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Integration of maritime transport in the EU Emissions Trading System

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Table of Contents

List of Boxes

List of Figures

List of Tables

List of Abbreviations

CBAM	Carbon Border Adjustment Mechanism
CBDR-RC	Common but Differentiated Responsibilities and Respective Capabilities
CII	Carbon Intensity Indicator
CORSIA	Carbon Offset and Reduction Scheme for International Aviation
CO_2e	Carbon Dioxide Equivalent
DCS	Data Collection System
EEA	European Economic Area
EEDI	Energy Efficiency Design Index
EEXI	Energy Efficiency Index for Existing Ships
EEZ	Exclusive Economic Zone
EF	Emission Factor
ETS	Emissions Trading System
EU	European Union
EUA	European Union Allowance
EUAA	European Union Aviation Allowance
GHG	Greenhouse Gas
GWP	Global Warming Potential
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
IMRB	International Maritime Research Board
IMRF	International Maritime Research Fund
IOPC Funds	International Oil Pollution Compensation Funds
LDC	Least Developed Country
MARPOL	International Convention for the Prevention of Marine Pollution from Ships
MBM	Market-based Measure
MEPC	Marine Environment Protection Committee
MRV	Monitoring, Reporting, Verification
MS	Member States
NDC	Nationally Determined Contribution
nm	Nautical Mile
OF	Ocean Fund
PSM	Price Stabilization Mechanism
R&D	Research & Development
SEEMP	Ships Energy Efficiency Management Plan
SIDS	Small Island Developing State
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America

Summary

Maritime transport contributes 2-3% to global greenhouse gas emissions. It is, nevertheless, the only sector which is not yet subject to greenhouse gas (GHG) reduction targets and policies in the European Union (EU). It is imperative that this gap is closed; corresponding policies should be implemented with urgency. One option for addressing GHG emissions from shipping is to incorporate them into the EU Emission Trading System (ETS), as foreseen in the European Green Deal. The inclusion of maritime transport needs to be viewed as part of a policy package since not all barriers to the decarbonization of the sector can be addressed by an ETS with current allowance price levels.

This paper analyzes different design options to be considered in the set-up of a maritime EU ETS. These different options include, for example, the choice of the regulated entity, the geographical scope and the allocation method. The experiences gathered from ETS for stationary sources and aviation should be taken into account when extending the EU ETS to incorporate another sector. The decisions on the individual options often involve trade-offs between different goals.

There are several options for defining the regulated entity under a maritime ETS. Currently, the definition of the regulated entity in the EU Monitoring, Reporting and Verification (MRV) regulation – the shipping company – serves as a good basis for a maritime ETS. A more detailed legal analysis is necessary to identify a more suitable approach given the multitude of stakeholders involved.

Intra-European Economic Area (EEA), outgoing and incoming voyages each account for approx. a third of the emissions covered by the EU MRV. From an environmental perspective, it is considered vital to cover all emissions of ships calling at EU ports. However, to avoid rejection by other countries, as experienced when the full scope was applied to aviation, 50% of each in- and outgoing voyage in addition to intra-EEA voyages should be covered.

A cap that is at least semi-open would allow regulated entities to surrender allowances from other sectors and, in this way, mitigate the volatility of allowance prices. The cap, determined based on the linear reduction factor, should not be weaker than for other sectors. Since the risk of relocating production is low for maritime transport compared to other sectors, all allowances should be auctioned. Provided that allowances are auctioned, revenues should, to a major extent at least, be recycled to the maritime sector with a view to facilitating the accelerated uptake of sustainable alternative marine fuels and other GHG-reducing technologies.

Stakeholders from the shipping industry suggest establishing a price stabilization mechanism. The concerns of the industry deserve careful consideration; it should therefore be further investigated whether such a mechanism needs to be established by the regulator or whether market participants like financial intermediaries would provide the same service.

If these features are considered in the incorporation of shipping into the EU ETS, it would ensure that the inclusion is both environmentally effective and administratively feasible for all regulated entities. The inclusion of shipping would be an important part of addressing maritime GHG emissions in the EU alongside other policies like the FuelEU Maritime Initiative.

It can be concluded that the inclusion of shipping in the EU ETS would not cause any technical barriers for the implementation of GHG reduction policies at global level. From a political perspective, since the EU policy is likely to be implemented earlier than any similarly market-based policy at global level, a maritime EU ETS may accelerate discussions and agreements on the design of such a market-based policy at the International Maritime Organization (IMO) – as was the case with emission control areas or IMO's data collection system.

1 Introduction

Maritime transport contributes 2-3% to global GHG emissions (IMO 2020a). In its Initial Greenhouse Gas Strategy (IMO 2018), the IMO adopted emission reduction targets for the shipping sector. Discussions on suitable policies and measures to achieve these goals are ongoing. The EU has meanwhile committed to achieving climate neutrality by 2050, which requires GHG emission reductions in all sectors. The extension of the EU ETS to maritime transport was put forward in the context of the EU Green Deal. So far, shipping is the only sector not subject to GHG emission reduction targets and policies in the EU.

CO_2 emissions from maritime transport made up 3% (138 Mt) of overall emissions in the EU (EC 2020a). Within the transport sector, the emission share of maritime transport amounts to approx. 13%. The Impact Assessment of the EU Commission (EC 2013) stated that CO_2 emissions from shipping could be reduced cumulatively by 336 Mt by 2030 if the sector were included in an open EU ETS with full auctioning. Since that Impact Assessment, the question of including maritime emissions has been on the table. The establishment of the EU MRV system (Box 1) and the current discussion about integrating the maritime transport sector in the EU ETS are part of a stepwise approach to addressing maritime emissions. Drawing on experiences gathered with the EU ETS for stationary installations and the aviation sector, the inclusion of maritime transport needs to be well-designed, also with respect to forthcoming policies at the global level. Recent studies have highlighted the need for a fast transition of the shipping sector and that policies need to incentivize not only energy efficiency but also e-fuels (Simon Bullock et al. 2020; Sharmina et al. 2020). E-fuels such as green ammonia and green methanol are alternative fuels which are produced with renewable energy and, if applicable, CO_2 or nitrogen captured from the air.

The inclusion of maritime transport in an ETS is considered as part of policy package by the EU to address different aspects of the decarbonization of the sector such as supply of alternative fuels and infrastructure. Other relevant policy initiatives by the EU are the FuelEU Maritime Initiative, the revisions of the Renewable Energy Directive (RED) and the Alternative Fuel Infrastructure Directive (AFID). While measures for decarbonizing inland waterway transport are being discussed (EC 2020b), this study refers to maritime shipping only.

Against this background, we assess how the inclusion of maritime transport in the EU ETS should be designed to ensure environmental efficacy and integrity and the extent to which its inclusion would interfere with discussions on GHG reduction policies under the IMO.

As a first step, we discuss the potential options for key design dimensions. We assess advantages and disadvantages of the options with a view to providing recommendations for an optimal design of the corresponding EU policy (chapter 2). In the second step, we assess the compatibility of a maritime EU ETS with potential IMO policies by reviewing the candidate measures discussed at IMO (chapter 3). Based on these deliberations, we finally draw conclusions and provide recommendations for the design of the shipping ETS and for strategies to promote effective GHG reduction policies at global level (chapter 4).

2 Assessment of design dimensions

2.1 Regulated entity

Designing a maritime EU ETS requires the definition of an accounting entity and a legally liable entity, called “responsible or regulated entity” here. The choice of both is interdependent (Heine und Gäde 2018). In maritime shipping, the accounting entity could either be defined as the ship or the cargo. The ship as an accounting entity causes the greenhouse gas emissions and is thus equivalent to an installation under the stationary ETS (e.g. power plant). Likewise, the vessel’s activity and related operational or technical measures on the ship influence the level of emitted GHGs. The existing emissions monitoring system in the EU (section 2.2) is centered around the vessel, too. CE Delft (2009) also recommends that the ship should be the accounting entity because the ship can be easily identified by its IMO number and anyone could submit allowances etc. on behalf of the ship to allow continued operation. The alternative accounting entity cargo is more relevant for freight-based schemes, which will not be discussed in detail here (section 2.2).

However, enforcement measures and environmental requirements need to be addressed to a legal entity or juridical person. Choosing the most appropriate regulated entity is challenging because several options can be considered. Firstly, it is common that many different entities are involved operating a ship. The legal responsibility of a ship may thus “*be spread over many national jurisdictions*” (UBA 2010, p. 129). Secondly, the selection of the most appropriate responsible entity cannot be assessed without considering other design dimensions like compliance or allocation method (CE Delft 2009).

Generally, the regulated entity should ensure compliance with the environmental requirements, be in charge of paying the fine in case of non-compliance and be able to influence the amount of emitted CO_2 (polluter-pays principle) (UBA 2010). Many factors influence the decision on CO_2 reduction or the uptake of alternative fuels. There is, for example, the problem of split incentives. The entity investing in a ship’s environmental performance is not always the entity reaping the benefits of that investment. A study conducted by the UCL Energy Institute (2016) showed that vessels with lower CO_2 emissions per nautical mile (relative to ships of the same ship type) were not earning higher time charter rates than those with higher CO_2 emissions per nautical mile. Some entities might have a higher incentive to improve the environmental performance of a ship, while others might mostly care about keeping costs to a minimum in the short term. The choice of the responsible entity should ideally reduce the risk of split incentives. Additionally, basing the ETS on the ship as the accounting entity requires a relatively stable link between the responsible entity and the ship. Due to the weak or missing link between, for example, the consignee and the ship, it is likely that allowances will be purchased instead of actions to reduce emissions because the allowances only make up a small fraction of the price of the goods (UBA 2010). Therefore, options for responsible entities which rely on freight-based vessel activity or which have only an indirect or a weak link to the ship are not taken into account here (e.g. consignee, master/captain, flag-state agent).

An upstream approach is to make the **fuel supplier** the responsible entity. However, it will likely decrease the effectiveness of the ETS because ship owners tend to bunker where fuel is cheapest and would thus bunker outside the scope of the scheme (CE Delft 2009). As a maritime EU ETS will likely be based on the existing MRV system which centers around the shipping company, the fuel supplier option will not be further discussed.

A more stable tie to the ship is given downstream if the **ship owner** is made the responsible entity under the EU ETS. The ship owner can be an individual, a group of people, investment firms or ship brokers. While the operation of a ship sometimes lies in the hands of changing commercial operators like charterers, the ship owner as a responsible entity provides consistency throughout the reporting year in case of operator changes. The ship owner is also mainly responsible for investments in the ship to reduce GHG emissions. Financial requirements for ship investments are increasingly tied to a 'greening of investment', like efficiency performance or climate-friendliness. The Poseidon Principles are a good example in this regard; they provide a framework for banks to assess the climate alignment of ship finance portfolios.[1] If serving as the regulated entity under the EU ETS, the ship owners might face pressure from different sides to improve the technical environmental performance of their ships. However, when a ship owner makes investments to improve the carbon footprint of his vessel, it will likely be the commercial operator that benefits from the lower fuel bill.

