meet decarbonization in line with the vision of the IMO's Initial Strategy of full decarbonization. There are potential short-term impacts on food security – where any transport cost increase can have a direct bearing on prices and the availability of food. This is complex and will vary as a function of the substitution opportunities available, which can vary on a country-by-country basis. Those impacts will be diminished as the sector reaches full decarbonization. It is concluded that the measure is highly cost effective and relates to a strong net-positive impact on socio-economic development, and in particular in those States currently in greatest need of development (SIDS and LDCs).

2.6.3 ISWG-GHG 13/4/11: Proposal for a GHG levy as a component in a basket of measures

The proposal provides additional details of the proposed GHG levy and its role as a component of the basket of measures designed to ensure a 1.5°C -aligned transition for international shipping that is efficient, effective and equitable.

Revenue generated should be used to support mitigation and adaptation action, both in shipping and outside shipping with spending being guided by the objective of equitable transition. The flexibility enabled by the levy will support international shipping to manage a period of rapidly evolving fuel availability. This will ensure that the resources and incentives are used to support early use of low- and zero-GHG emission fuels, providing funds to target supporting fuel availability in developing countries leaving no one behind, whilst also ensuring that, should markets not mature supply chains in time, there is no short-term disruption to shipping operations and trade. The proposal discusses how future revenue would be available and used to avoid future pollution and repair the damage caused by the emissions. If a global fuel standard is adopted, it should not have a flexibility mechanism as this could potentially result in some

countries being left behind and missing out on the transition. Revenue use needs to be procedurally fair, equitable in relation to maritime mitigation and equitable in responding to climate impacts. A GHG levy and fuel standard should be in force by 2025. The levy paid by each ship can be derived from the bunker delivery noted and corresponding receipts. The levy will be increased every 5 years.

3 Comparative Summary of the Proposals

In total, 26 submissions were reviewed spanning proposals and refined proposals, initial impact assessments, and additional supporting documents. In terms of sponsors, 6 submissions were received by ICS (one of which with INTERCARGO), 4 submissions by Japan, 5 submissions by Norway, 1 submission by China, 1 joint submission by Argentina, Brazil, China, South Africa and the United Arab Emirates, 2 joint submissions by the Marshall Islands and the Solomon Islands and 7 joint submissions by EU countries and the European Commission. The proposals for mid-term measures comprise of technical and economic elements and their possible combinations.

3.1 Economic Elements

All proponents suggested the use of economic elements to achieve decarbonization targets including bridging the price gap between zero-carbon fuels and conventional fuels. The proposed economic elements fall into four categories: First Levies or flat rate contributions. Second Feebates or reward mechanisms. Third, Emission Cap and Trading Systems (ECTS). Finally, some proposed flexible compliance instruments associated with technical elements (e.g.: GHG Remedial Units (GRUs)) are assessed for the purpose of this review as economic elements as they could imply financial transfers.

A pure levy-based element per tonne of CO_{2e} emitted is proposed by the Marshall Islands and the Solomon Islands. The universal mandatory levy proposed by the Marshall Islands and the Solomon Islands is set at a 2025 entry price of \$ 100 per tonne emitted with upward ratchets on a 5-yearly review cycle.

The submissions by Japan, ICS and Argentina, Brazil, China, South Africa and the UAE as well as the updated IMSF&F proposed by China support the use of a feebate or reward mechanism. It should be clarified that a feebate system is a contribution-based system that uses all or part of the revenues raised to offer a rebate to first movers and reward ships that are built for and/or utilize alternative fuels. As part of its proposed Zero-Emission Shipping Incentive Scheme or ZESIS, Japan advocates a feebate measure whereby the levy (fee) charged on ships over 5000 GT on a on Well to Wake (WtW) basis is used to finance (rebate) a reward scheme to incentivise first movers and fill the price gap between eligible and conventional fuels. The proposal suggests a fee well below \$100/CO₂ tonne, at least in the initial phase, based on an analysis of the impacts on ships and shipping costs. The proposal by Argentina, Brazil, China, South Africa and the UAE also proposes a feebate system as part of an IMSF&R mechanism based on the CII whereas all other proposals use the GFS as the preferred technical element. The ICS proposal system supports a phased approach starting with a fee of \$12.5 per metric tonne of CO₂.

An Emission Cap-and-Trade System (ECTS) is proposed by Norway and would apply to ships of 400 GT and above based initially on a TtW approach until a WtW methodology is put in place. The proposal argues that the expected volatility and variations of a CO₂ price under an ECTS provides certainty to zero carbon ships; but it accepts that a price ceiling may be needed at times and proposes an allowance borrowing mechanism to alleviate any concerns.

Initial submissions by the EU seemed to be open about either the levy or the ETS as an MBM economic element, instead the emphasis was on combining either element with technical element(s) as part of a combination proposal advocating the use of a basket of measures. However, in their latest submission (ISWG-GHG 15/3/2), the co-sponsors explicitly support the MBM as an important part of a basket of measures. Any mechanism used should apply to all ships above 5,000 GT, with the potential to lower the threshold to 400 GT, both based on WtW GHGs and verified bunkered fuels.

The updated IMSF&F proposal submitted by China does not specifically introduce an independent revenue generating measure nor set a price on emissions from ships. Instead, an exchange mechanism of emitted units below or above a GFI benchmark is suggested between over-complying and under-complying ships. When the exchange mechanism is not able to cover emissions above the GFI, Remedial Units (RUs) can be purchased from the Sustainable Shipping Fund (SSF), a proposed entity tasked with granting and managing RUs. The revenues generated from the sale of RUs are earmarked for use in the shipping sector.

In the submissions of both China and the EU, the flexibility mechanism proposed contains flexible compliance elements namely the RUs and the GHG Remedial Units (GRUs). The RUs are similar in architecture to the GRUs and aim at offering an alternative compliance mechanism to the proposed systems besides the exchange of FCUs or SRUs. From UNCTAD's point of view, both the GRUs and RUs are inherently economic elements since they aim at pricing the Flexible Compliance Units or else referred to as Deficit Units. However, it is understood that differences exist between tGRUs and RUs as regards linkages to emission reductions.

3.2 Technical Elements

All proponents suggested the use of technical elements, often set as a GHG emission benchmark level or boundary brackets. Argentina, Brazil, China, Ecuador and the UAE have proposed the use of the CII metric. The remaining submissions (China, ICS, Norway, Japan, EU, Marshall Islands and Solomon Islands) have all proposed the use of the GFS as the main technical element.

Most proponents favour combining technical and economic elements when developing a basket of elements as part of mid-term measures, where applicable. Marshall and Solomon Islands suggest that the economic element of the levy should be implemented by 2025 and the technical element of GFS by 2030 because compliance with the GFS will not be feasible without sufficient deployment and up-scaling of alternative fuels and their technologies. The scale up of these advances is expected to be a result of a levy implementation through funding of the respective relevant projects.

Elsewhere, a compliance mechanism, sometimes referred to as the Surplus Reward System (SRS), was put forward in several proposals (EU, China) with a view to rewarding overcompliance. While the set of modalities of the proposed compliance mechanisms tend to differ between proposals, they also involve some level of revenue generation or staking. However, the EU proposal on the basket of measures suggests that its Flexible Compliance Mechanism (FCM) does not imply financial payments since, according to the EU proposal, units can be exchanged for free. In this case, i.e., when FCUs are not priced through GRUs, they are considered as purely technical elements.

Other proposals such as the one from the Marshall Islands and Solomon Islands, also support the use of GFS to further incentivize the uptake of low carbon intensity fuels; but do not endorse the flexibility compliance mechanism that comes with it in the EU proposal.

3.3 Basket of Elements

Most proponents support the development of a basket of elements and recognize the need for concrete GHG fuel intensity targets to further incentivize the uptake of low and zero carbon fuels and technologies and reach the Initial and Revised IMO strategy targets.

The various submissions have outlined the core issues to be incorporated in a combined proposal where both technical and economic elements would assist in addressing coordination and non-pricing barriers, providing clear economic incentives and generating revenues. However, as shown above, not all proposals support the parallel introduction or implementation of the various elements of the basket of measures.

3.4 Revenue Generation and Recycling

As outlined above, not all submissions propose an explicit revenue generating mechanism. Those that specifically do as part of an MBM, suggest a carbon price levy or a fee ranging from \$12.5 to \$100 per emitted tonne of CO₂, in the initial phase, with possible upward changes afterwards. Technical measures such as a GFS and a GFI may also generate additional revenues depending on how they are defined and structured. However, the degree and extent of indirect revenue generation via technical measures remains unclear in most proposals.

Whatever the source and size of the revenue generated, its recycling and disbursements remain an area of divergence among proposals. Most proposals (Japan, EU, ICS) provide broad indications on the destination of the generated revenues, from rewarding first movers and promoting R&D on alternative fuels to supporting negatively impacted developing States. Other proposals are more specific, for instance Argentina et al. provides an illustrative allocation of the revenues generated with higher proportions allocated to rewarding superior players and supporting capacity building against lower proportions earmarked for R&D and administration costs. The proposal of the Marshall Islands and the Solomon Islands is even more explicit about the need of the majority of generated revenues to include both in-sector and out-of-sector spending. Out of sector spending should be targeted at supporting an equitable transition, avoiding future

pollution and repairing the damage caused by the emissions; while a portion of revenues raised can be used for subsidizing research, development and deployment.

The proposals also differ as regards the institutional set up of revenue management and disbursement, as well as the type and/or proportion of the revenues to be managed by any entity tasked with doing so. Both the ICS and the EU propose an IMO-based fund (IMO Climate Fund, IMO Maritime Sustainability Fund, IMO Climate Transition Fund), while others such as Norway and the Marshall Islands and the Solomon Islands opt for the existing Green Climate Fund (GFS). Japan, China and Argentina et al. did not propose any specific structure, whether within or outside the IMO, for managing and distributing the revenue generated. China proposes a Sustainable Shipping Fund, without specifying whether such fund will operate within or outside the IMO framework.