The **ship operator or manager** (operating one or multiple ships) also has a relatively stable relationship to a vessel but changes occur more often than an owner change. The operator organizes the finances and manning of the ship (including charter contracts) and is responsible for the daily operation of the vessel. The latter includes compliance with local, national or international standards on board (UBA 2010). It also means that a ship operator can influence the amount of emitted GHGs, for example by operational changes like slow steaming This approach would be similar to the aviation EU ETS for which airlines are the regulated entities.

A **charterer** is a company purchasing the vessel's services for partial, full, single, short- or long-term operations (UBA 2010). Sometimes the charterer and operator of a vessel can be the same entity. The charterer is, like the operator, able to influence the GHG emissions of the vessel. The influence might be limited due to short duration of chartering and because the charterer is linked to the freight. Liner shipping charterers might, however, have a higher motivation as they usually have long-term contracts and sometimes influence the design of new-built vessels (UBA 2010).

Existing monitoring and reporting systems might offer a practical basis for defining the regulated entity under an EU ETS. The **shipping company** is responsible for compliance under the EU monitoring, reporting and verification (MRV) system (Box 1), defined therein as the shipowner or anyone who has assumed the responsibility of operating the ship, e.g. a manager or bareboat charterer. The IMO set up an emission monitoring shortly after the EU in 2019, called IMO Data Collection System (DCS). The DCS, regulated in MAPROL Annex VI (IMO 2016), uses the same definition of a 'shipping company' which is derived from the definition in the International Safety Management Code for shipping.[2] The DCS also requires that shipping companies submit emission reports for their operated ships. The two systems have the same purpose but vary in a few points. The EU MRV collects, for example, more parameter data and the data is publicly available while the DCS is not.

1 Poseidon Principles: https://www.poseidonprinciples.org/#about.

2 ISM Code: https://www.imo.org/en/OurWork/HumanElement/Pages/ISMCode.aspx.

Box 1: EU MRV Regulation (2015/757)

- Data publicly available in EMSA data base called THETIS-MRV
- EU MRV covers all ships calling at EU ports during the reporting period (one calendar year) above 5 000 gross tonnage which transport cargo or passengers for commercial purposes (Art.2 and 3).
- Regulated entity: shipping company defined as the shipowner or anyone who has assumed the responsibility to operate the ship like a manager or bareboat charterer (Art.3(d))
- Reported emission type: CO_2 emissions
- Geographical scope covering CO_2 emissions:
  - that occur when ships are at berth
  - from voyages between the European Economic Area (EEA) ports (intra-EEA)
  - from voyages between the last non-EEA ports and the next EEA ports (incoming voyages)
  - from voyages between the last EEA ports and the next non-EEA ports (outgoing voyages)
- First reporting period in 2018:
  - 90% of all maritime EU CO_2 emissions covered but only 55% of all ships calling at EEA ports
  - included over 11 600 ships and over 2 000 companies

Sources: EMSA THETIS-MRV (2020), EU (2015), EC (2020a).

Given all these options for regulated entities, it becomes clear that there is variety of entities which can influence the GHG emissions during a voyage of a ship depending on the setting (e.g. if the ship is chartered or operated by the owner). It makes sense to find a definition which takes into account the daily operation of a ship while not excluding the owner, who also has an impact in the case of chartered ships, e.g. on longer-term investment decisions. Both the EU and the IMO systems target the entity operating the ship for compliance. However, this definition could be extended to better represent the variety of possible entities impacting the GHG emissions. The latest proposal of the European Parliament (EP 2020, Art.3(d)) to amend the EU MRV Regulation suggests such a definition of the regulated entity under an EU ETS by defining a shipping company as " [..] *the shipowner or any other organisation or person such as the manager; the time charterer or the bareboat charterer, which has assumed the responsibility for the commercial operation of the ship from the shipowner and is responsible for paying for fuel consumed by the ship*" – or in other words, a 'commercial ship operator'.

Choosing the commercial ship operator is also preferable in case a price stabilization mechanism (PSM) is implemented in the EU ETS (section 2.6.3). For example, as a shipping company's emissions are not verified until April of the following year under the EU MRV, there is a risk of developing a gap between the emissions that have been paid for during the contract of a commercial operator (assuming the operator makes use of the price stabilization mechanism, section 2.6.3) and the actual verified emissions (e.g. due to calculation errors in the fuel bill). In such a case, it would be the responsibility of the shipowners to pay for the difference, either by ensuring the commercial operator pays the correct amount in hindsight or by covering the difference themselves.

However, a detailed legal assessment would be useful to evaluate whether it is really necessary to deviate from the definition of the regulated entity in the EU MRV and IMO DCS. It does not lie within the scope of this study to assess the legal implications of the different options. A more detailed impact assessment of the operational costs, administrative costs/burden and legal implications of the different entity options is recommended before the regulator, e.g. the European Commission, decides on this design option of a maritime ETS.

Subject to a more detailed legal analysis, the EU ETS and EU MRV should be synchronized in their definitions of the regulated entity for now.

2.2 Scope

2.2.1 Regional scope

For determining the appropriate boundaries of a regional emission trading scheme, several factors have to be taken into account: environmental effectiveness, political feasibility and acceptability, evasion risk, data requirements, administrative burden and verification. The environmental effectiveness is determined by the amount of GHG emissions covered and mainly depends on the geographical coverage of the scheme and the potential for carbon leakage in the form of evasion.

Evasion or avoidance describes the risk that ships, or the regulated entity, avoid or circumvent a regulation by switching to other transport modes or changing the shipping routes to include other ports or by avoiding EU ports all together. Additional port calls are generally more likely to occur as an avoidance strategy than modal shift. From a ship's financial perspective, the likelihood of an evasive port call is determined by the balance between the ETS compliance cost and the additional costs such as extra port charges and fuel costs, and opportunity costs (incl. time loss), caused by evasion (T&E 2020c). Evasion becomes profitable if the CO_2 price is higher than the extra cost caused by evasive port calls.

In principle, there are different ways to establish the basis for the scope of the emission trading scheme. The amount of allowances can be calculated based on the fuel consumed (and related emissions) during a certain period or distance travelled (route-based schemes) or it can be based on freight (freight-based schemes). Freight-based schemes have received less attention in literature (Dominioni et al. 2018). In such a scheme, emissions could be calculated based on the energy efficiency of the vessel, distance travelled and the cargo weight – the latter two are already available to custom authorities. Even though there are studies which highlight a theoretical potential of cargo as a basis for a unilateral market-based measure (Dominioni et al. 2018; UBA 2010; Heine und Gäde 2018; CE Delft 2009), discussions on a maritime EU ETS based on voyages and the EU MRV are quite progressed. Taking this and the considerations in section 2.1 into account, freight-based scope options will not be discussed further in this paper. Options for route-based schemes are presented in the following.

In 2018, the 138 Mt CO_2 emitted by European seaborne transport activity represent approx. one fifth of the 740 Mt CO_2 emissions of international shipping (EC 2020a; IMO 2020a). Most of these emissions that are related to European economic activity occur on voyages which go beyond the territorial sea (12 nm zone) or even the 200 nm Exclusive Economic Zone (EEZ), which are areas under national jurisdiction (UBA 2010; EC 2020a). Figure 1 illustrates that the majority of EU-related

seaborne CO_2 emissions can be attributed to incoming and outgoing voyages from/to these national waters from Member States (MS) of the European Economic Area (EEA). The EEA is an economic zone which extends the European Union's single market to the MS of the European Free Trade Association. The EEA thus connects the EU MS with Norway, Iceland and Liechtenstein into one market with the same overarching rules. An ETS that covers only voyages in the 12 nm or EEZ can be easily avoided by incoming and outgoing ships if these navigate parallel to the border of 12 nm/EEZ for most of the distance and only enter the 12nm/EEZ in a straight line towards the port. The avoidance risks are thus high. An ETS that covers only emissions from voyages within the EEA (meaning national maritime waters) and when ships are at berth would require ships to make an evasive port call in between in order to get outside of the geographical scope of the EEA, which is unlikely due to high costs (T&E 2020c). Additionally, this intra-EEA scope would have little environmental effectiveness; it would cover only about 55 Mt CO_2 (EMSA THETIS-MRV 2020). An intra-EEA scope would naturally be the minimum for integrating shipping in the EU ETS.

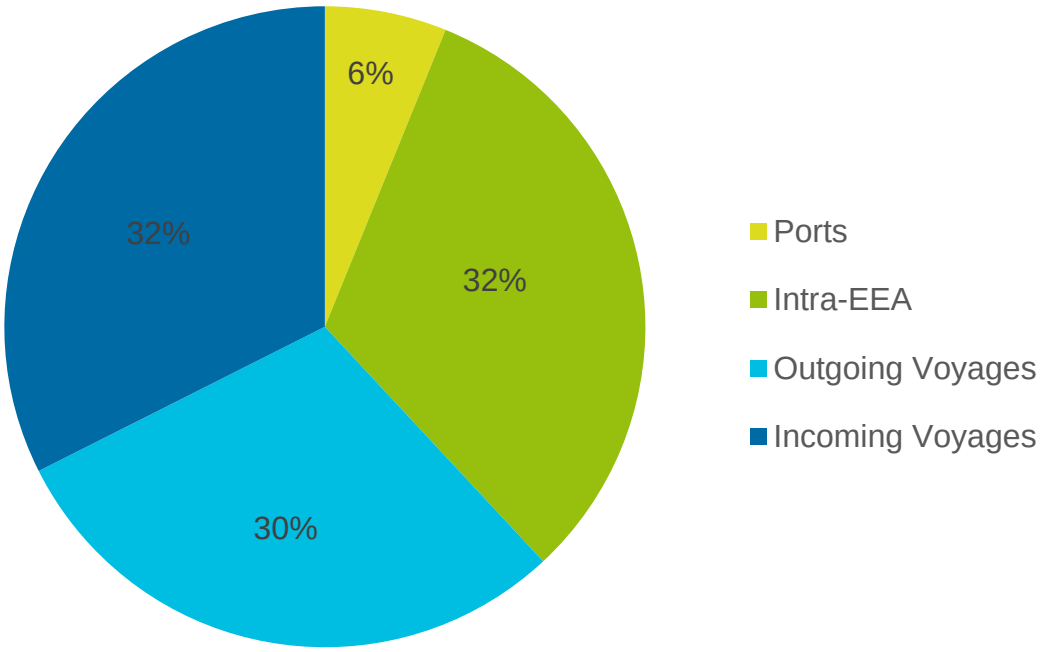
To increase the environmental effectiveness and to reflect the European share of maritime emissions, as measured by the EU MRV, the ETS could also be extended to emissions taking place in international waters (see more on legal details in section 2.6).

The EU MRV regulation provides a good basis in terms of data availability and existing administrative set-up. The regulation requires ships to report emissions that occur (EU 2015):

- when ships are at berth;
- between the European Economic Area (EEA) ports (intra-EEA);
- between the last non-EEA ports and the next EEA ports (incoming voyages);
- between the last EEA ports and the next non-EEA ports (outgoing voyages).

Thus, the EU MRV already covers voyages outside the EEA. Shipping companies need to report emissions for each ship with EU-trade related activities during the reporting period (one calendar year). The current ETS includes more than 11 000 stationary installations and airlines, which belong to approx. 5 000 companies. In comparison, the EU MRV system included over 2 000 companies and over 11 600 ships in the first reporting year 2018.