Table 1 – Mapping of the proposals¹

Type of Measure	Proposal	Economic element				Technical element		Revenues					Scope of emissions covered
		Levy/ Fund/ Contribution/ Fee	Cap and Trade (ETS)	Feebate	FCUs/ SRUs/ GRUs / RUs	GFI	CII	Rewards	R&D	Capacity Building	Support for developing countries, SIDS, LDCs	Administration	
Economic measures	ISWG-GHG 13/4/1 (Norway)		X										TtW CO2 open to expand
	ISWG-GHG 15/3/7 (ICS)	X		X				X	X	X	X	X	First TtW then Wtw CO2 or GHG
	MEPC 76/7/12 (Marshall Islands and Solomon Islands)	X		X				X	X	X	X	X	WTW GHG
	ISWG-GHG 14/3/1 (Japan)	X		X				X	X	X	X	X	WtW GHG
Technical measures	ISWG-GHG 15/3/1 (Austria et al.)				X	X				X			WTW GHG
Basket of measures	ISWG-GHG 13/4/2 (Norway)		X			X				X	X	X	TtW CO2 open to expand
	ISWG-GHG 12/3/9 (Argentina et al.)	X		X			X	X	X	X	X	X	TtW CO2
	ISWG-GHG 14/3 (ICS)	X		X		X		X	X	X	X	X	First TtW then Wtw CO2 or GHG
	ISWG-GHG 13/4/11 (Marshall Islands and Solomon Islands)	X		X		X		X	X	X	X	X	WTW GHG
	ISWG-GHG 15/3 (Japan)	X		X		X		X	X	X	X	X	WtW GHG
	ISWG-GHG 15/3/2 (Austria et al.)	X		X	X	X		X	X	X	X	X	WTW GHG
	ISWG-GHG 15/3/4 (China)	X		X	X	X		X	X	X	X	X	WtW GHG

¹ A feebate system is a levy- based system that uses all or part of the revenues raised through the levy\fund\contribution to offer a rebate to first movers and reward ships that are built for and will utilize alternative marine fuels. GRUs\RUs FCUs\SRUs are also classified as economic elements when flexible compliance with GFI entails pricing of the FCUs.

4 Review of the Impact Assessments and Elements to be Considered for a Future Comprehensive Impact Assessment

It should be noted at the outset that the present review does not assess nor evaluate the comprehensiveness of the initial impact assessments and their proposals. Instead, it looks at the data assumptions, methodological tools, and outcome results with a view to informing and strengthening future work on impact assessments. This preliminary review seeks to identify elements to be considered for a future Comprehensive Impact Assessment (CIA) while considering recommendations made by various proposals and their initial impact assessments, and in view of the lessons learnt from previous impact assessments. The suggestions made may also inform further reviews for the Revised Procedure for Impact Assessment.

In examining the economic aspects addressed in the impact assessments that were prepared by sponsors of the various proposals reviewed by UNCTAD in this report, reference is made to the IMO's Revised Procedure for assessing impacts on States of candidate measures as set out in MEPC.1/Circ.885/Rev.1 approved by MEPC 79 in December 2022 (hereafter referred to as the IMO Impact Assessment Framework). It specifies that the impact assessment should be simple, inclusive, transparent, flexible, evidence-based, and measure-specific. It further indicates that the comprehensiveness of any impact assessment should be commensurate with the complexity and nature of the proposed measure.

According to the set modalities, the Initial Impact Assessment should indicate whether the proposal for the measure provides a description of impacts on ships and emissions as well as identify which impacts should be assessed, taking into account, as appropriate, inter alia (1) geographic remoteness of and connectivity to main markets; (2) cargo value and type; (3) transport dependency; (4) transport costs; (5) food security; (6) disaster response; (7) cost-effectiveness; and (8) socio-economic progress and development.

The Initial Impact Assessment should also indicate both positive and negative potential impacts and analyse the extent of the impacts (e.g., by quantifying them and relating them to normal variations in transport costs, trade, or GDP). It should also assess whether the measure is likely to result in disproportionately negative impacts and, if so, how these could, as appropriate, be addressed (e.g., avoided, remedied, mitigated). The Initial Impact Assessment should also indicate the methodological tools and data sources used and may indicate the limitations of the analysis.

Table 2 summarizes the various initial impact assessments submitted to help inform subsequent discussion about the aspects to consider in the case of a future CIA.

Table 2 – Summaries of initial impact assessments

<i>ISWG-GHG 12/3/8 (ICS)</i>	
Impact	Assessment of Impacts
Geographic remoteness of and connectivity to main markets	The impact on geographically remote States would depend on the quantum of the carbon levy adopted. For a voyage of 1,100 nm, a levy of \$100 per tonne of CO ₂ would increase the price of iron ore in the import country by 4%, whereas a levy of \$400 per tonne by 15.8%. For a voyage of 3,500 nm, a levy of \$100 per tonne of CO ₂ , would increase the import price by 1.3% while a \$400 per ton by 5.4%. This initial impact assessment therefore suggests that, for cost sensitive iron ore trades, a levy initially set at \$100 per tonne of CO ₂ or lower might be less likely to be viewed as having disproportionately negative impacts on States that are geographically remote from their markets than a higher levy amount, but arguably would not have significantly less impacts on geographically remote States than a levy which was set at a lower quantum than \$100 per tonne of CO ₂ . The assessment also looks at price of delivered foodstuff. A levy of \$100 per tonne of CO ₂ would increase prices by 21% whereas a levy of \$200 or \$400 by 41% and 83% respectively. For a voyage of 5,800 nm, a levy of \$100 would increase delivered prices of crude oil by 0.6% while a levy of \$200 or \$400 by 1.2% and 2.4% respectively.
Cargo value and type	Given that the prices on delivery of all the cargoes examined are volatile, generally speaking the delivery price impact of any of the levy quantum examined, up to and including \$400 per tonne of CO ₂ , fell within the average monthly volatility of delivered cargo prices the during 2021. However (other than for container trades for which freight rates were exceptionally high during 2021) the impact of a levy of \$100 per tonne of CO ₂ on most trades would be to bring freight rates in these trades in the vicinity of their 10-year average, whilst a levy of \$400 per tonne of CO ₂ would bring freight rates in the vicinity of their 10-year peak.
Transport dependency	The proposed measure should not disproportionately impact States which are dependent on maritime transport and – by expediting the use of zero-carbon fuels that will make decarbonisation of the sector possible – it will allow these States to continue to enjoy access to low cost and efficient maritime transport whilst meeting the levels of ambition set by the Initial IMO Strategy (due to be revised by 2023) which will be particularly important for LDCs and SIDS.
Transport costs	The proposed measure should not significantly impact transport costs to an extent beyond those impacts in most trades which already result from significant volatility of fuel oil prices and variations in freight rates due to changes in supply and demand (plus unexpected developments such as the COVID-19 pandemic and the conflict in Ukraine). Moreover, programmes to be supported by the proposed IMO Fund could be designed to identify potential mechanisms for reducing the cost of transportation to LDCs and SIDS, and other geographically remote locations, whilst complying with existing and future regulations that require a reduction in carbon intensity.
Food security	The analysis above with respect to the impact on freight rates in dry bulk trades (iron ore and coal), which suggests that the impacts of the levy quanta examined generally fall within the average monthly volatility of delivered cargo prices, is equally applicable to bulk carriers which are used to move key food stuffs in bulk. With respect to the transport of

<i>ISWG-GHG 12/3/8 (ICS)</i>	
	containerized perishable cargoes, this assessment suggests that whilst a levy initially set much above \$100 per tonne of CO ₂ might be seen as having large impacts on the price of delivered perishable foodstuffs, when seen as a proportion of the delivered cargo price the impact will be significantly less in the context of the much higher freight rates experienced in liner trades since the middle of 2021.
Disaster response	No adverse impact on disaster response.
Cost-effectiveness	IMO Fund to help expedite the transition to zero-carbon emissions without any direct financial cost to States and with minimal administrative burden. The proposed levy-based economic measure is therefore considered to be a cost-effective measure which will help facilitate successful delivery of the 2050 levels of ambition set out in the Initial IMO Strategy.
Socio-economic progress and development	The proposal should have no adverse impacts on socio-economic progress and development. To the contrary, by assisting global decarbonization efforts it will contribute to socio-economic progress and development, consistent with the UN SDGs for 2030.

<i>ISWG-GHG 13/4/6 (Japan)</i>	
Impact	Assessment of Impacts
Geographic remoteness of and connectivity to main markets	N/A
Cargo value and type	N/A
Transport dependency	N/A
Transport costs	It is indicated that the average increase in shipping costs is 3.8% for (\$25/ CO ₂ tonne), 7.6% for (\$50/ CO ₂ tonne), 15.3% for (\$100/ CO ₂ tonne), and 30.5% for (\$200/ CO ₂ tonne). The results were obtained from the estimated fuel cost share of shipping costs, which averaged 36.6% (ranging from 11.7% to 48.5%) for bulk cargo shipping and 27.1% (ranging from 0.5% to 60.1%) for container shipping. The impact of the mandatory contribution on shipping costs can be compared against the normal volatility of container freight rates, as had been done for assessing impacts of short-term measures on maritime logistics costs (see MEPC 76/7/13, annex, pages 14 to 15). For instance, the level of estimated increase in average shipping costs under the four scenarios seem to lie within normal volatility of container freight rates from China to South America before the COVID-19 pandemic (see Figure 5). The analysis assumes that payment is made by all ships and does not account for the changing fleet composition of fossil-fuelled ships and ZEVs. In other words, deployment of ZEVs which do not need to pay a mandatory GHG contribution is not considered in the model. (para 22, ISWG-GHG 13/4/6).
Food security	N/A
Disaster response	N/A
Cost-effectiveness	N/A

<i>ISWG-GHG 13/4/6 (Japan)</i>	
Socio-economic progress and development	N/A

<i>ISWG-GHG 12/3/14 (Norway)</i>	
Impact	Assessment of Impacts
Geographic remoteness of and connectivity to main markets	N/A
Cargo value and type	N/A
Transport dependency	N/A
Transport costs	Consumers and end users will experience some increases in prices. The indications of the increases in the context, however, are based on the end users bearing all costs, and that the price surge on freights is representative for the measure discussed here. Under these assumptions, the indicated price increases are still relatively modest (e.g., 2% increase in consumer prices for SIDS). Given that some of this increase will likely be shared by shipowners, cargo owners and others in the supply chain, the costs increases are likely to be relatively modest for each involved.
Food security	Certain goods are of larger significance for people's welfare than others, and there are likely variations in how different industries/goods are affected (see Figure 24 in document ISWG-GHG 12/3/14). Prices for imported foods will likely increase, meaning that people critically relying on imported foods, also occasionally, could face reduces food security. Water transport costs make up a small part of the food industry demands (>0.5%), but the impact of the costs increases also depend on purchasing power of the consumers. This should be explored further in a comprehensive impact assessment.
Disaster response	The capacity and response times for responding to the measure has not been investigated. This will depend on the design of the cap-and-trade system.
Cost-effectiveness	N/A
Socio-economic progress and development	N/A

<i>ISWG-GHG 12/3/4 (Austria, et al.)</i>	
Impact	Assessment of Impacts
Geographic remoteness of and connectivity to main markets	The study shows that the impacts created by a generalized GHG reducing policy (such as the GFS or others) are typically much less than a tenth of a percent for most countries and regions, although they vary across different types of economy. These figures exclude potential benefits from fuel exports, which have not been modelled. The results are the product of the interactions between carbon intensity of different transport modes and the potential for substitution, the relative balance between imports

ISWG-GHG 12/3/4 (Austria, et al.)

	<p>and exports (and the respective trading partners for these), along with the consequent impacts on investment. Below, some of the results are presented and interpreted. Furthermore, higher transport costs may affect States that are far away from their main markets more significantly than States close to their main markets or better connected. On the other hand, States which have the capacity to produce and export renewable fuels will be positively impacted. The consequence of a generalized increase in transport costs depends on the country or region's circumstances. For nearby trading partners, the generalized increase in transport cost can result in substitution occurring and an increase in market share relative to more remote trading partners. The transport cost increase can also cause imports to be substituted with domestic production – therefore increasing investment in the country or region.</p>
Cargo value and type	<p>In general, higher transport costs may affect trade of low-value cargoes more negatively than high-value cargoes. Likewise, transport of specific types of cargo like perishable goods may be negatively affected when higher transport costs change for example optimal speeds. Considering this specific impact is also important from the perspective of ensuring food security, especially with respect to possible changes in import prices of essential food commodities, additional time or possibility to procure them.</p>
Transport dependency	<p>States that are highly dependent on maritime transport, e.g., to provide essential goods or services, are more likely to be affected more significantly by changes in shipping costs than States which have a lower transport dependency.</p>
Transport costs	<p>The results of a study on the potential economic impacts of a global increase in transport costs due to a carbon price of \$200/t CO₂. The study finds that high-income economies, such as the EU, Canada, Japan, and the USA, would see minor increases or small reductions in GDP and similar reductions in exports. However, the impact on investment varies across regions, with the EU experiencing the most significant negative impact, while Japan and the USA see increases in investment driven by import substitution. Middle-income developing countries and emerging economies would have small overall impacts, with China, India, Russia, Brazil, and the rest of South America having net positive economic impacts. However, some regional aggregations of economies, such as South Asia and Southeast Asia, experience net negative impacts. Small Island Developing States (SIDS) and Least Developed Countries (LDCs) have net negative impacts, with only five SIDS included in the study. The results for LDCs are particularly variable, with approximately twice as many having net negative impacts than those with net positive impacts. The quality of data available for many of these economies limits the depth of analysis, but SIDS and LDCs are less able to counterbalance the consequences on the sectors of their economy negatively impacted.</p>
Food security	<p>Transport of specific types of cargo like perishable goods may be negatively affected when higher transport costs change for example optimal speeds. Considering this specific impact is also important from the perspective of ensuring food security, especially with respect to possible changes in import prices of essential food commodities, additional time or possibility to procure them.</p>

<i>ISWG-GHG 12/3/4 (Austria, et al.)</i>	
Disaster response	Some States are also more prone to disasters than others and may be less resilient, e.g., because they are more likely to be hit by disasters that affect the entire State rather than a specific region within a State. Apart from changes in transport costs, which may impact disaster relief costs, a GFS could also require different inventory requirements for essential goods.
Cost-effectiveness	N/A
Socio-economic progress and development	Increase in the use of low- and zero-GHG fuels in the shipping industry is expected to have a marginally positive impact on employment for seafarers, as it will require additional investment in their training and certification. Equipment suppliers, ship construction and repair, and R&D employment are expected to see more positive impacts, while job growth in the bunkering sector may be more restrained. The use of non-drop-in fuels and innovative propulsion technologies will require the highest innovation efforts. The further development of internal combustion engines and energy efficiency measures, including the use of wind assistance, is also expected to increase. The uptake of zero-emission ships is expected to have a significantly positive impact on public health due to the decrease in air pollution.

<i>ISWG-GHG 15/3/7 (China)</i>	
Impact	Assessment of Impacts
Geographic remoteness of and connectivity to main markets	Qualitative
Cargo value and type	N/A
Transport dependency	N/A
Transport costs	N/A
Food security	N/A
Disaster response	N/A
Cost-effectiveness	N/A
Socio-economic progress and development	N/A

MEPC 76/7/1 (Marshall Islands and Solomon Islands)

Impact	Assessment of Impacts
Geographic remoteness of and connectivity to main markets	An initial assessment finds that the long-term impact of the proposed GHG levy is most likely positive overall for the sector. Should negative impacts occur, most are likely short- to medium-term in nature, and in most instances are likely no more than minor and are routinely already absorbed from oil market and freight price variations currently. Disproportionate negative impacts are most likely found in the case of a small and narrow number of States. Such States are highly likely to already experience disproportionately high shipping costs combined with low security of transport supply.
Cargo value and type	N/A
Transport dependency	N/A
Transport costs	N/A
Food security	N/A
Disaster response	N/A
Cost-effectiveness	N/A
Socio-economic progress and development	N/A

ISWG-GHG 12/3/9 (Argentina et al.)

Impact	Assessment of Impacts
Geographic remoteness of and connectivity to main markets	Qualitative
Cargo value and type	N/A
Transport dependency	N/A
Transport costs	N/A
Food security	N/A
Disaster response	N/A
Cost-effectiveness	N/A
Socio-economic progress and development	N/A

Table 3 – Summary of approaches to the impact assessments relating to proposals of mid-term measures

Impact	ICS	Japan	Norway	EU	Argentina et al.	China	RMI & SI
Geographic remoteness of and connectivity to main markets	Variable impact depending on the quanta used and type/value of goods-ranging from insignificant impacts for quantum less than \$100/t CO ₂ for iron ore, to very high impacts on foodstuff (21% for a levy of \$100 and up to 83% for a levy of \$400).	Not investigated	Not investigated	Higher transport costs affecting States away from main markets. States producing and exporting renewable fuels will be positively impacted. Risk of modal shift and product substitution for nearby trading partners.	qualitative	Qualitative	Long-term impact of proposed GHG levy is most likely positive overall. Disproportionate negative impacts are most likely in small and narrow number of States. Such States are.
Cargo value and type	All cargoes examined are volatile. Impact on the price of cargoes on delivery fell within the average monthly volatility of delivered cargo prices the during 2021, except for container trades.	Not investigated	Not investigated	Higher transport costs may affect trade of low-value cargoes more negatively than high-value cargoes, including foodstuff for which food security shall be ensured especially for essential food commodities.	Not investigated	Not investigated	Not investigated
Transport dependency	Qualitative	Not investigated	Not investigated	Qualitative	Not investigated	Not investigated	Not investigated
Transport costs	No significant impact beyond volatility of fuel oil prices and in freight	Impact of contribution can be compared against normal	Modest (2%) increase in consumer prices for SIDS.	High-income economies would experience minor increases, small	Not investigated	Not investigated	Not investigated

Impact	ICS	Japan	Norway	EU	Argentina et al.	China	RMI & SI
	rates due to supply chain and war crises.	volatility of freight including at times of crises such as COVID 19. rates, as had been		reductions in GDP Middle-income countries have small overall impacts. Some regional aggregations of economies, such as South Asia and Southeast Asia, experience net negative impacts; while SIDS and LDCs have net negative impacts,			
Food security	Impacts of the levy quanta examined generally fall within the average monthly volatility for applicable bulk carriers used to move key food stuffs in bulk. For containerized perishable cargoes, a levy initially set above \$100 /t CO ₂ will large impacts on the price of delivered perishable foodstuffs.	Not investigated	Prices for imported foods will likely increase, with impact on food security.	Qualitative	Not investigated	Not investigated	Not investigated

Impact	ICS	Japan	Norway	EU	Argentina et al.	China	RMI & SI
Disaster response	No adverse impact on disaster response	N/A	Not investigated	Apart from changes in transport costs, which may impact disaster relief costs, a GFS could also require different inventory requirements for essential goods.	Not investigated	Not investigated	Not investigated
Cost-effectiveness	Qualitative	Not investigated	Not investigated	Not investigated	Not investigated	Not investigated	Not investigated
Socio-economic progress and development	No adverse impacts on socio-economic progress and development. Instead, proposal it will contribute to socio-economic progress and development, consistent with the UN SDGs for 2030	N/A	N/A	Marginal positive impact on employment for seafarers, while equipment suppliers, ship construction and repair, and R&D employment are expected to see more positive impacts. The uptake of zero-emission ships is expected to have a significantly positive impact on public health due to the decrease in air pollution.	N/A	N/A	N/A

5 Exploring Potential Impacts of Increased Shipping Costs

5.1 Insights from literature

Traditional climate change policies are divided into “command and control” policies² and “Market-Based Measures (MBMs)”³ (Helm, 2003), also called “economic measures”. Command-and-control policies include concrete benchmarks set by regulators to restrict the factors that lead to GHG emissions. For shipping they can take the form of speed, power, carbon or fuel intensity limits. MBMs, which include carbon pricing policies, aim, inter alia, to enforce the “polluter-pays” principle and internalize the external cost of emissions (Fowlie et al., 2016; Heine et al., 2020). MBMs provide fiscal incentives for reducing emissions by increasing the cost of fossil fuel consumption. Examples span fuel or carbon levy/tax, ECTS, the provision of subsidies and various offsetting mechanisms.