Figure 1: EU-related maritime CO_2 emissions from EU-related maritime transport 2019



Source: EU THETIS MRV, extract 2019-v95-05112020 EU MRV Publication of information.xlsx. Figure derived from Transport & Environment.

In the case of an ETS including voyages outside the EEA, shipping companies might try to shorten the length of their voyages, and thereby the emissions, which are covered by the ETS. By adding port calls at non-EEA ports close to EEA ports, regulated entities can reduce their exposure to the ETS. The Impact Assessment of the EU MRV by the European Commission (EC 2013) has already highlighted that an adequate definition of a port call can significantly mitigate the risk of avoidance. The EU MRV Regulation provides a good basis by defining a port of call as: "[..] *the port where a ship stops to load or unload cargo or to embark or disembark passengers*" (EU 2015, p. 2). Stops for all other purposes (e.g. refuelling, obtaining supplies, relieving the crew, shelter from adverse weather) do not count as a 'port of call'. According to CE Delft (2009) and EC (2013), the complete transshipment[3] of cargo is costly but the definition allows for partial unloading of cargo to count as a port call. This is rather difficult for some vessel types like bulk carriers or oil tankers but is, for example, easier for container ships. The definition could be strengthened by prescribing a substantial percentage of passengers or cargo to be (un-)loaded, as proposed in EP (2020). This could also be applied to EEA ports with a high evasion risk only (T&E 2020c). Alternatively, specific rules could be applied to high evasion risk ports, e.g. always the last two legs of a journey are included for these ports. The following options are ways in which emissions could be included in a broader scope than only intra-EEA (including when ships are at berth).

[3] Transfer of goods to smaller short-sea ships at an intermediate destination to another/final destination.

- **Option 1 - 50/50 scope:**

  An option for incorporating emissions from international waters in the ETS would be subject to only half of the total distance (half of the emissions) from a voyage to/from an EEA port to a non-EEA port to complying with the scheme. Ideally, the other half of the emissions on these voyages is covered by other regional or national regulations from third countries. In this way, a 50/50 scope could also be used as a stepping stone for extending the ETS to the full scope in case the other 50% of emissions are not covered by third countries until a certain point in time. The coverage of emissions under a 50/50-full scope would double compared to an intra-EEA scope to approx. 99 Mt CO_2 (EMSA THETIS-MRV 2020). As a study by T&E (2020c) shows, there is no incentive for evasive port calls from a financial perspective, given a CO_2 price of 30 €/tCO_2. This option might be less likely to be legally or politically challenged as it would not cover foreign territories. The latter was a relevant argument for countries like China or the USA in the discussion about including aviation in the EU ETS a few years ago, when ETS was applied to all incoming and outgoing EU aviation emissions. They argued that the EU violates their sovereignty because the EU ETS also addresses emissions which occur within their territories. A 50/50 scope might therefore be easier to realize politically with a relatively high environmental effectiveness than the full scope.

- **Option 2 - incoming voyages or outgoing voyages only:**

  A variation of the 50/50 scope is to cover only incoming or only outgoing voyages under the maritime ETS (including intra-EEA shipping and at berth respectively). A scope of incoming voyages would represent around a third of emissions based on current emission reporting (46 Mt CO_2). Thus, a scope of incoming voyages only would cover slightly more emissions than including only outgoing voyages (43 Mt CO_2), but only half of a 50/50 split (99 Mt CO_2) (Figure 1). It could also be argued that covering incoming voyages reflects the goods imported in the EU and therefore EU consumption (or further processing of imported goods) and the environmental footprint. Additionally, it might be easier to monitor and verify incoming voyages as the emissions have already occurred when the ship enters an EEA port.

- **Option 3 - full scope (full EU MRV):**

  The option with the largest scope could be based on the full EU MRV scope. This would result in a higher environmental effectiveness compared to the other options, covering about 144 Mt CO_2 (EMSA THETIS-MRV 2020). Based on this scope, the EU could take responsibility for most emissions caused by European maritime activity. The amount of emissions is equivalent to approx. 9% of the emissions from stationary ETS sources. T&E (2020c) concluded that the evasion risk will likely be slightly higher than under a 50/50 scope as the amount of emissions (and thus the carbon pricing) covered is higher - but the percentage of possibly affected voyages would still be well below 10%. The full scope has the highest environmental effectiveness but might face the strongest opposition from affected stakeholders.

2.2.2 Covered GHG emissions

Over 90% of emissions caused by maritime transport are CO_2 emissions. Apart from CO_2, shipping causes other emissions with a strong climate impact (IMO 2020a):

- nitrous oxide (N_2O)
- methane (CH_4)
- and black carbon (BC).

While CO_2 emissions are already reported under the EU MRV, the others are not. CO_2 emissions are calculated based on the combination of the amount of fuel consumed and a fuel-specific CO_2 emissions factor (EF). Similarly, fuel-specific CO_2e EF could be used to include other GHGs, as it was carried out in the methodology of the Fourth IMO GHG study (IMO 2020a). The existing EU ETS covers CO_2 emissions from power generation, energy-intensive industry and aviation. While the focus is on CO_2 emissions, the monitoring of N_2O emissions from producing nitric, adipic and glyoxylic acids and glyoxal, and perfluorocarbons (PFCs) from aluminium production is required.[4] The directive also mentions other GHGs like CH_4 in its Annex (EU Directive 2003/87/EC), but regulated entities are not required to surrender allowances for these GHG emissions. Non-CO_2 GHGs need to be reported in CO_2e based on the Global Warming Potential (GWP).

Nitrous oxide emissions, with a GWP of 298 over a 100-year period including climate-carbon feedbacks (Myhre et al. 2013), could become more important in the future if ammonia is combusted as an alternative fuel. Today, there are no vessels in service with an ammonia engine and further research and testing will be required to investigate potential emission from ammonia combustion (EDF 2019; Hansson et al. 2020). The inclusion of N_2O emissions could thus be considered in upcoming reviews of the maritime EU MRV (section 2.5).

There is an ongoing discussion about the calculation of the climate impact of **methane** over a 20-year time horizon. However, even with a 100-year time horizon, CH_4 is a much stronger GHG than CO_2 with a GWP of 28-34 (including climate-carbon feedbacks) (Myhre et al. 2013). CH_4 emissions are becoming more and more relevant in maritime shipping as emissions have increased in recent years due to a growing popularity of LNG as a fuel in shipping (IMO 2020a). Methane emissions can occur, for example, through incomplete combustion, so-called methane slip. LNG is used as an alternative fuel, e.g. to comply with stricter sulphur regulations. Additionally, LNG-fuelled ships have the potential to run on (sustainable) bio- or e-LNG in the future (DNV GL 2020). If CH_4 emissions are not included in a maritime ETS, the use of LNG on ships will be incentivized because burning methane in internal combustion engines produces less CO_2 emissions than conventional fuels. Any decision on the scope of the maritime ETS needs to consider these consequences. If CH_4 emissions were included under the EU ETS due to their increasing relevance in shipping, CH_4 emissions could be incorporated in the ETS and EU MRV by using a fuel-specific EF, e.g. as provided in ICCT (2021), as is currently the case for CO_2 in the MRV (see above).

In general, **black carbon** has a large warming effect, especially in the short term, because aerosol-radiation interactions of BC emissions and the deposition of BC on snow result in a positive radiative forcing of BC emissions (Myhre et al. 2013). The Fourth IMO GHG study (IMO 2020a) calculated that BC emissions constituted approx. 7% of the climate impact of international shipping. This small share of BC emissions of the total amount of shipping emissions could thus be significant for the overall climate impact of shipping. There is uncertainty, however, about the exact contribution of BC to the overall climate impact of shipping as the calculation of the GWP of BC is still being debated (IMO 2020a). The climate impact of BC depends, among other things, on the emission location (e.g., around Arctic) and the definition of black carbon or soot. For the Fourth IMO GHG Study the calculation of BC EFs was based on ICCT (2017b; 2017a), which defined a 100-year GWP of 900 for BC. Pricing BC requires a clear definition of its climate impact (e.g., in CO_2e based on a 100-year

[4] EU ETS: https://ec.europa.eu/clima/policies/ets_en.

GWP) to integrate it in a carbon pricing system with CO_2. Additionally, the calculation of BC emissions as a basis for carbon pricing is not as easy as the measurement of CO_2 emissions. While measurement techniques for BC emissions from ships exist, it might be difficult to conclude on a BC emission factor (EF) as BC emissions are influenced by several factors including engine load, fuel type and engine age (ICCT 2017b). The EFs for BC are generally less certain compared to EFs for CO_2 (ICCT 2017a). BC emissions, although not strictly a greenhouse 'gas', have a relevant climate impact and clearly need to be addressed through policy. The integration in an EU ETS is still challenging but the EU could go ahead if it is possible to reach an agreement on an EF and measurement criteria. Alternatively, BC emissions from ships could be addressed via regulatory measures such as emission standards or limits.

A well-to-wake approach for e-fuels is very important to achieve the long-term decarbonization of sector. Certificates (guarantees of origin) will need to be established as a proof for the emissions from well-to-wake of a fuel. In this way, fossil ammonia and ammonia produced from renewable energies can be distinguished, even though the final product is indistinguishable.

Based on these certificates, EF for different kind of (post-fossil) fuels can be established as is currently carried out in the EU MRV or IMO DCS as well. The EF of e-fuels would consequently be lower or zero compared to conventional fossil fuels. If e-fuels are used partially or completely on voyages covered by the ETS, the guarantees of origin would lower the burden for buying ETS emission allowances.

To summarize, a maritime ETS should cover all GHG emissions that are already monitored and reported under the EU MRV – currently only CO_2 emissions. However, considering the rise in and relevance of CH_4 emissions in shipping, the EU should strive to include CH_4 emissions in the EU MRV and subsequently the EU ETS. Also, the inclusion of BC and N_2O emissions should be considered, at least in later reviews of the ETS (section 2.5). Following a proposal by the European Parliament, discussions are already being held about extending the maritime MRV system to other GHG emissions (EP 2020).

2.2.3 Covered ships

A de minimis rule is applied in the ETS stationary source to reduce transaction costs; such a rule is also applied in the EU MRV. The EU MRV covers all ships calling at EU ports above 5 000 gross tonnage (GT). The IMO DCS applies to ships equal and above 5 000 GT. A maritime ETS applied to ships larger than 5 000 GT benefits from data available on these ship types. An ETS coverage of ships larger than 5 000 GT with the full geographical scope mentioned before (section 2.2.1) would – like the EU MRV - be able to cover 90% of all maritime EU CO_2 emissions and 55% of all ships calling at EEA ports (EC 2020a). However, every polluter would need to be covered if the policy should be in line with the polluter-pays principle. CE Delft (2009) has already suggested the inclusion of all ships with 400 GT or more. This is also the threshold for ships needing to comply with MARPOL Annex VI, which includes, for example, the EEDI.[5] The inclusion of smaller vessels would be useful because they typically operate near to shore and any reduction in GHG emissions and corresponding air pollutants will be beneficial for the coastal population. Additionally, smaller vessels already have decarbonizing options available to them which bigger deep-sea ships do not (e.g. batteries as an energy source). However, the administrative and communicative expenses might be

[5] IMO's work on GHG emissions: https://www.imo.org/en/OurWork/Environment/Pages/Historic%20Background%20GHG.aspx.

disproportionate to the additional CO_2 emissions covered by including smaller ships. In the context of a review of the maritime ETS (e.g. end of 2022), the extension of the scope to ships larger than 400 GT could be reconsidered with an impact assessment estimating the trade-off between the expenses versus environmental impact. If not covered by the EU ETS, emissions from ships smaller than 5 000 GT would need to be addressed by other means. This has to be evaluated in the context of other forthcoming policies at EU level and is beyond the scope of this study. For the sake of alignment with the EU MRV and IMO DCS, applying the ETS to ships larger than 5 000 GT might be easier to convene and implement.