5.1.1 Design and implementation of carbon pricing policies

Most of the literature related to GHG emission reduction in shipping has focused on MBMs including carbon pricing, but many of the findings from the literature are also relevant to command-and-control GHG reduction policies.

The two most prominent types of MBMs implemented regionally, nationally or sub-nationally are in the form of carbon levies/taxes and of emission trading systems. As of April 2022, there were 68 carbon pricing instruments operating worldwide with three more scheduled for implementation. This includes 37 carbon taxes and 34 ECTSs and covers approximately 23% of the total global GHG emissions (The World Bank, 2022b). A feebate system falls under the general category of a levy but revenues are explicitly distributed back to the regulated entities in the form of rebates for the adoption of carbon abatement measures. A feebate system can be carbon revenue neutral (Yang, 2018).

Carbon levies follow the fixed-price approach which entails a predetermined tax set by the regulators that can be reviewed regularly to ensure its efficacy within the overall market conditions. The carbon tax is a levy-based policy that collects taxes based on the quantity of fossil fuels consumed or of the emissions and thus can be set in price per metric tonne of fuel or per metric tonne of carbon (Hoeller & Wallin, 1991). The ECTS is a “cap-and-trade” system and follows a fixed-quantity approach in which regulators set a predetermined cap or limit on the quantity of annually released emissions. The cap is translated into a fixed amount of carbon allowances, each one representing the ability to emit one metric tonne of CO₂ and then allowances are split among the regulated entities. Under an ETS the allowances are auctioned, traded or allocated for free, and the carbon price derives as a result of supply and demand for carbon allowances (Gu et al., 2019).

² Commonly referred to as technical measures or elements.

³ Commonly referred to as economic measures, elements, or instruments.

All types of MBMs come with conceptual merits and shortcomings. Both carbon taxes and ETSs can gather revenues, however the tax has higher cost predictability because the carbon price is fixed. It also comes with lower administrative costs as gathering and administering the carbon tax appears to be simpler to implement and more straightforward to sustain than in an ETS. However, a fixed carbon price cannot guarantee emissions reductions as this will be determined by the effectiveness of the overall design principles of the system. These are, among others, the timeline, the tax level as well as the scope of emissions covered.

More specifically, according to IMF (2022), in terms of administration, a carbon tax provides a straightforward approach that is relatively easier to implement compared to an ETS. The price certainty associated with a carbon tax encourages low and zero carbon technology innovation due to the predictability on cost increases which can incentivize businesses to reduce their emissions. Additionally, the tax rate can be periodically adjusted based on uncertain emission levels, allowing for flexibility in aligning with emission reduction goals. Revenue generated from a carbon tax can be used for various purposes such as cutting other taxes or making general investments which offers flexibility in its allocation. Furthermore, the revenue can be recycled to ensure a distributionally neutral or progressive policy outcome, promoting fairness and equity.

As a policy instrument, an ETS has its unique set of characteristics (IMF, 2022). Despite potential administrative challenges that may be faced by middle-and low-sized companies and capacity-constrained countries, an ETS can be more acceptable, politically, than a carbon tax, especially when accompanied by free allocation of permits or grandfathering. Grandfathering can help increase the acceptability of the policy but lowers revenue generation. So far, in most cases ETSs have been established utilizing grandfathering instead of auctioning which resulted in low demand for carbon allowances and thus very low carbon prices that do not provide sufficient incentives for investments into carbon abatement technologies (The World Bank, 2022b). An ETS can be compatible with overlapping carbon pricing instruments, allowing for the reduction of emissions through multiple policies. However, the measure needs to be carefully designed to avoid double counting of emissions and increases in the administrative burden for the stakeholders. The automatic alignment of prices with targets in an ETS, assuming consistent emissions caps, ensures a direct link between market dynamics and emission mitigation goals. The certainty over emission levels in an ETS provides a clear framework for achieving emission reduction targets. In fact, IMO discussions on MBMs had already started in 2010 but were suspended in 2013 (IMO, 2013; Lagouvardou et al., 2020; Psaraftis et al., 2021; Shi, 2016).

5.1.2 Environmental effectiveness of carbon pricing policies

The environmental impact of an MBM in shipping will be seen both in the short run, through the implementation of operational measures to regulate the vessel's fuel consumption, and in the long run, through the provision of incentives to adopt low and zero carbon fuels onboard vessels. Many papers in the literature have focused on the investigation of both operational and technological improvements induced by an MBM. Operational measures in the form of slow steaming and the uptake of energy efficiency measures aim to reduce the overall fuel

consumption (Cariou & Cheaitou, 2012; Corbett et al., 2009; Kapetanidis et al., 2014; Psaraftis & Kontovas, 2021; Tanaka & Okada, 2019) and technological measures and the use of carbon pricing revenues to boost R&D (Sheng et al., 2018; Zis et al., 2020) and technology deployment can help close the competitiveness gap between alternative and conventional fuels while enabling an equitable transition (Baresic et al., 2022; Smith et al., 2019; Halim et al., 2019; The World Bank, 2021, 2022a).

The effects of a carbon tax on vessel's speed have been estimated by various studies. According to Wang et al. (2015) carbon pricing mechanisms could have a significant impact on speed reduction of ships, which translates into emission reductions due to the nonlinear relationship between the service speed and fuel consumption and thus the yield GHG emissions. The effectiveness of carbon pricing on ship speed is influenced by the overall shipping market conditions (i.e., freight rates and bunker prices) (Gkonis & Psaraftis, 2012; Gu et al., 2019; Psaraftis, 2019). However, the strength/responsiveness of the relationship between price signals and efficiency is debated, with some literature finding only weak relationship (Adland et al., 2017a, Adland et al., 2017b).

When fuel prices are high and freight rates are low, there is already an incentive for slow steaming, which limits the effectiveness of carbon pricing in triggering further speed reduction (Giovannini & Psaraftis, 2019; Gu et al., 2019). In prosperous periods with high freight rates and low bunker prices, ships tend to sail faster and thus a sufficiently high carbon price can lead to significant GHG emissions reductions through slow steaming. However, many researchers advocate that in order to retain global throughput during slow steaming, new vessels need to be added to the global fleet which will further increase GHG emissions (Cariou, 2011; Lagouvardou et al., 2022).

In addition to having an impact on efficiency, MBMs can also induce technological changes by incentivizing the adoption of alternative marine fuels and their supporting technologies. There is an increasing number of studies advocating that technological measures and especially the uptake of alternative marine fuels is unavoidable to decarbonize shipping (Ashrafi et al., 2022; Korberg et al., 2021; Lindstad et al., 2021; McKinlay et al., 2021; Y. Wang & Wright, 2021; Xing et al., 2021). Carbon pricing regulations will gather revenues that can accelerate R&D, close the price gap between alternative and conventional fuels, and provide incentives for newbuild alternative fuel ships while accelerating the upscaling of alternative fuels production, storage and distribution facilities.

Various studies have calculated the marginal abatement cost curves (MACC) that could help to estimate the required carbon price needed to bridge the price gap. A MACC has been widely used in environmental theory and energy economics to indicate in a straightforward way the carbon tax (= marginal abatement cost) associated with a specific reduction level or the carbon price resulting from an emissions cap in a cap-and-trade system (Huang et al., 2016; Kesicki & Ekins, 2012; Newell & Stavins, 2003; Requate, 2005). In shipping, MACCs have been used to evaluate different carbon mitigation measures (Eide et al., 2009; Franc & Sutto, 2014; Longva et al., 2010; Smith et al., 2016), including operational and technological mitigation measures. Both the 2nd and

4th IMO GHG studies developed MACCs on a model-based approach (Buhaug et al., 2009; Faber et al., 2020), and CE Delft has published their analysis on model-based MACCs (Faber et al., 2009, 2011).

These studies indicate that to meet the Initial IMO Strategy's goal of reducing GHG emissions by at least 50% by 2050, a carbon price ranging from \$100 to \$500 per tonne of carbon would be necessary. The specific carbon price required depends on various assumptions. For instance, in a hypothetical scenario where biofuels are readily available, significant absolute emissions reductions could be achieved even with a low marginal cost of carbon (\$50 per tonne). This is because biofuels are priced similarly to their fossil fuel equivalents and do not rely on the carbon price to incentivize their adoption (IMarEST, 2018; Smith, 2020).

Finally, the scientific literature discusses the geographic coverage of a policy involving a maritime carbon tax. If a carbon tax is implemented regionally or is designed with many route exemptions, there is a high risk of carbon leakage and excessive tax base erosion because ships could alter their route to evade the system and/or refuel easily outside its jurisdiction (Lagouvardou & Psaraftis, 2022; Psaraftis et al., 2021; Walter, 2008). The predominant view in the literature is that the carbon tax should be levied at a global level as shipping is a globalized industry with an international reach (Miola et al., 2011; Mundaca et al., 2021). For an overview of the implementation and impacts of carbon pricing in shipping see also ITF (2022).

Whether a MBM or command-and-control measure, the consequence of the policy is an increase in the cost of maritime logistics (transport and time costs), and therefore trade costs. Most of the literature has focused on the increase in cost arising from various levels of carbon pricing, however the cost increases and impacts can be considered like those created by command-and-control policy set with equivalent stringency/effectiveness in GHG reduction.