According to EC (2020a), container ships, bulk carriers, oil tankers and RoPax ships are the biggest emitters. It is thus important to include these ship types in the ETS. The EU MRV covers voyages from ships which transport cargo or passenger for commercial purposes (EU 2015, Art.2.1 and 3(c)). The regulation thereby excludes ship types such as warships, fishing vessels, wooden ships. Generally, any EU policy should strive to include all ship types in accordance with the polluter-pays principle. For example, also fishing vessels contribute significantly to GHG emissions (4% according to IMO (2020a) - which is similar to RoPax ferries and cruise ships. However, for a start, the scope of ship types could be aligned with the EU MRV and the extension to other ship types could be considered in a review of the ETS and MRV. This paper focuses on an ETS for maritime shipping, but it should be mentioned that there are discussions at European level on measures for decarbonizing inland waterway transport as well (EC 2020b).

2.3 ETS type and cap

2.3.1 Closed, open or semi-open ETS scheme

A cap-and-trade system like the EU ETS can be designed in different ways. An ETS for the maritime sector can be set up as a closed, open or semi-open scheme. A closed system means that emission allowances can only be traded within the sector. An open system allows the buying and selling of emission allowances with other sectors, e.g. the stationary sector in the EU ETS. A semi-open system can allow for partial flow of emission allowances. This typically means that one sector can draw on emission allowances of another sector but not the other way around. Semi-open schemes, like open schemes, could still allow for impacts in one sector (e.g. a recession) to spill-over into another depending on the design. The overall volume of GHGs that can be emitted by power plants and energy-intensive industry sectors covered under the ETS is limited by a cap on the number of emission allowances in the market (EC 2021). ETS allowances (EUAs) are essentially rights to emit GHG emissions equivalent to the global warming potential of 1 tonne of CO_2 (tCO_2e) (EC 2015). Within the overall EU-wide cap, companies receive or buy emission allowances, which they can trade as needed. While the aviation sector is also covered under the ETS, its cap has been separately calculated (EC 2021). The cap for aviation is not a ‘hard cap’ that directly limits aviation’s emissions growth, though. The aviation sector functions under a so-called semi-open ETS scheme, under which airlines can fulfil their ETS obligations by surrendering specific EUAAs (EU Aviation Allowances, unavailable to other sectors) and/or EUAs.

Theoretically, the ETS could include all sectors, with a cap aligned with the EU’s 1.5°C compatible reduction target and then emissions reductions would occur where they are most cost effective. Under such an open scheme, the ETS would be extended to the maritime sector without creating a specific cap for the sector. However, emission reductions might then mainly take place in other sectors while shipping, with relatively high marginal abatement costs, might remain largely untouched. To prevent this from happening, a specific cap for the maritime sector under a closed or

semi-open ETS scheme could be envisaged. A closed maritime ETS would be an emission trading system without links to the rest of the EU ETS or external carbon markets. The only allowances authorized to be surrendered would be the new allowances created specifically for the maritime sector. Such a system would establish a 'hard cap' on maritime emissions as regulated entities would not be able to emit more than the amount of allowances available under the maritime scheme (T&E 2020a). Additionally, given the continued growth in maritime emissions, a closed ETS with a 1.5°C compatible cap would likely lead to a much higher price of allowances than those observed under the stationary ETS. IMO (2020a) estimated the abatement costs of the maritime sector at 400 US$/tonne of CO_2. The carbon price in a closed ETS would therefore tend towards this level. However, there is little certainty about abatement costs and future fuels, making useful carbon prices in maritime decarbonization hard to project. Furthermore, the fluctuation in demand in the maritime sector year-on-year would make a closed ETS inefficient and could result in a regular abundant oversupply or a severe scarcity of allowances. A semi-open maritime scheme would model the aviation ETS, allowing responsible entities to use EUAs as well.

An alternative way to ensure short-term action in the maritime sector would be to set up specific provisions for the maritime sector under an open ETS. For example, recycling ETS revenues back to the sector (section 2.6.3) could support the deployment of zero-emission ocean-going vessels.

2.3.2 Tightening the stringency of a maritime ETS

Since there would not be a specific cap for maritime emissions under an open ETS, nor a 'hard cap' under a semi-open ETS, the EU would need to improve the environmental ambition of the overall stationary ETS to further tighten the stringency of the maritime ETS. The EU could also consider a multiplier for shipping emissions in order to reflect the urgency and delay of mitigation activity in this sector. Such a multiplier would make the emission of each tonne of GHG more expensive than the general ETS price. For example, a multiplier of 2 would require regulated entities to purchase twice as many allowances in order to be able to emit GHG emissions equivalent to the global warming potential of one tonne of CO_2e (T&E 2020a).

Besides increasing the environmental ambition of the scheme, multipliers could also help to reduce the price gap between fossil marine fuels and sustainable alternatives like e-fuels and in addition raise higher revenues that can be used to subsidize the accelerated uptake of such fuels. However, even with a multiplier in place, the ETS alone will not be able to completely bridge the price gap between fossil and post-fossil marine fuels in the foreseeable future. Additional regulatory initiatives will also be necessary to set shipping on a course towards full decarbonization by 2050.

Alternatively, under a semi-open scheme, the stringency could be improved by limiting the quantity of allowances that can be used from the stationary sector (T&E 2020a). Without a limit on the quantity, responsible entities would be free to purchase as many emissions allowances from the stationary sector (EUAs) as they like. Hence, they could exceed the maritime cap under a semi-open scheme. The relative size of the maritime sector compared to the stationary market and the relatively low price elasticity of the seaborne transport demand (Coto-Millán et al. 2011) would mean that shipping would draw on the stationary ETS allowances in the foreseeable future. Under a semi-open set-up, this would create an effect similar to the one that has been observed in the aviation sector, in which approx. 50% of the surrendered allowances from aircraft operators come from the stationary ETS. Putting a limit on the quantity of allowances from the stationary sector that can be used by the maritime industry could be one way for introducing a hard cap on shipping emissions.

Another design feature which determines the stringency of the maritime cap is the Linear Reduction Factor (LRF). The LRF was introduced in phase 3 of the ETS (2013-2020) in the context of the overall 20% reduction target so that the total cap would decrease each year to 2020 and beyond, in order to reach a 21% reduction compared to the EU ETS emissions in 2005 by 2020. The cap was set to decrease each year by a linear factor of 1.74% compared to 2010. In phase 4 (2021-2030), the cap on emissions is subject to a higher annual linear reduction factor of 2.2%.

Another way to ensure lasting environmental ambition of the cap would be through voluntary cancellation of maritime and stationary allowances in the case of reduced maritime transport demand (T&E 2020a). Under Art. 12(4) of the ETS Directive, Member States have the right to voluntary cancel allowances in the event of a policy-driven coal phase-out. This could be expanded to the shipping sector.

2.3.3 The baseline year

Part of the industry argues for the use of 2008 as the baseline year, as this is the baseline year used by the IMO in its Initial GHG Strategy. However, there is no monitored and verified emissions data available for EU shipping prior to 2018. The EU could backcast shipping emissions from 2018 data. However, that data will involve some inaccuracies. If allowances are not allocated free of charge but rather auctioned (section 2.4), such inaccuracies should not be a major issue as the historic emissions are not needed for the auctioning. Nevertheless, another option would be to make use of the data gathered through the EU MRV Regulation (2015/757). Ships above 5 000 GT have been required to report their emissions under the EU MRV Regulation since 2018. Therefore, the EU has granular and verified data of EU shipping's emissions for 2018, 2019 and 2020. It would thus make the most sense to use 2018 (or an average of 2018, 2019 and 2020) as the baseline year for determining the cap.

2.3.4 Linking of regional ETS

When designing a regional ETS such as a potential maritime EU ETS, the future linking with other national or regional emissions trading schemes needs to be considered. The establishment of international emissions trading and/or carbon pricing could be realized through gradually linking national and regional approaches with the result that more and more emissions of the global fleet would be covered over time. In this way, the EU ETS can be an important part of developing a global network of carbon pricing schemes and increase the pressure on the global level to introduce appropriate carbon pricing policies for shipping.

Concerning ETSs specifically, the linking of the EU ETS with other ETS could improve the functioning of the systems by means of, for example, increased liquidity and reduced carbon leakage risk. Article 25.1a of the EU ETS Directive (2003/87/EC) allows for the linking of the EU ETS with "*compatible mandatory greenhouse gas emissions trading systems with absolute emissions caps established in any other country or in sub-federal or regional entities*". If the environmental integrity of the EU ETS is not undermined, allowances of another ETS and the EU ETS would be mutually recognized. A maritime EU ETS could be linked with other regional ETS in the future through a legislative design that allows corresponding adjustments during reviews to align different systems. Important design features which need to be aligned for linking are the stringency of the cap, mandatory participation, cap type (absolute or intensity-based), timeframes, robustness of MRV systems, stringency of enforcement, compatible registry systems and stability mechanisms like price floors.

While the EU is discussing a proposal for a maritime EU ETS based on the EU MRV, other regions are also taking steps towards introducing carbon pricing in the shipping sector:

- **USA**: The House Natural Resources Committee, a Congressional committee of the United States House of Representatives, has started a process on copying the EU's MRV legislation and thereby laying the foundation for carbon pricing in shipping. The Ocean Climate Based Solution Act (OCBSA)[6] foresees a monitoring, reporting and verification system for ships of 5 000 GT or larger, as in the EU MRV Regulation. It will apply to all ships arriving, leaving, transitioning between or when at berth in ports of the United States, regardless of their flag. Total CO_2 emissions released in the EEZ of the USA and CO_2 emissions per transport work should be reported.
- **UK**: In its Clean Maritime Plan, the UK also announced that it would increase data transparency on maritime emissions in the face of the increased reporting through the IMO DCS and EU MRV (UK Department for Transport 2019). Following the EU's plans, the UK is now also considering including shipping in its new carbon market.[7]
- **China**: China has started a national ETS with the potential to be the largest ETS so far. In one of its sub-national pilot ETS maritime transport is already covered.[8] Concerning its nation-wide scheme, China is expected to wait for the outcome of the EU's discussions on the inclusion of shipping in the EU ETS before making further decisions.[9]

There is an increasing number of regional initiatives[10] which could be potential partners in creating a network of maritime ETS or carbon pricing schemes in future.

2.4 Allocation

The existing EU ETS adopted a hybrid approach to allocation of emissions allowances. Allowances are typically allocated via auctioning, especially in the power sector.[11] In other sectors, the allocation of allowances is gradually transitioning from free allocation to auctioning. In the period from 2013 to 2020, the amount of free emission allowances decreased to 30% in 2020 in the manufacturing industry whereas the aviation sector received the majority of their base period emissions as allowances free of charge during this period. Sector-specific benchmarking is used to allocate those free allowances (PMR; ICAP 2016). However, in practice, airlines needed to purchase half of their allowances to cover all their emissions due to significant growth during that period. The strengthening of the ETS for aviation is being discussed in the context of the current review of the aviation ETS, e.g. by reducing the amount of free allocation (Oeko-Institut 2020). The experience from other sectors and the ongoing discussion about a maritime ETS based on auctioning (EP 2020) should be

6 OCBSA: https://www.govtrack.us/congress/bills/116/hr8632/text.

7 Splash247.com, 23/03/2021, UK mulls adding shipping to its emissions trading system, https://splash247.com/uk-mulls-adding-shipping-to-its-emissions-trading-system/

8 International Carbon Action Partnership (ICAP): https://icapcarbonaction.com/en/ets-map?etsid=73.

9 China's ETS: https://splash247.com/china-looks-at-adding-shipping-to-the-worlds-largest-emissions-trading-scheme/.

10 ICAP provides a global overview of ETS and carbon pricing initiatives, https://icapcarbonaction.com/en/ets-map.

11 EU ETS: https://ec.europa.eu/clima/policies/ets_en.

kept in mind when the different allocation methods and a price stabilization mechanism are presented in the following.

2.4.1 Auctioning

The auctioning of allowances has several economic advantages and is seen as the easiest and fairest way to issue allowances (CE Delft 2009). Auctioning can create substantial revenues and the risk of windfall profits is reduced compared to free allocation if no market consultation are possible between big emitters in the market (CE Delft 2009; PMR; ICAP 2016). The likelihood of windfall profits in shipping depends though on the extent to which marginal costs could be passed on from the regulated entity to the 'consumer' (freight owners or passengers). As carbon pricing would insignificantly increase prices for shipped goods revision (T&E 2020b), auctioning is preferable compared to free allocation. Furthermore, auctioning ensures market liquidity and rewards early action (PMR; ICAP 2016). Rewarding early movers (and not disincentivizing them through free allocation like grandfathering) is important in shipping as time is running out, given the long lifetime of vessels and long lead times for investment decisions. Additionally, early movers still currently have advantages in the sector because the uptake of measures to reduce emissions is generally still low. This allocation method could also be implemented quickly as EU MS already have experience in this area and it does not require any monitoring or reporting of emissions at entity level before the allocation. Auctioning is a more transparent method than free allocation and reflects the polluter-pays principle.

While auctioning allowances might generally be the simplest way, there are challenges to this at the beginning of a maritime EU ETS. A gradual introduction to auctioning might mitigate the volatility of carbon prices and economic impacts at the beginning (Oeko-Institut 2019; PMR; ICAP 2016). A temporarily or partially free allocation of allowances could ease the way for shipping into an emission trading system (UBA 2010). Alternatively, a phase-in could be implemented by continuously increasing the share of emissions for which allowances have to be surrendered (e.g., 10%, 20% … to 100%). Compared to a temporarily free allocation, no extra data is needed; it would also provide a predictable and increasing incentive to reduce emissions. In any case, a timeline needs to be set for the phase-in period. However, any phase-in period will delay the desired emission reductions in the sector. Another (or additional) way to reduce the burden on the shipping sector could be the recycling of some of the revenues back into the sector (e.g. Ocean Fund).

The existing EU ETS involves many small emitters. However, empirical data shows that despite the considerable trading volumes observed on exchanges, the number of companies that are actually active in exchange-based trading of emission allowances is comparatively small. Most market participants with a compliance obligation use an intermediary to acquire allowances. In particular, small- and medium-sized companies tend to participate in trading via intermediaries. Hence, a small number of market players trade most of the volume on exchanges (FutureCamp 2014, p. 10). The intermediaries are already in operation (Wang et al. 2020) and could be happy to serve shipping companies as well. This could reduce the administrative burden on the small shipping emitters, who might not have enough resources to engage in the exchange-based trading of emission allowances. They could theoretically provide the hedging of CO_2 prices required (as for fuel prices) to include the cost of allowances/CO_2 in current priced calculations (Schopp und Neuhoff 2013).

2.4.2 Grandfathering

In general, free allocation of emission allowances is used to protect companies in international competition from carbon leakage and should be used in sectors which are least able to pass on carbon costs to consumers (European Court of Auditors 2020). The risk for carbon leakage in shipping is relatively low compared to other sectors (T&E 2020c). Grandfathering is the free allocation of allowances based on historic emissions during a reference period. It rewards companies with historically high emissions and would disincentivize companies that recently took action on reducing GHG emissions (Wan et al. 2018). Historic emissions would have to be estimated during a specific reference period. The challenge in shipping is that ships are very mobile and can easily change their flag, trades or schedules. Some ships are active in one part of the world during a certain period but are active in another part of the world in the next period. Estimating the historic emissions during a specific reference period for grandfathering might therefore lead to unequal treatment among different ship types and routes and might not properly reflect reality (CE Delft 2009). This can lead to distortions of competition and discredit the scheme (UBA 2010). Grandfathering is not in line with the polluter-pays principle and is not regarded as an appropriate allocation method for a maritime EU ETS.

2.4.3 Benchmarking

Benchmarking describes the free allocation of emissions based on a benchmark defined by the average CO_2 intensity of an activity or sector. In contrast to grandfathering, the reference is the historic output level rather than just historic emissions. This approach was used in phase 3 of the EU ETS for the manufacturing industry where a series of benchmarks was created for different products under the cap (PMR; ICAP 2016). Like the auctioning of allowances, benchmarking rewards early action, for example energy efficiency improvements prior to implementation of the scheme. Compared to grandfathering, benchmarking better reflects the polluter-pays principle and sets more incentives to reduce emissions (UBA 2010). Calculation of sector benchmarks can be data-intensive (PMR; ICAP 2016; CE Delft 2009).

In phase 3 of the EU ETS, the aviation sector received free allowances based on a benchmark that represents average airline efficiency in transporting passengers and cargo. The total annual number of free allowances was divided by the sum of previously submitted airline tonne-kilometre data. A similar approach could be applied with regard to the shipping sector. However, defining an output metric that fits all ships is problematic, e.g. bulk carriers use tonne-miles whereas container ships normally use TEU miles (CE Delft 2009). Since tonne-mile would be available for container ships as well, the tonne-mile could be used as an allocation metric across the entire sector. UBA (2010) suggest not differentiating between vessel sizes because the service of transporting a unit of cargo does not depend on the ship size; it acknowledges that this might promote larger vessels since they usually have lower emissions per unit of cargo. The benchmarks would be retrieved by dividing the allowance quantities available by the sum of respective serviced tonne-miles. Alternatively, a benchmark could be based on, for example, the 30% most efficient vessels covered by the system. The share of allowances available for free allocation would be distributed across the different benchmarks based on historic activity data of each group during a certain period. Free allocation like benchmarking could create additional administrative burden, especially for smaller companies.

2.4.4 Consistency with other sectors

The auctioning of allowances provides a fast and advantageous way into a maritime ETS. Current discussions also suggest auctioning as the preferred allocation method. Considering this and drawing on the experiences gathered in sectors in the existing EU ETS, for which free allocation was used to avoid relocation of production outside of EU borders but will likely be replaced by a Carbon Border Adjustment Mechanism (CBAM) (EP 2021), auctioning seems to be preferable for the maritime ETS. The establishment of a CBAM is a complex and politically sensitive topic currently discussed at EU level. It is typically applied to goods like steel. As a maritime EU ETS will likely be based on emissions from voyages in/out of the EU, the current debate around a CBAM is not an issue for shipping. A phase-in with gradual increase of the share of monitored emissions subject to a surrender obligation covered by the system could be an option for a limited period. To not further delay mitigation action in the sector, auctioning of all allowance would be preferable.

2.5 Review clauses

The systematic review of legislation plays an increasingly important role in the context of the EU Better Regulation agenda (EPRS 2018). For example, of 225 legislative acts adopted through the ordinary legislative procedure during the eighth parliamentary term (2014-2019), 147 contained provisions for reviews, evaluations or implementation reports. However, there is no 'typical' review clause in EU legislative acts and programs. They vary in terms of their requirements, formulation, level of complexity, detail and time period in between two reviews.

2.5.1 Review clause under the existing ETS

Article 30 of the ETS Directive determines its review requirements (EU 2018). Since the last changes to the Directive in 2018, the Directive is set to be reviewed *"in the light of the implementation of the Paris Agreement and the development of carbon markets in other major economies"*. The Commission is also *"to report to the European Parliament and to the Council in the context of each global stocktake agreed under the Paris Agreement, in particular with regard to the need for additional Union policies and measures (...). The Commission may make proposals to (...) amend this Directive where appropriate".*

Article 30 further contains specific requirements for the aviation sector. It requires the Commission to *"present an updated analysis of the non-CO_2 effects of aviation, accompanied, where appropriate, by a proposal on how best to address those effects"* before 1 January 2020. As such, when the ETS is extended to the maritime sector, Article 30 can also contain specific review clauses for the maritime sector. During its revision of the shipping MRV Regulation (which included a proposal for a maritime ETS), the European Parliament proposed to review the maritime ETS in the event of adoption of a global market-based policy, with the aim to ensure *"consistency between Union and global measures in a manner that preserves the environmental integrity and effectiveness of Union climate action*" (EP 2020, p. 17).

2.5.2 Aligning the ETS with IMO GHG reduction policies

The potential inclusion of maritime transport in the ETS will be part of the Commission's overall revision of the ETS Directive to bring it in line with the revised EU emission reduction target for 2030, while the review of the aviation ETS is addressed via a separate proposal (EC 2019). Given the lack of experience gained with maritime ETS to date, the review periods should not be too long so that

upcoming issues can be addressed quickly. The review should take into account progress made on market-based policies at the IMO and enable alignment between EU and IMO policies if deemed appropriate for the EU's climate ambition. It seems therefore adequate to delink the review of the shipping ETS from the general ETS review schedule, at least in the initial phase.

2.5.3 Aligning the ETS with global GHG mitigation efforts

The ETS Directive foresees reviews *"in the light of international developments and efforts undertaken to achieve the long-term objectives of the Paris Agreement"* (EU 2018, Art.30). Therefore, the ambition level of the EU ETS can be reviewed in the light of progress made in other countries and regions. The Paris Agreement includes a so-called 'ratchet mechanism' that serves to increase the ambition of the scheme over time (UNFCCC 2015). Based on the current Nationally Determined Contributions (NDCs), the world is not on track to keep global temperature rise 'well below' 2°C, let alone below 1.5°C. The ratchet mechanism however requires countries to submit new NDCs every five years, each of which must be progressively more ambitious than the last. Every third year of the NDC cycle, a so-called 'global stocktake' assesses collective progress towards the goals of the Paris Agreement and identifies the 'ambition gap'. The first of these stocktakes will take place in 2023. As with the facilitative dialogue in 2018, countries must use the outcomes of the stocktake to inform their next NDCs.