5.1.3 Impacts of carbon pricing policies on States

There is a considerable amount of scientific literature that focuses on the impacts of carbon pricing mechanisms on States. Halim et al. (2019) investigate the impacts of a carbon price applied to bunker fuels on state gross domestic product (GDP) and conclude that in the range of \$10–50/tonne of CO₂, transport costs will increase by 0.4% to 16%. This increase, however, would only marginally raise the import prices of goods (by less than 1%). Therefore, the impact of a carbon price set between \$10–90/tonne of CO₂ on national economies is expected to be modest (0.002% to 1% of GDP). A comprehensive literature survey conducted by Rojon et al. (2021) concluded on similar estimates and showed that carbon pricing policies – depending on the scenario – would increase maritime freight costs by between 0.4% and 16%. Certain regions, such as the Pacific SIDS, could experience more significant effects in terms of transportation costs. On average, SIDS face a 6% higher per-unit transport cost compared to the rest of the world, and they may also encounter more severe consequences from further cost increases. If per-unit transport costs rise by 10%, these countries could see a reduction in exported units ranging from 8.3% to 18.5%. Among these nations, Fiji would be particularly affected (Rojon et al., 2021). According to the

study, coffee exports in the region are the most sensitive to changes in transport costs, showing a decline of 20% to 30% for every 10% increase in transportation expenses (Rojon et al., 2021).

The changes in demand for shipping due to mid-term measures cannot be known from empirical evidence as there are few example schemes for shipping. Instead, factual observable changes in the price of ship fuels provide indications on the price elasticity of shipping, which could be relevant for an assessment of potential impacts of policies that increase the price of shipping (including both command and control and market-based measures). Price elasticities differ substantially across products and industries, with effects ranging from -0.03 to -0.42 in a study that looked at products at a highly disaggregated level (Mundaca et al. 2021). The greatest reductions in carbon emissions for international trade of various products can be attained for products with relatively low value- to-weight ratios, such as fossil fuels (11.5%), ores (10.5%), cereals (8.4%), iron and steel (8.3%), and fertilizers (8.1%), when a carbon tax is set at a relatively low level (\$40/ton). The lowest carbon emissions reductions can be achieved for those with the highest value-to-weight ratios, such as furniture (1%) and motor vehicles (1.8% (Mundaca et al., 2021).

Sheng et al., (2018) indicates that implementing carbon pricing in the shipping industry leads to a decrease in the trade of low-value, high-volume commodities from distant sources, while promoting the trade of high-value, low-volume commodities. However, the study finds that the impact on real GDP, assuming a bunker emissions charge of \$18 per tonne of CO₂, was estimated to be less than -0.5%. Additionally, it was demonstrated that less developed countries would not face disadvantages if a well-designed revenue distribution mechanism were in place.

In another study examining the implementation of a fuel tax or levy in the shipping industry, it was found that the cost pass-through rate, representing the portion of the levy costs transferred to consumers, was 52% in 2007, during a period of highly favourable market conditions for the shipping sector. However, the pass-through rate decreased to 10% in 2013 when conditions were less favourable (Kosmas & Acciaro, 2017). It can be anticipated that the long-term effects of a carbon tax on pass-through rates would be higher compared to the pass-through resulting from short-term fluctuations in oil prices.

Lee et al. (2013) finds that even a high level of a global maritime carbon tax (\$90 per metric tonne of CO₂) will not lead to significant economic impacts: the highest loss in real GDP was modelled to take place in China, but even there the reduction in real GDP would be small: around 0.02%.

According to a recent study by the European Commission (2021), the effects from a carbon price set at \$250 per tonne of CO₂, observed in most countries and regions were generally less than 0.1%. These relatively small impacts can be attributed to imports and exports constituting a small portion of GDP, and changes in trade values being partially balanced out by shifts in domestic production, consumption, and investments. The study revealed that middle and emerging economies mostly experienced net positive impacts, while many SIDS and LDCs faced negative impacts. Among SIDS and LDCs, the largest net negative impact observed was approximately -3% of GDP.

Wu et al. (2022) examines China's share of global carbon emissions from international dry bulk sea freight is 7%. Assuming a carbon price of \$100 to \$300, the cost associated with the carbon charge for dry bulk shipping in China was estimated at \$7.7 to \$23.1 billion. The carbon tax would have a significant impact on freight rates and trading prices for bulk cargoes. Freight costs for imports from Australia (a major source country for iron ore) and Indonesia (a major source country for coal) would increase by 10–30%, while trading prices for iron ore and coal would increase by 1-4%.

Finally, the report of Parry et al. (2018) illustrates the impact of a carbon tax that gradually increases to \$75 per tonne of CO₂ in 2030 (\$240 per tonne of bunker fuel) and \$150 per tonne in 2040. This measure alone leads to a reduction in maritime CO₂ emissions below business-as-usual (BAU) levels, achieving nearly a 15% decrease in 2030 and 25% in 2040. Furthermore, it generates significant revenues of approximately \$75 billion in 2030 and \$150 billion in 2040. However, it does result in a slight increase in shipping costs, equivalent to 0.075% of global GDP in 2030. A revenue-neutral carbon tax with the same emissions price was also examined. This strategy would target operators with higher emissions intensity, while subsidizing those with lower emissions intensity. Although slightly less effective in reducing CO₂ emissions, this approach has a minimal impact on average shipping costs. Lastly, the study compares the effectiveness of a performance standard for new ships, which is currently implemented by the IMO, with carbon taxes. The results show that the performance standard has approximately one-third of the effectiveness of carbon taxes when considering the same implicit CO₂ price.

5.2 Insights from an empirical analysis: Assessing the impact of a hypothetical increase in shipping costs

UNCTAD previously reported on the possible impacts of GHG reduction measures on States as part of the Comprehensive Impact Assessment conducted in 2021 at the request of the IMO secretariat (UNCTAD, 2021).

In the present exercise, UNCTAD carried out simulations using the same methodology and data as in the 2021 UNCTAD report, albeit with a higher increase in maritime logistics costs in line with the deeper reductions in GHG emissions than those targeted through short-term measures. According to UNCTAD, the IMO mid-term measures contained in the proposals whether technical (command and control) elements, or economic (MBM) elements fit broadly within the guidelines established by three simulations.

- Scenario 1: Maritime logistics costs increase by 10%
- Scenario 2: Maritime logistics costs increase by 30%
- Scenario 3: Maritime logistics costs increase by 50%

The simulation is neutral as regards the causes for this increase in maritime logistics costs, i.e. they may result from an economic or a technical measure, and they may be associated with transport costs or time costs.

In the 2021 comprehensive impact assessment, specific and different changes in transport costs and time costs were calculated for each trade, by country pair and industry sector, leading to 130,236 individually calculated different increases in maritime logistics costs (i.e. combining the different increases in transport costs and time costs for each of the 130,236 cases) ranging from a 10% increase to a 50% increase.

For illustrative purposes, the increase in maritime logistics costs in the present simulation, was assumed to be identical for every trade, i.e., the same increase for each one of the 130,236 cases. Thus, the simulation helps generate information about the order of magnitude of the impact on global trade and GDP resulting from different increases in maritime logistics costs.

All scenarios are translated into ad valorem equivalent import price terms and adjusted for observed maritime transport shares. The baseline year is 2015. Simulated outputs show comparative static changes in trade and macroeconomic variables for each scenario. For each set of outputs, changes are recorded using the mean and the median values across countries, as well as the sum across countries. When assessing total changes a greater weight is assigned to larger countries.

Figure 1 - World average, median, and total macroeconomic impacts by situation, percentage change relative to 2015 baseline.

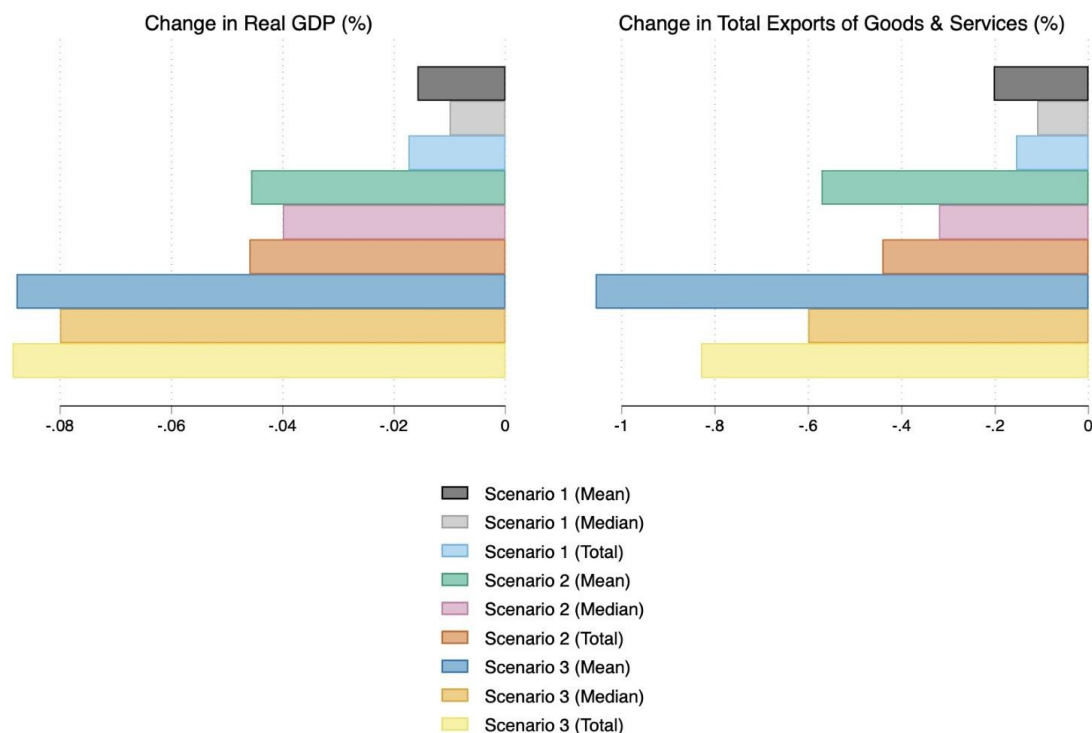


Figure 1 shows that, at a global level, all three scenarios imply changes in trade flows, slightly over 1% on average, which translates into a smaller impact on real GDP of less than 0.1%. Changes are negative under all three scenarios. As expected, a higher increase in maritime logistics costs also leads to a higher decline in trade and in GDP.