While the EU works with ten-year targets, it is required to communicate or update its target every five years. In updating the target, the EU should review, and propose to revise where necessary, all relevant climate-related policy instruments. This review process should aim to raise global ambition in the lead-up to the 'global stocktake' and reflect Europe's historic responsibilities. Assuming that the legislative process around the current review of the overall ETS will run until the end of 2022, it might make more sense to organize the first review of the renewed ETS architecture after the global stocktake. From the second 'global stocktake' in 2028, the ETS review should always come ahead of the stocktaking in order to take full advantage of the EU's climate leadership.

2.5.4 Strengthening the environmental ambition of the maritime ETS

As the maritime ETS will be a new addition to the overall EU ETS, there needs to be a specific assessment of its architecture after two years of implementation. This is in line with review clauses in other EU legislative acts. Looking again at the previous parliamentary term, about 40% of all acts containing a review clause have a 'short' time period of one to two years from their application (or transposition deadline) to their first review (EPRS 2018). Assuming that the maritime ETS can start on 1 January 2023, it means a first review should be scheduled for 2025. The aim of the review should be to analyze its effectiveness and, whenever appropriate, increase the environmental ambition and stringency of the scheme. Depending on the current design, potential areas for improvement could be the geographical and emissions scope of the scheme (sections 2.2.1 and 2.2.2), the cap (section 2.3), the allocation of allowances (section 2.4) and the use of revenues (section 2.6.3).

2.6 Administrative issues

An analysis of Client Earth (2011) concluded that an EU policy with an extraterritorial effect is generally unlikely to be legally challenged if it is enacted in accordance with:

- the principles of non-discrimination, good faith and non-abuse of right;
- minimizing the impact on the right of innocent passage and freedom of high seas;
- respecting the sovereignty of other countries.

In general, states have the right to make the access to port conditional on unilaterally enforced standards, like the sulphur content in fuels (Kågeson 2007). If vessels enter ports voluntarily, they thereby consent to the conditions of entry to that port which could be conditions like surrendering emission allowances (ECSA; ICS 2020; Dominioni et al. 2018).

2.6.1 Compliance and penalties

An ETS covering emissions outside the EEA (see options in section 2.2.1) would be based on the same legal port state control jurisdiction as the current EU MRV.[12] Under Article 211(3),[13] the United Nations Convention on the Law of the Sea (UNCLOS) explicitly allows countries to implement national/regional schemes on national and foreign vessels through port state control. This facilitates enforcement of an ETS in ports; liability under the scheme arises as a condition of entry into port irrespective of the flag (flag-neutral). Port state control (for foreign ships) or the flag state authority (for vessels under national jurisdiction) would enforce compliance as is common for other port state control requirements, e.g. controlling sulphur limit compliance. In the existing EU ETS, MS are responsible for ensuring compliance and deciding on the penalties. These would have to be expanded accordingly for non-compliance with the maritime ETS. As a port state, enforcement can generally include amongst others the inspection of a vessel, withdrawing future access to the port, refusing to land or process cargo, fines and penalties or the detention of a vessel (Client Earth 2011). While the latter is currently confined to cases in which there is a threat to the safety of the ship or the environment. For a maritime ETS, the appropriate sanctioning mechanism should be derived from established practices in the maritime sector.

2.6.2 Monitoring and accounting

The administrative burden of a maritime EU ETS is expected to be reduced by building on the EU MRV Regulation and because enforcement is already carried out by Port and Flag state control in other matters.

As provided in the shipping MRV Regulation, the ship company submits the (annual) verified emission report to the EC and flag states via the EMSA data base. Verification of the report content is carried out by an accredited third party such as verifiers or classification societies.

In the existing ETS, all fixed installations and airlines are registered in the Union registry.[14] It includes the account of MS and all entities holding allowances, all the verified emissions, transactions concerning allowances and the annual balance of surrendered allowances and verified emissions as well as the compliance status. Data on verified emissions is currently available via the EMSA data base. The verification of emissions reported by ship owners is conducted by external verifiers, e.g. classification societies. The current documentation of the verification (process, methods, potentials

[12] https://www.euractiv.com/section/shipping/opinion/lets-end-the-debate-putting-international-shipping-into-the-ets-is-clearly-legal.

[13] UNCLOS Art.211(3): https://www.un.org/depts/los/convention_agreements/texts/unclos/part12.htm.

[14] EU ETS Union registry: https://ec.europa.eu/clima/policies/ets/registry_en.

errors) is not sufficiently transparently communicated to EMSA or other (port) authorities. If the accounting of allowances were to be set up in or linked to the EMSA data base, data integrity and documentation of the verification process for the respective authorities would need to be improved. The current EU MRV compliance cycle might not be sufficient for a more complex compliance and administration structure in an ETS. However, the EP has proposed strengthening EMSA competencies in the context of the EU MRV revision (EP 2020). A dedicated legal and administrative analysis might be required to determine the most appropriate structure for monitoring and accounting in a maritime EU ETS, and the role that EMSA and its data base might play. Alternatively, regulated entities would need to register at the Union registry for accounting of the allowances and the scope of the EMSA data base would remain confined to emission data.

2.6.3 Price stabilization mechanism (PSM)

Theoretically, the current ETS could also provide certainty to emitters since the emission is linked to the use of fuel. Most covered entities link the purchase of allowances to fuel purchase which results in a mark-up of the (volatile) fuel price. Given that charterers are responsible for the fuel bill, these ETS costs could similarly be passed through to the charterers.

However, shipping companies, especially those engaged in the time charter market, have consistently pointed out the asymmetric bargaining power between the shipowners and charterers, which could reduce their ability to pass on the ETS costs. This could notably happen when charter-party contracts last only for a few months or weeks, and ship owners might not be able to retroactively bill the charterers at the end of the compliance period. Even though adding a mark-up to the fuel bill under the charter contracts could help alleviate this problem, the issue of choosing the CO_2 price rate will remain. However, the most suitable assignment of responsibilities among stakeholders in a maritime ETS is subject to a more detailed legal assessment as noted in section 2.1.

One way to address the potential problem would be to create a CO_2 price stabilization mechanism (PSM) under the maritime ETS. The PSM is addressed here because the European Parliament and industry associations have suggested similar forms of such a mechanism (EP 2020; ECSA 2021; SEA Europe 2021). The price would be equivalent to, for example, the average or highest allowance price from every preceding compliance year. Regulated entities could opt to pay the fixed CO_2 prices into a fund instead of surrendering allowances. The fund would purchase and surrender allowances on behalf of the regulated entities.

However, a fixed CO_2 price (or mark-up) poses the risk that there is a deficit or a surplus in the fund at the end of the compliance period as ETS prices tend to fluctuate throughout the year. To account for this, a buffer could be incorporated in the CO_2 price in the PSM as a surcharge based on the average annual fluctuations of the previous years. Additionally, emissions from shipping are not verified until April of the following year under the EU MRV.

The PSM could be optional in a flexible system in which regulated entities in a maritime ETS could choose at the beginning of a compliance year if they would like to comply via the PSM or by buying and surrendering allowances directly. Large commercial operators might prefer, for example, to engage in emission trading than to pay a fixed amount into a PSM.

This would also allow the regulated entities to pay for their dues either at the end of the charter contract or at the end of an ETS compliance year (in case the charter contract exceeds the ETS compliance cycle). The PSM might lower the administrative burden, especially for smaller regulated entities, because they would simply pay for the respective amount of emissions according to their

fuel bills during the contract period instead of engaging in emission trading. The proposal of the European Parliament suggests a time period of 2022 to 2030 for their Ocean Fund (EP 2020). The fixed price would allow regulated entities to estimate their costs before they start emitting and to account for these costs internally for the upcoming year. Most importantly, it would empower their bargaining power vis-à-vis the charterers as the corresponding costs could be directly reflected in the charter-party contracts as a function of the fixed CO_2 rate and expected fuel consumption during the charter period. The PSM would be administered by a new or an already existing EU authority. Such a mechanism would ensure that shipping companies have price certainty on carbon pricing, while also making the system compatible with the overall ETS directive. However, from a market perspective, it can be questioned whether such a PSM needs to be established by the regulator or whether market actors such as intermediaries would mitigate the price uncertainties anyhow. On the one hand, the establishment of such a PSM might reduce the opposition from some stakeholders and thus facilitate the start of a maritime ETS. On the other hand, the usefulness of a PSM is also subject to the detailed legal assessment of regulated entity options mentioned in section 2.1.

2.7 Use of revenues

Currently, revenues from the auctioning of allowances under the EU ETS are collected by the MS which declare to use at least 50% of these for climate- and energy-related purposes. MS report annually on the amount and use of these revenues. In phase 4 of the EU ETS (2021-2030), two funds are set up to facilitate the transition of the energy-intensive and power sector.[15] The Innovation Fund will receive funding equivalent to the market value of 450 million allowances. The Modernisation Fund will also be financed by the auctioning of allowances and support modernizing the power and energy system in the lower-income MS. Already in the existing ETS, only a part of the auction revenues is directly used for accelerating and facilitating decarbonization.

The decarbonization of the shipping sector requires investments in new ships and/or retrofitting new fuel systems onboard of existing ships but mainly support for the accelerated uptake of e-fuels. UMAS (2020) calculated that to achieve the IMO goal of at least 50% reduction in GHG emissions by 2050 would require 1-1.4 trillion US$ in investments. A higher number (1.4-1.9 trillion US$) would be necessary to decarbonize shipping by 2050 (in line with the EU's climate neutrality goal of 2050) – with the majority needed for land-based infrastructure and the production of non-fossil fuels. Additionally, the price for e-fuels will be higher than the expected CO_2 price in the short term, inducing improvements in energy efficiency rather than a fuel switch in the maritime sector. Hence, the revenues from the ETS in addition to other policies (section 1 and 3) are needed to drive the necessary transformation of the sector.

Looking at potential scopes for a maritime ETS (section 2.2.1), full auctioning of allowances would generate 2 970 million € for a semi-full scope and 4 320 million € for a full scope (given a CO_2 price of 30 €/tCO_2). If all these auctioning revenues directly went into the MS' budgets, the maritime ETS will not significantly help decarbonization of the sector and will likely receive lots of opposition from the maritime industry. The Innovation Fund is primarily designed to support the power and energy-intensive industry. A dedicated fund for the maritime sector might address this issue. The revenues of a maritime ETS could be used for different purposes. Part of the revenues could be used for national or EU climate change mitigation as under the existing ETS, another part might support the decarbonization of the maritime transport. The EP (2020) suggested establishing an

[15] EC – Revision of phase 4: https://ec.europa.eu/clima/policies/ets/revision_en.

Ocean Fund (OF). This fund could enable the flow of revenues back into the sector with a view to helping finance the investment needs described above. All ships calling at EU ports could, for example, benefit from financing of e-fuel or onshore power supply infrastructure from these revenues.

The budget of the OF could be used to finance investments for improving ship efficiency or additional costs for making ships and bunkering infrastructure ready for using e-fuels or other energy sources like wind or batteries. However, since the cost differential between fossil and e-fuels is the largest barrier for the uptake of these fuels (Korberg et al. 2021; LR; UMAS 2020), the major share of the OF's budget should be used to incentivize the accelerated uptake of e-fuels.