These results indicate that higher maritime logistics costs translate into higher trade costs, which in turn drive a larger wedge between consumer and producer prices, which acts to the disadvantage of consumers and firms that use imported intermediates. The trade numbers in Figure 1 are for total goods and services trade, and so take account of the fact that some economic activity would be reoriented towards services due to higher trade costs in goods.

The simulation of the three scenarios can help provide indicative values for the order of magnitude of the potential impact of decarbonization measures on trade and GDP, if the impact of the measures on maritime logistics costs can be estimated.

6 IMO Impact Assessment Framework and General Limitations

The Revised IMO Impact Assessment Procedure provides a general 'Framework' outlining the process and procedure of impact assessment including guidelines on the various principles and aspects to be considered for both initial and comprehensive impact assessments. However, the IMO Framework does not provide detailed guidelines for the economic impact assessment including on how to address some specific issues that may arise from the implementation of the proposed measure(s). Instead, the burden is on the authors of the initial impact assessments to justify the methodological tools and data sources used and to outline the merits and the limitations of their analysis and results.

While specifying detailed guidelines and methodological tools may itself present a risk or a limitation to any impact assessment, the lack of a standardized tool or benchmark instrument for assessment is even more problematic, especially given the type(s) of measures or combination of measures currently being considered and their far-reaching impacts on regulatory and policy decision makings within the IMO and beyond. The Revised procedure contains additional guidance regarding the process and the methodological aspects involving the conduct of comprehensive impact assessments.

Below are some issues to consider in future comprehensive assessments.

6.1 Sets of Measure(s) and Review Criteria

One of the main difficulties in reviewing the various proposals and their initial impact assessments stems from the variations of the measures being put forward. The latter include technical measures, economic measures, a variation and/or a combination of both. This raises a methodological difficulty given that each measure or subset of measures has implications on the economic evaluation and appraisal approach including elements and criteria not considered under the IMO Impact Assessment Procedure or under other previous impact assessments. This includes for instance issues related to the level and quantum of carbon pricing, revenue generation, recycling and distribution, as well as aspects related to the economic cost and benefit of various institutional structures for revenue management and allocation.

Building on the experience with the 2021 CIA for short-term measures undertaken by UNCTAD, it should in principle be possible in the CIA of the basket of mid-term measures to combine and

compute ad-valorem equivalent costs of different measures. One of the differences is that the 2021 CIA excluded ships and journeys in ballast or in unknown loading conditions, but for the purpose of a CIA of the proposed mid-term measure(s), the journeys and emission intensities of these ships must not only be included but also allocated to trades and country destinations. In addition, it may also be possible to model the impacts associated with assumptions or specifications of revenue use, including those aimed at addressing the costs stemming from administering the measures.

6.2 Time Frame for Evaluation: Ex-ante versus Ex-post Evaluation

Given that the implementation of the proposed measure(s) spans several years with potential future reviews of key elements of the measures, it is important to incorporate ex-post approaches and procedures for evaluation. The current IMO Impact Assessment Framework is largely based on ex-ante approaches that predict rather than evaluate the ex-post impacts of the proposed measures, some of which incorporate novel carbon pricing and revenue generating policies.

While this is inevitable given that the proposed measures, especially those advocating mitigation measures such as carbon pricing and ETS, are relatively new in the maritime field, the implications from the above is that some form of ex-post assessment to assess interim impacts of the measures on emission reduction, low-and-zero carbon innovation, and even more on economic outcomes on States should complement the comprehensive impact assessment of the basket of mid-term measures.

6.3 Costs and Benefits of the Transition

As we embark on a long-term journey of green transition, any proposed measure will have impacts beyond those initially targeted by the proposed measure(s), for instance in terms of out-of-measure and indirect costs and rewards. The extent to which the costs and benefits from these impacts are included or not in the comprehensive impact assessment of the basket of mid-term measures should be further considered. If set against clear environmental and carbon pricing targets, it would for instance be possible to model the environmental benefits of the measures as well as the associated benefits of productivity and technological change, which can then be used to estimate the costs reduction to both industry and 'society' once the spillover impacts are considered. Furthermore, it would then be possible to assess the environmental cost effectiveness of the measures, either by looking at input-cost minimization or environmental-output maximization, or both. This way, it would be possible to assess the environmental effectiveness of the measure.

The take from above is that it is not only possible but also desirable to extend the CIA beyond the initial focus on the impact of the measures on costs (on trades and States) to include the (potential) benefits from both the environmental and technological impacts of the measures, as well as the revenue use associated with the measures.

6.4 Scope and Methods of Economic Evaluation

One of the challenges arising from the proposed measures and their combinations is the multiplicity of stakeholders: for instance in the case of revenue collection of and the allocation from carbon pricing (ship operators, governments, R&D institutions, etc.). In a typical economic evaluation, this raises the question on whose costs or benefits to scope and consider and how these costs and benefits can be shared or distributed among them.

One way to overcome these challenges when carrying out a CIA of the basket of mid-term measures is to use Stakeholder Analysis (SHA) and Multi-Criteria Analysis (MCA) among other methods to categorise and prioritize stakeholders, then incorporate their views and feedbacks in the CIA. SHA and MCA are particularly relevant in ensuring appropriate stakeholders' coverage and representation, especially among those who might be overlooked or under-represented under traditional stratified sampling or other similar tools.

6.5 Transaction Costs and Administrative Burden

Any of the proposed measures or basket of measures will generate administrative and transaction costs, whether those borne by shipping interests directly subjected to the measure (shipowners and operators) or accrued to maritime administrations (or other relevant agencies) entrusted with implementing and/or administering the measures. An indirect administrative burden might also arise from the operational and transaction costs of revenue collection and disbursements, including the proposed funds. Transaction costs will differ from measure to measure and so will be the administrative burden and institutional capacity required to administer each of them. It is therefore suggested that the CIA of the basket of mid-term measures incorporates an assessment of the cost and administrative feasibility of the proposed measures.

6.6 Addressing Distributional and Disproportionality of Impacts

The IMO emphasizes the importance of addressing disproportionately negative impacts identified in impact assessments. However, no guidelines were provided on how disproportionately negative impacts should be understood, assessed, and addressed and these issues are subject to ongoing considerations within the IMO.

This is becoming more relevant given that most of the proposed measures and their initial impact assessments have put forward some elements and combinations of revenue generation and distribution. To address such impacts on States such as SIDS and LDCs, it is suggested that further criteria be considered in the CIA of the basket of mid-term measures.

7 GHG Pathways and Future Impact Assessment

At MEPC 57, the IMO decided to take the following nine fundamental principles as its reference for further debate on GHG emissions from international shipping, including economic measures. According to these principles, a future MBM shall be:

- Effective in contributing to the reduction of total global greenhouse gas emissions,
- Binding and equally applicable to all flag States to avoid evasion,
- Cost-effective,
- Able to limit, or at least, effectively minimize competitive distortion,
- Based on sustainable environmental development without penalizing global trade and growth
- Based on a goal-based approach and not prescribe specific methods
- Supportive of promoting and facilitating technical innovation and R&D in the entire shipping sector
- Accommodating to leading technologies in the field of energy efficiency
- Practical, transparent, fraud-free, and easy to administer.

It is not clear whether any further revisions or amendments to the above principles will take place in the future, but regardless of the basket of measures considered, the pathway towards maritime decarbonization entails risks and barriers. Understanding these is key not only for mitigating their impacts but also for informing policy makers on the most appropriate pathway to achieving GHG emission reduction.

7.1 Technical and Economic Measures

Climate change presumes a market failure which is reflected in the GHG emission externality and other concurrent failures such as information asymmetry and gaps, network effects and the lack of innovation incentives. To correct those market failures, policy interventions may be needed to send a clear signal to markets, guide the policy decision making and stimulate R&D, innovation and uptake of low to zero carbon technologies.

Traditional climate change policies may be divided into technical measures or technical elements, also referred to as direct regulatory approaches or command and control policies, and economic measures (or “economic instruments” or “economic elements”) often referred to as (MBMs). Command and control instruments set specific limits on GHG emissions or mandates concrete benchmarks to restrict the factors that lead to GHG emissions. In shipping and maritime transport, these can take the form of operational, performance and/or fuel efficiency standards. Economic measures, on the other hand, take the form of carbon pricing policies aimed at internalizing the external cost of emissions to enforce the polluter-pays principle. Economic measures include carbon taxes and levies and Emissions Trading Systems (ETS). Feebates, subsidies, tax breaks, indirect transfers and various offsetting mechanisms are other forms of Economic Measures though they may fall under either one of the main instruments. Economic elements may also be incorporated into a combined approach within a technical measure.

As discussed above in the literature review, both types of measures have merits and shortcomings. Issues considered include GHG reduction effectiveness, practical feasibility, legal

compatibility, administrative burden, implementation timeline, revenue generation and distribution, commercial risk and impact, and impacts on States. They may be used exclusively or in combination with other instruments and in that case the risk of double counting of emissions, reward staking and increased administrative costs should be properly assessed. The environmental impact of an Economic Measure in shipping will be seen both in the short run, through the implementation of operational measures to regulate the vessel's fuel consumption, and in the long run, through the provision of incentives to adopt low and zero carbon fuels.

Arguably, most existing IMO regulations fall within the remit of technical measures and as such there is a great degree of experience and expertise in managing their implementation, review, and monitoring. On the other hand, there are few to no historical parallels of an Economic Measure by the IMO in MARPOL, especially in terms of universality and revenue generation. However, there is the experience of the International Oil Pollution Compensation Funds, where the IMO⁴ designed a mechanism for the compensation of victims of a pollution incident.

7.2 Pricing the Carbon Tax

The policy of taxing firms according to the marginal external costs that they impose on society assumes that the scope and value of this cost has been assessed and quantified so that a tax equivalent is set to internalize the GHG externality by making the polluter pay, a principle incorporated into international law at the 1992 Rio Summit. Setting the price at the social cost of carbon is theoretically appealing but practically difficult to estimate given the uncertainty about the scope, scale, and frequency of future damages from shipping emissions and the discount rates applied to them. A more feasible alternative is to estimate the carbon prices needed to achieve a GHG or temperature reduction target level, commensurate with IMO targets and ambitions.

In shipping and maritime transport, various studies have calculated the MACC that could help estimate the required CO₂ price needed to reduce or bridge the price (or competitiveness) gap between incumbent fossil fuels and zero carbon fuels. They indicate that to meet the Initial IMO Strategy's goal of reducing GHG emissions by at least 50% by 2050, a carbon price ranging between \$100 and \$500 per tonne of carbon would be necessary. Others have indicated even lower and higher estimates.

In any case, estimating a carbon price relies on many assumptions including on the price, availability, and type of the alternative fuel(s). There are also variations of those assumptions across countries and regions. For instance, some jurisdictions still grant direct subsidies at various stages of fossil fuel supply chain production, distribution, sales, and consumption. Other jurisdictions offer direct and indirect subsidies to the production of alternative and renewable, but also conventional fuels. Sometimes, both sets of subsidy interventions may take place within the same jurisdiction. The fragmentation of policy intervention is another course of uncertainty for carbon price setting.

⁴ However, Governments have already adopted and implemented economic measures in shipping globally, e.g., the 1992 International Oil Pollution Compensation Funds and the Supplementary Fund.

7.3 Revenue Generation and Recycling

Another important aspect in policy intervention is the revenue generation from the economic measures and their recycling. Not all Economic Measures raise revenues. This is the case for example of green subsidies, baseline-and-credit schemes and cap-and-trade scheme where allowances are distributed for free. However, for those which do, a question then arises on how to collect, administer, allocate and manage those revenues.

Recent studies and projections indicate that the revenues that could be raised from a carbon price on shipping emissions could be significant, ranging from a few hundred million to potentially tens of billions of dollars per year. Most submissions seem to agree that some sort of fund or similar institutional structure, be it within or outside the IMO, would be required to manage the revenues generated. There is also some sort of convergence on the possible uses of the revenues with various allocation proportions among uses (rewards for superior players/prime movers, grants and project financing to negatively impacted countries, innovation and R&D, etc.). Depending on the price charged, the revenue raised may be too small to make a tangible change on GHG targets or too high to exceed the minimum levels of decarbonization targets.

Aside from legality and administrative issues, there are at least two areas that deserve further attention and may even intersect with the future comprehensive impact assessment CIA of the basket of mid-term measures. The first is related to the need from any fund or institutional structure in charge of managing the revenues raised to have some expertise in fund management, grant funding (and financing), some aspects of economic regulation, and many aspects of capacity building, project management and the management of R&D funding and execution . The second is related to the extent of the use of the revenues generated, especially with regards the split between in-sector/out-sector spending depending on how a sector and its activities are scoped and defined.

7.4 Policy and Regulatory Risks

The interaction between long term decarbonization policies and short-term market changes creates risks and uncertainties for ship and shipping interests, terminal and port operators, bunker and fuel providers, lenders and insurers, and other market participants. Given the significant investment required to achieve a high uptake of decarbonization targets, a stable and consistent policy landscape is required so that there is sufficient confidence that investment and market opportunities will be sustainable in the medium and long runs.

The market simply requires a clear and stable landscape with minimum regulatory uncertainty. Delays to low-carbon fuel regulations would pose a major barrier to decarbonization and significantly increase its costs. If a lack of investment leads to a shortage of maritime transport capacity, a market that is characterized by steep (inelastic) demand and supply curves can lead to situations with surges in maritime freight rates, as seen for example during the Covid-induced logistics crisis in 2020-2021.

Another barrier to decarbonization will be the risk of imposing different tiers of overlapping regulations, e.g., at multinational, regional, and national levels, as well as the risk of creating regional tiers of compliance such as specific green corridors or regional exemptions. If a carbon tax is implemented regionally or is designed with many route exemptions, there will be a high risk of carbon leakage and excessive tax base erosion because ships could alter their route to evade the system and/or refuel easily outside its jurisdiction.

As we move together towards a shared goal of a globally decarbonized maritime sector, policies and safeguards must be put in place to promote technological neutrality, protect against the risks of regulatory capture, minimise fragmented interventions and carbon leakage, and ensure that any regulatory intervention does not compromise the role of shipping and the maritime industry in the global supply chain.

7.5 Coordination and Interface Risks

To achieve a synchronized transition to low and zero carbon shipping, coordination will be required across the maritime supply chain. Coordination risks include interface risks, split-incentive risks, operational interoperability risks, and risks from unharmonized regulatory systems and procedures. To achieve a synchronized transition to low-carbon and zero carbon shipping, coordination of policies and measures would be required across the maritime supply chain to avoid duplication of efforts and maximize positive outcomes.

7.6 Interplay with Domestic Shipping

Domestic shipping emissions fall directly within national government responsibility and the Fourth IMO GHG Study found that around 30% of total shipping emissions are attributable to domestic shipping. Notwithstanding the definition of domestic shipping for the purpose of emissions' regulation and reductions, there may be a risk of carbon offloading through artificial changes of service and network routing, bunkering and fuel supply, and cargo and logistics distribution in ways that evade emissions' regulations on international shipping. Conversely, some countries and regions are considering enacting regulatory measures on their domestic shipping that go beyond those currently proposed at the IMO. These could further widen the environmental and emissions' gap between domestic shipping and international shipping operations.

7.7 Modal Shifts Risks and Impacts

There is a wealth of practical and theoretical literature on the drivers and dynamics of modal shifts to/from maritime transport and their variations across trades, commodities, countries and regions. However, scant literature exists on the risks and impacts of modal shifts due to GHG emission regulations affecting maritime transport, and this may be largely due to the differences in operating costs, regulatory standards, prices and taxes between modes and jurisdictions. Modal shifts may also occur as a result of transfer pricing between divisions of vertically integrated transport and logistics businesses.

Maritime shipping tends to be the most energy efficient mode of transport on per unit of transport work basis. When assessing the potential impact of maritime GHG emission regulations, the potential of a modal shift could be considered, even if the emissions and the economic impacts of regulations from other modes cannot be included in an impact assessment focusing on maritime transport. However, global solutions covering all modes of transport, as well as international and domestic regulations could be considered.

7.8 Information Barriers and Gaps, and Time Frames

Information gaps and barriers may be the symptom or outcome of imperfect information or asymmetry, both slowing the uptake of regulatory measures and the green transition. The availability of reliable and accurate data is a prerequisite for understanding and addressing the needs of developing countries, including SIDS and LDCs. For example, the validity of the assessments of measures' impacts on States would benefit from better availability, granularity and reliability of data on transport and trade costs.

A sequenced impact assessment could also help adjust for new economic and technological developments as new information will become available during the decarbonization pathway.

7.9 Regulatory impacts

IMO members may also consider assessing the legal and regulatory impact of the candidate GHG emission reduction measures for the shipping sector. This would require conducting a legal analysis of the proposed measures. This may entail reviewing relevant national and international laws, regulations, and treaties to ensure that the new IMO measures are aligned with existing legal obligations. The analysis will help determine whether potential for conflict may arise with such laws and regulations and the potential for legal challenges to occur.

Depending on the context of the assessment, some relevant national laws and regulations that can be considered when making assessments could include environmental protection laws, labour laws, intellectual property laws, data protection laws, and consumer protection laws.

7.10 Impact on States

There is a considerable amount of literature that focuses on the impacts of carbon pricing mechanisms on States. An overview of the existing literature shows that carbon pricing would increase maritime freight costs by between 0.4% and 16% on average; with the results of some studies exceeding this range. Given the lack of historical and empirical evidence from shipping, existing studies have generally relied on analysing observable changes in bunker prices and bunkering adjustment factors. These have been used as a proxy to a carbon tax or fuel standard mandating the use of more expensive and/or lower GHG intensity fuel to estimate the price elasticity of shipping services. But price elasticities differ considerably across countries, products/commodities, ship types, and distance travelled, to mention but a few variables. Still, across these studies, SIDS seem to incur relatively a higher transport cost burden due to their small-size, remoteness and trade structure.

Aside from the difficulty to empirically measure the real impact of a carbon price on shipping costs, there is also a difficulty on how to translate changes in transport costs into changes in ad-valorem costs which can then feed into changes in GDP. UNCTAD has helped to address this methodological challenge as part of its 2021 comprehensive assessment. Going forward, one way to strengthen the analysis is to consider existing empirical evidence from other similar sectors in the transport industry (e.g., urban transport) and beyond (e.g., utilities) which have been subject to some form of carbon pricing.

The impact of technical measures on States is more difficult to assess, as the impact on maritime transport costs and speeds needs to be assessed first. Collaboration with technical bodies will be necessary and assumptions and models will need regular updating.

8 Conclusions and Key Findings

Although shipping contributes relatively smaller shares of GHG emissions on per unit of maritime transport work basis, if left unchecked, emissions from the sector are set to increase from about 90% of 2008 emissions in 2018 to 90-130% of 2008 emissions by 2050. It has been estimated that halving shipping's emissions by 2050 could require \$1.4 trillion in investment (Global Maritime Forum, 2022) For shipping to succeed in decarbonizing and help prevent dangerous levels of global warming, the sector needs to act and more importantly to reach consensus regarding the regulatory framework and measures of the future as soon as possible.

Rapid progress at IMO is crucial and adopting requisite GHG reduction measures, including technical, economic and the combination of both elements, is of the essence. Delaying action will generate more costs and will undermine the legal certainty required to incentivize investment and prompt action in low carbon ships, fuels and bunkering infrastructure.