To ensure that the budget used for this purpose is spent both effectively and in a non-discriminatory manner, a system of contracts for difference (CfDs) could be set up (DECC 2011, pp. 37-48). CfDs are long-term contracts (usually 10 to 15 years) which allow investors in e-fuel production technology (renewable electricity, electrolyzers, direct air capture, etc.) to recover their investment since they always receive the so-called strike price on delivery of their output. Part of the revenue would be raised from selling the e-fuel at current market prices of fossil fuels while the remaining gap will be paid by the fund. If the market price exceeds the strike price, e-fuel providers have to refund the excess revenues. If such contracts are issued in a revers auction, it is also ensured that the OF's budget is used both effectively and non-discriminatory.

3 Compatibility with envisaged IMO policies

The alignment of regional with global policies is important for an international sector like shipping. With the revision of the EU MRV the alignment with the IMO DCS is already under way. We assess below which of the IMO policies to reduce GHG emissions of maritime transport might overlap with the inclusion of maritime transport in the EU ETS (section 3.1) and discuss the political challenges to adopting market-based policies for GHG reduction at IMO (section 3.2).

3.1 Overlap with IMO candidate measures

The Initial IMO GHG Strategy includes short-, mid- and long-term candidate measures (IMO 2018). The strategy foresees that short-term measures are agreed before 2023, mid-term measures between 2023 and 2030 and long-term measures by or beyond 2030. It lists 13 short-term, 5 mid-term and two long-term candidate measures. Table 1 provides an overview of the candidate measures and an assessment of their potential interaction with the inclusion of maritime transport in the EU ETS.

Table 1: IMO candidate measures

No	Description	Type of measure	Type of policy	Interaction with EU ETS
Candidate short-term measures				
1.	Improve EEDI and SEEMP	Ship design	Standard	Complementary
2.	Technical and operational energy efficiency for new and existing ships	Ship design and operation	Standard	Complementary
3.	Existing Fleet Improvement Programme	Ship design	Standard	Complementary
4.	Speed optimization and speed reduction	Ship operation	Standard	Complementary
5.	Address methane and VOC emissions	Ship design	Standard	Complementary
6.	Encourage national action plans	Monitoring	Voluntary effort by countries	None
7.	Enhance ITCP	Capacity building	Voluntary effort by countries	None
8.	Port infrastructure and renewable on-shore power supply	Infrastructure	Standard	Complementary
9.	IMRB Fund	Research and development	Market-based	Overlapping
10.	Incentives for first movers	Deployment	Subsidy	Complementary
11.	Develop guidelines for lifecycle GHG intensity of fuels	Monitoring	Standard	Supportive
12.	Promotion of IMO's work on GHG reduction	Outreach	Joint IMO effort	None
13.	Undertake GHG emission studies	Monitoring	Joint IMO effort	None
Candidate mid-term measures				
1.	Implementation programme for uptake of zero-carbon fuels	Fuels	Standard	Complementary
2.	Technical and operational energy efficiency for new and existing ships	Ship design and operation	Standard	Complementary
3.	Market-based Measures (MBM)	Ship design and operation	Market-based	Overlapping
4.	Enhance ITCP	Capacity building	Voluntary effort by countries	None
5.	Feedback mechanism on lessons learned	Monitoring	Joint IMO effort	None
Candidate long-term measures				
1.	Development and provision of zero-carbon fuels	Fuels	Standard	Complementary
2.	Innovative emission reduction mechanism	Research, Development and Deployment	Subsidy	Complementary

Source: IMO (2018), author's compilation and assessment.

The strategies for reducing GHG emissions from international shipping cover a broad range of activities, some of which focus more on technological measures (EEDI/EEXI, port infrastructure, fuels, etc.) while others are essentially rather political instruments, which would provide the incentives to implement several technological measures (IMRB Fund, market-based measure (MBM)[16]). Since technological measures and political instruments involve different aspects of the same reduction activity, we identified the most likely representation of each activity measure and policy based on the more detailed description of the mitigation activity in the Initial IMO Strategy.

Table 1 illustrates that the assessment is not always clear-cut because some of the reduction activities could involve different technical measures or be incentivized by different policies. Methane

[16] Even though a MBM is essentially a policy rather than a measure, which makes the term 'market-based instrument' (MBI) more appropriate, we use the terminology of the Initial IMO Strategy.

and VOC emissions, for example, can be addressed by investing in improved engines and/or catalysts (ship design) but changes in the operation of ships may also contribute to reducing these emissions. The incentives to invest in catalysts would most likely be induced by a standard but could also be provided by a market-based approach.

The assessment in Table 1 reveals that four activities involve emission monitoring, three involve ship design and operation while another three focus on ship design only. Two of the potential activities address the transition to e-fuels and another two focus on capacity building. In terms of policy type 10 of the activities are likely to be implemented through technical standards and regulations. Three of the activities are likely to be implemented individually by IMO Member States while another three would be implemented jointly under the IMO. Two of the considered activities most likely involve subsidies while the remaining two activities are essentially market-based approaches which provide incentives for mitigation activities in international maritime transport.

While some of the activities will likely have no concrete interaction with the inclusion of maritime transport in the EU ETS such as national action plans, many short-term measures will be complementary to the maritime EU ETS. This is the case, for example, for measures on technical and operational efficiency, as currently underway (section 3.1.1), or activities promoting port infrastructure. However, some overlap with a unilateral EU policy could arise with the proposed IMRB Fund (section 3.1.2) and any hitherto undefined MBM (section 3.1.3).

3.1.1 Standards for energy efficiency

Submissions to the MEPC have focused on short-term measures to date; first amendments to MARPOL Annex VI were adopted at MEPC 76 in this regard.[17] Discussions on mid- and long-term measures have barely started and lack the necessary urgency and progress in spite of long lead times for introducing e-fuels in the sector. A work plan for mid-term measures was developed at MEPC 76:

- Spring 2021 to spring 2022: collation and initial consideration of proposals for measures,
- Spring 2022 to spring 2023: assessment and selection of measures(s) to further develop,
- Spring 2023: development of(a) measure(s) to be finalized within (an) agreed target date(s).

MEPC 76 adopted two goal-based measures to improve the energy efficiency of ships and to achieve the IMO goal to reduce CO_2 emissions per transport work by at least 40% in 2030 relative to 2008 (IMO 2018):

- **Energy Efficiency Index for Existing Ships (EEXI)**: It will require every operator to improve the technical energy efficiency of existing ships in order to catch up with a new ship of the same type and deadweight in correspondence with the applicable Energy Efficiency Design Index (EEDI). The attained EEXI of a ship, its energy efficiency compared to a baseline, will be calculated and evaluated compared to a required EEXI based on a required reduction factor, which is a percentage relative to the EEDI baseline (LR 2020).

[17] IMO (2021): Further shipping GHG emission reduction measures adopted: https://www.imo.org/en/MediaCentre/PressBriefings/pages/MEPC76.aspx.

- **Carbon Intensity Indicator (CII)**: The regulation on operational carbon intensity management which will require a linear reduction of in-service carbon intensity of a ship (of 5 000 GT or larger) between 2023 and 2030 (LR 2020). Ships will be rated according to their attained annual carbon intensity reduction measures by the CII, with a scale from A to E, compared to a required annual operational CII. The rating will be documented in the Ships Energy Efficiency Management Plan (SEEMP). Underperforming ships (meaning a rate of D for three consecutive years or E) will have to submit a plan for how they want to improve their performance to a rating of C or above. Except for the corrective action plan, no penalties are foreseen in the regulation. This can lead to a situation in which a ship can underperform continuously by ensuring one compliant year every three years. Port authorities and other stakeholders are simply 'encouraged' (IMO 2020b, Annex 5 p.10) to provide incentives to ships with a good rating. MEPC 76 agreed on annual reduction factors for the CII for a C-rating relative to a 2019 baseline. CII reduction rates should increase by 1 % per year for 2020–2022, by 2% per year for 2023–2026, resulting in a reduction factor of -11% in 2026 (DNV GL 2021). The reduction factors for 2027-2030 have not yet been decided.

The amendments will enter into force 16 months later, i.e. in 2023. The two regulations will be reviewed by January 2026 at the latest. Hence, they will not contribute to any additional emission reductions before 2023.[18] According to ICCT (2020), the EEXI is not very effective and not sufficient for achieving the IMO 2030 target of a reduction in carbon intensity of at least 40%. The EEXI and CII should be strengthened so that EEXI targets are in line with future EEDI phases. An annual reduction in carbon intensity of 7% up to 2030 would be necessary to align with a Paris Agreement temperature goal of 1.5°C.[19] Between 2008 and 2018, energy efficiency improved by 21% or 29% in the voyage-based allocation (depending on the methodology) (IMO 2020a).

These analyses illustrate that the regulations aiming at improving energy efficiency in maritime transport would hardly interact with an EU shipping ETS. However, if allowances were allocated free of charge, for example based on the benchmarking approach (section 2.4.3), the IMO or more stringent EU standards should be considered on average in the baseline for determining the volume of allowances.

From the perspective of a regulated entity, these two IMO regulations most likely provide synergies with requirements of a shipping EU ETS. However, they may overlap with any forthcoming efficiency policies at EU level. The EU has not yet adopted an energy efficiency target for the EU maritime sector. The EP (2020) proposes reducing annual CO_2 emissions per transport work by at least 40% by 2030 as an average across all ships of a shipping company "*compared to the average performance per category of ships of the same size and type as reported under the MRV regulation*". The proposal does not specify what the exact baseline will be. An energy efficiency certificate with a rating scale for comparison of ships is also mentioned in the document. Any further work on efficiency policies at EU level should consider compatibility of key features with the regulations already adopted at IMO, e.g. reporting, definition of the target (fuel/carbon intensity, baseline) without compromising efficacy and efficiency of the EU's ambition.

[18] https://www.forbes.com/sites/nishandegnarain/2020/10/24/global-shippings-un-climate-talks-fail-amid-threats-of-a-walkout/?sh=13a6a09a3897.

[19] ICCT (2021) - Choose wisely: IMO's carbon intensity target could be the difference between rising or falling shipping emissions this decade: https://theicct.org/blog/staff/imo-carbon-intensity-target-may2021.

3.1.2 IMRB Fund

ICS et al. (2019) suggested establishing a non-governmental international maritime research board (IMRB), which would be responsible for managing the international maritime research fund (IMRF) and coordinating R&D projects. The main purpose of the fund is to accelerate the introduction of low- and zero-carbon technologies and fuels (LR 2020). The fund is financed by a mandatory levy of 2 US$/t of fuel purchased. It is expected to raise about 5 billion US$ over the next 10 to 15 years. Additionally, an IMO supervisory body will report to the committee and approve the IMRB budget (IMO 2020b).

The IMRB proposal would establish a carbon price of 2 US$/t of marine fuel, equivalent to less than 0.60 €/tCO_2 in 2019.[20] Compared to the average EU ETS allowances price of 25 €/t in 2019 (EEA 2020), the price level is very low (< 2.5%) – and even lower compared to allowances prices of around 50 €/tCO_2 in summer 2021. However, the two policies differ in purpose: the 2 US$/t fuel is a dedicated contribution for funding R&D while the ETS is primarily a system to price CO_2 emissions (with varying uses of the revenues). Revenues from auctioning of allowances could, among other things, be used to finance R&D or investments in the shipping sector including the deployment of zero emission fuels and vessels (section 2.6.3). In this regard, the two policies are to some extent overlapping but could potentially be aligned (as is the case with the EU MRV).