While many estimates have been floating around underscoring the magnitude of damages and losses that may result from unchecked global warming, in a recent briefing, Oxford Economics finds that 2.2°C of warming by 2050 has the potential to reduce global GDP levels by up to 20%.

A universal decarbonization regulatory framework that applies to all ships irrespective of their flags or regions of activity is critical to avoid a two-speed decarbonization shipping landscape and ensure a level-playing field. For developing countries, a multilateral solution adopted under the auspices of the IMO which considers the special needs for assistance of the most vulnerable economies such as SIDS and LDCs, will provide a workable outcome and avoid fragmented regional and unilateral approaches. Fragmentation increases uncertainty, undermines the level playing field, distorts markets while jeopardizing the achievement of climate targets due to, among other factors, lack of incentives, carbon leakages, compliance evasion, etc.

The shipping industry requires a clear, uniform and predictable operating landscape with minimum regulatory uncertainty. Delaying the adoption of the IMO mid-term or long-term measures aimed at managing shipping carbon emissions will jeopardize decarbonization and could lead to the emergence of different tiers of overlapping regulations, e.g., at multinational, national and regional levels. It could also create regional tiers of compliance such as specific green

corridors or exemptions. If a GHG mitigation policy (e.g. fuel standards or an economic measure) is implemented regionally or is designed with many route exemptions, there is a high risk of carbon leakage and excessive tax base erosion because ships could alter their route to evade the system and/or refuel easily outside its jurisdiction. It could also pave the way to regional pockets of unsustainable and substandard shipping.

Proposals reviewed in this report have shown efforts made by the various proponents to strike a balance between these wide-ranging aspects and perspectives and enable the prompt adoption of the mid-term measures that are based on economic and technical elements as well as solutions that combine both. All proponents of the various proposals and measures seem to favour the introduction of the proposed technical elements, in particular the GFS, in parallel with the introduction of an economic element for the development of a basket of elements as part of mid-term measures, where applicable. As such, these efforts should be commended given the challenge of introducing for the first time such instruments into shipping and the difficulty of knowing beforehand what the precise impact would be.

In reviewing the proposals, it may be argued that a solution is not necessarily far from reach despite the complexity and the challenge faced when aiming to achieve the perfect proposal/measure. Progress can be realized by ensuring that the decarbonization measures that may be adopted at IMO also allow for an economic component generating a revenue stream, which in turn, can be recycled back to benefit the maritime sector and help manage some of the transition costs affecting both industry and States, in particular developing States, SIDS and LDCs. Most submissions seem to agree that some sort of fund or similar institutional structure, be it within or outside the IMO, would be required to manage and deploy the revenues generated. There is also some sort of convergence on the possible uses of the revenues but with various allocation proportions among uses (rewards for superior players/prime movers, grants and project financing to negatively impacted countries including both in-sector and out-of-sector support, capacity building, innovation and R&D).

It should be stressed that this preliminary review by UNCTAD does not assess nor evaluate the comprehensiveness of the initial impact assessments and their proposals, instead the review considered the data assumptions, methodological tools and outcome results with a view to informing and strengthening future work on impact assessments. This preliminary review seeks to identify elements to be considered for a future comprehensive impact assessment of the basket of mid-term measures while taking into account the recommendations made in the various proposals and their initial impact assessments, and in view of the lessons learned from previous impact assessments. Suggestions made may inform further reviews for the *Revised Procedure for assessing impacts on States of candidate measures* (MEPC.1/Circ.885/Rev.1, paragraph 4).

The lack of historical or empirical evidence in shipping has led existing studies to rely largely on observable changes in bunker prices and bunkering adjustment factors, as a proxy to a carbon tax and to estimate the price elasticity of shipping services. But price elasticities differ considerably across countries, products/commodities, ship types, and distance travelled, etc. Most studies

converge, however, and conclude that SIDS seem to incur relatively a higher transport cost burden owing to their small-size, remoteness, dependency on maritime transport, and trade structure.

Bearing this in mind and aiming to explore the potential impact of a change in fuel costs driving a change in maritime transport costs, UNCTAD has modelled the outcome of a hypothetical increase in maritime logistics costs on trade and GDP at a global level. To obtain a range of orders of magnitude, simulations assumed three levels of maritime logistics cost increases of 10%, 20% and 50%. At a global level, the scenarios imply changes in trade flows of slightly up to 1%. These translate into a smaller impact on real GDP of less than 0.1%. While changes may be considered relatively small in global terms, there remains a potential for greater impacts with greater increases in maritime logistics costs and for countries that are dependent on their trade in their most affected sectors.

Taking into consideration the review of the various proposals for the development of mid-term measures, the bilateral discussions with the proponents of the proposals which sought to clarify some elements as well as the UNCTAD preliminary empirical assessment which explores through a trade model the potential impact on trade and GDP of hypothetical increases in maritime logistics costs, several considerations have emerged as important and can be summarized as follows:

- The review underscored the variations in the proposals put forward, from technical to economic elements, as well as a combination of both. In this context, comparing these proposals is difficult due to the related implications on the economic evaluation and appraisal approach. However, most proposals are to be defined to achieve the IMO's levels of ambition, and this will help define a key component of the increase in maritime logistics costs; regardless of whether this is driven by technical or economic elements. The impact of revenue use for addressing disproportionate negative impacts and contributing to a just/equitable transition is harder to quantify but here, too, past economic analysis on the positive impacts of, for example, port investments or trade facilitation reforms can help in this regard.
- Economic Measures are relatively new to the IMO and as such ex-post assessments to determine interim impacts may be required. Some methods could be relied upon to bridge the gap and be used to complement the comprehensive impact assessment of the basket of mid-term measures (e.g., quasi-experimental design, case study and comparative case study analyses).
- One of the challenges underscored by the proposed elements and their combinations is the multiplicity of stakeholders, for instance in the case of revenue collection of and allocation from carbon pricing (ship operators, governments, R&D institutions, etc.). This raises the question of whose costs or benefits to scope and consider and how these costs and benefits can be shared or distributed among them. In this respect, methods such as Stakeholder Analysis (SHA) and Multi-Criteria Analysis (MCA) can be relied upon for a selection of identified cases. Future impact assessment should redefine the scope and parameters of SHA to include not only ship operators but other relevant players.

- Any comprehensive impact assessment should incorporate an evaluation of administrative costs and the feasibility of the proposed measures. This is because these will generate administrative and transaction costs, whether those borne by shipping interests directly subjected to the measure or accrued to maritime administrations (or other relevant agencies) entrusted of implementing and/or administering the measures. Transaction and administrative costs will vary by measure and depending on the size of the administrative burden and the institutional capacity.
- Given that revenue streams may be generated through some of the proposed measures, enabling the possibility of channeling some of the revenues to various purposes in support of climate action in shipping will be important. There is also a need to consider how distributional impacts should be understood, assessed, and addressed. It is suggested that additional criteria could be proposed and considered in any future initial or comprehensive impact assessment to address these issues, especially when relating to SIDS and LDCs.
- Traditional climate change policies may be divided into technical measures, also referred to direct regulatory approaches or command-and-control policies, and economic measures also referred to as an MBM. Both sets of measures have benefits and disadvantages. They may be used exclusively or in combination with other instruments, thereby potentially causing a double counting of emissions, reward staking and increased administrative costs. The environmental impact of an economic measure in shipping will be seen both, through the implementation of operational measures to regulate the vessel's fuel consumption, and through the provision of incentives to adopt low and zero carbon fuels. While there is a great degree of experience and expertise in managing the implementation, review and monitoring of technical measures, there are few to no historical parallels of an economic measure by the IMO, especially in terms of universality and revenue generation. There will be a need to develop such expertise prior to and during the design and introduction of the mid-term measures.
- Setting a carbon price implies the need to make assumptions about the price, availability, and type of alternative fuel(s), among other things. Assumptions vary across countries and regions with some countries providing direct subsidies to fossil fuels while others provide support to the production of alternative and renewable fuels. Addressing uncertainty that may arise in connection with these aspects will be important.
- Any fund or institutional structure in charge of managing the revenues raised needs to have some expertise in fund management, grant funding and financing, economic regulation, capacity building, and R&D project management. The use of the revenues generated, especially will depend on how the scope of the sector and its activities are defined.
- There will be a need to devise policies and safeguards to promote technological neutrality, protect against the risks of regulatory capture, fragmented interventions, and carbon leakage, and ensures that any regulatory intervention does not compromise the role and modal competitiveness of the shipping and the maritime industry in the global supply chain.

- Having access to additional data can help to better understand and address the needs of developing countries, SIDS and LDCs. The current work on the transport cost database at UNCTAD in collaboration with the World Bank and the development of a Guidebook on Maritime Transport Cost Data Collection by IMO, in collaboration with UNCTAD, can help to narrow the existing data and information gap.
- Translating changes in transport costs into changes in ad-valorem costs which can then feed into changes in GDP is difficult. UNCTAD has helped to address this methodological challenge as part of its 2021 comprehensive impact assessment of the short-term measures. For a comprehensive impact assessment of mid-term measures, additional challenges are to be considered, including on the status of ships on ballast and their journeys, the allocation of their emissions to countries and regions, and the costs and benefits from revenue use and distribution. Going forward, one way to strengthen the analysis is to also consider existing empirical evidence from other similar sectors in the transport industry (e.g., urban transport) and beyond (e.g., utilities) which have been subject to some form of carbon pricing.
- The review of the proposed measures and their initial impact assessments confirms that the shipping decarbonization will lead to somewhat higher maritime logistics costs including both shipping and time costs and thus trade costs. These costs can be estimated, and their impact on States can be assessed. It will also be important to consider the time required to agree and implement the measures, as delays are likely to generate additional costs, notably: a) higher maritime transport costs resulting from the uncertainty faced by the industry; b) higher transition costs if the time left to achieve the necessary decarbonization is shortened further; and c) additional costs associated with not achieving the necessary climate change mitigation targets.

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