For both policies, it would need to be ensured that the definitions of the regulated entity are compatible. The monitoring could be based on existing emission monitoring systems. The necessary alignment of the EU MRV and IMO DCS is ongoing. However, the significant difference in carbon price levels remains. The CPLC (2017) concludes that price levels of at least 40 to 80 US$/t$CO_2$ in 2020 and 50 to 100 US$/t$CO_2$ in 2030 are required globally to stay on a Paris compatible pathway. More recent projections which aim to meet Germany's GHG reduction targets in 2030 assume price levels of 93 to 140 €/tCO_2 in 2030 and 130 to 220 €/tCO_2 in 2037 (Prognos et al. 2020), while the marginal abatement cost curves for 2050 in the IMO's Fourth GHG study put the necessary price levels as above 400 €/tCO_2 (IMO 2020a).

Since 2019, the EU allowance price has risen continuously; in 2021 it frequently exceeded the threshold of 50 €/tCO_2. Since even this price level is not stringent enough to provide incentives for the reductions required to stay on a pathway compatible with the Paris Agreement, the EU should pursue its regional approach to incentivize efforts towards decarbonization until there is a sufficient carbon price signal for the sector at the global level. Whether this price signal will be delivered by an emission trading scheme or a fixed carbon price through some form of levy depends on future negotiations of IMO Member States.

Moreover, the EU ETS could be linked and harmonized with the IMRB. Potential options include that contributions made to the IMRB fund would be discounted under the EU system. This could also ultimately result in virtually 'cancelling-out' the EU ETS if the IMRB contribution matched the average EU ETS price level. Given that even the EU ETS price might not be sufficiently high, a parallel application of IMRB and ETS could still be preferable. However, these considerations illustrate that, despite some overlap, the IMRB and the EU ETS could be aligned in such a way which would enable co-existence of both policies. The recent MEPC 76 did not make a decision on the IMRB proposal; further submissions are expected of the next session (DNV GL 2021).

[20] Based on 3.12 t CO_2e/t fuel as the average emission factor in 2019 (EMSA THETIS-MRV (2020)) and 1.12 US$/€ as average exchange rate in 2019 (ECB (2021)).

3.1.3 Market-based policies

The proposed IMRB is not considered as a market-based policy, as per the listing of candidate measures in Table 1. Current discussions at IMO do not include proposals like the EU ETS as currently in place for stationary installations and airlines.

Mid- and long-term measures have not been the focus of the last MEPC meetings since the adoption of the Initial GHG Strategy. Three submissions to MEPC 76 which addressed market-based policies can be highlighted:

- Norway (MEPC 76/7/2) proposes three policy concepts for the uptake of low- and zero-carbon fuels: fuel CO2/GHG limit, emission cap and trading, carbon intensity indicators with credit trading/fleet averaging.
- Four EU Member States, including Germany, (MEPC 76/7/15) highlight the need to start work on mid-term measures as soon as possible and provide examples such as a GHG tax or levy, a cape-and-trade scheme or a low GHG-fuel standard.
- The Republic of the Marshall Islands and the Salomon Islands (MEPC 76/7/12) propose one distinct market-based policy: a mandatory levy on GHG emissions of 100 US$ per tonne of emissions by 2025 and is strengthened in 5-year intervals. Revenues collected would be used to support climate adaptation and mitigation activities in vulnerable countries, RD&D in new technologies and fuels, and administration. The proposal suggests 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*" (MEPC 2021, p. 3).

The proposals were not discussed in detail at MEPC 76 and were postponed to the next meeting (DNV GL 2021). MEPC 76 adopted a work plan which sets the timeline for the further consideration of mid- and long-term measures.[21]

The proposal by the Marshall Islands and Solomon Islands is similar to what has been suggested by Trafigura (2020), one of the world's largest charterers. Trafigura suggests establishing a system of fees and a rebates, in short a 'feebate,' which would put a mark-up on carbon-intensive fuels while simultaneously subsidizing primarily low- and zero-carbon fuels as well as R&D and Small Islands Developing States (SIDS) in their transition. For implementing the system, a benchmark based on CO_2e emissions of fuels would need to be established. Fuels with a CO_2e above the benchmark are subject to the levy and fuels below receive a subsidy. The system would be overseen by the IMO and would require determination of the well-to-propeller carbon intensity of fuels used in maritime transport.

Trafigura estimates that initially a mark-up of 250-300 US$/t$CO_2$e would be required to close the price gap between fossil and e-fuels in maritime transport. However, given that the suggested carbon price would function in parallel with a rebate mechanism to low carbon fuels, this could double the effect of the levied carbon pricing. Once the price gap narrows, the mark-up can be adjusted accordingly. The suggested carbon price is higher by a factor of 400-500 than the contribution to the IMRB Fund (section 3.1.2). Moreover, it puts a strong emphasis on penalizing carbon-intensive fuels and rewarding the deployment of climate-friendly fuels.

[21] IMO (2021) - Further shipping GHG emission reduction measures adopted: https://www.imo.org/en/MediaCentre/PressBriefings/pages/MEPC76.aspx.

These submissions and industry ambitions like the proposal by Trafigura show that the pressure is increasing on the IMO to discuss a MBM as a necessary policy to drive the decarbonization of the sector. If Member States manage to agree on a MBM like the levy proposed by the Republic of Marshall Islands, there would be an overlap of the global and EU policy regimes. Both the MBM of the IMO and the inclusion of maritime transport in the EU ETS have not yet been established; the details of their design have also not been decided upon. It is thus difficult to forecast an exact solution to the overlapping policies. Generally, an adjustment or alignment of the policies is facilitated if key elements are the same (e.g. targets including baseline, reporting/data integrity). A partial deduction of the global levy towards the ETS allowance price could be an option for voyages covered by both policies. It might also be possible to draw a comparison in the future to the outcome of the current discussion about the implementation of Carbon Offsetting Reduction Scheme for International Aviation (CORISA) of the International Civil Aviation Organization (ICAO) versus the EU aviation ETS.

The concept of 'market-based' approaches may, however, be broader than carbon pricing and/or emissions trading. If, for example, a goal-based approach (like an energy efficiency standard) with a stringent target trajectory for GHG emissions per tonne-kilometre also provided flexibility through trading of certified reduction units among regulated entities, it resembles a market-based approach even though it looks more like a regulation. The submission of Norway (MEPC 76/7/2) to MEPC 76 included a similar idea with a carbon intensity indicator and credit trading. Such an approach has advantages and disadvantages:

- Disadvantages
  - Even though defining the baseline for each ship is a one-off event, it will certainly be a cumbersome process which remains subjective to some extent.
  - No raising of revenues which can be used to subsidize the transition toward e-fuels.
- Advantages
  - Achieving the GHG reduction target within the sector rather than through offsets.
  - No raising of revenues at international level.

Interestingly 'no raising revenues' is simultaneously an advantage and a disadvantage, whereby the disadvantage most likely predominates. Even though there is a precedent for an international tax,[22] raising revenues at international level through auctioning of allowances or through a form of levy or tax has so far proved a major barrier for establishing market-based approaches at international level. The allocation of the revenues to countries faces the same challenges as the allocation of emissions. Every potential allocation method would be preferable for some countries, while other countries would be disadvantaged, with the result that governments cannot agree on one method that is acceptable to all countries. The ICAO was facing the same challenges and made progress in terms of establishing a market-based policy for reducing GHG emissions of international aviation partially

[22] The International Oil Pollution Compensation Funds was introduced as early as 1969 and covers damage from oil spills in maritime transport not covered by mandatory insurances. It is levied to receivers of crude oil and is usually significantly below 1 €cent/t of crude oil (IOPC Funds (2020)), i.e. it is lower by several orders of magnitude than the levels required to ensure decarbonization of maritime transport.

because it focused on establishing reduction requirements which do not involve money transfer at international level.[23]

3.2 Political feasibility

The political feasibility of adopting a global MBM for shipping depends on several factors - most importantly, reconciling the conflicting principles of non-discrimination, i.e. equal treatment of all ships under the IMO with the principle of common but differentiated responsibilities and respective capabilities (CBDR-RC) under the UNFCCC. This involves, among other things, agreements on the distribution and/or use of the potential revenues, impacts on states, but also on the general trust in the effectiveness of MBMs in terms of emission reduction or technological transition. The initial IMO discussions on the IMRB Fund (section 3.1.2) during MEPC 75 in November 2020 – which is not an MBM according to its co-sponsors but which raises revenues based on fossil fuel consumption – demonstrated that these issues are far from being resolved. Several developing countries and emerging economies will likely continue their strong opposition to a global MBM in the foreseeable future. Despite this, some IMO Member States, especially those in the South Pacific, are still keen to put a global MBM on the IMO agenda for the upcoming discussions of the MEPC. In this regard, discussions at MEPC 76 will be a litmus test for the feasibility of a global IMO MBM.

3.2.1 CBDR-RC

The principle of CBDR-RC has long been the root cause of slow progress in global action on climate change for international aviation and maritime transport. The Kyoto Protocol of 1997 dealt with it by dividing countries into Annex I and non-Annex I, based on their development status. The former comprised developed nations and was given a greater role and obligation in terms of climate mitigation than the non-Annex I group, which consisted of developing countries. The Paris Climate Agreement of 2015 did away with such a division and required all parties to undertake emission cuts based on their Nationally Determined Contributions (NDC) while also recognizing the respective capabilities of each country.

At the IMO, developing countries have been pushing to apply CBDR-RC to shipping as well. Arguably, the issue is more complex than historical emissions from land sectors. Even though it is true that historical emissions from developed nations far outstripped those of the developing nations, it could be argued that both groups bear equal responsibility for historical shipping emissions since maritime transport has been serving international trade, which benefited developed and developing countries alike.

The transition of the sector to zero-carbon technologies will increase the costs of seaborne transport. The impact of these costs on individual countries will likely vary based on different factors, including but not limited to distance from the main transport hubs and markets, their trade profiles, their ability to access new technologies, fuels, capital, etc. This could lead to disproportionate negative impacts on some countries compared to others. For this reason, the disproportionate impact on states has

[23] That does not imply that the establishment of the Carbon Offset and Reduction Scheme for International Aviation (CORSIA) is adequate to deliver the necessary contribution to global GHG reduction efforts. Avoiding financial transfers being regulated at international level nevertheless contributed considerably to dissolving the year-long standstill with regard to regulating GHG emissions of international aviation.

become one of the major roadblocks in the way of the IMO adopting stringent regulatory measures, including MBMs.

The problem is further confounded by the increasingly vocal calls by LDCs and SSIDs to use the revenues from a potential shipping MBM to "support climate change mitigation and adaptation efforts in vulnerable countries" (IMO 2021). Industrialized countries have been reluctant to date to support such calls in case it sets a precedent for similar calls from other regions.

3.2.2 Progress on a global MBM

Discussions on an MBM have already taken quite some time at the IMO. While potential MBMs have been considered at the IMO since MEPC 56 in July 2006,[24] it was not until July 2009 that the IMO asked Member States, Associate Members and observer organizations to submit MBM proposals for further consideration (Kosmas und Acciaro 2017). Various Member States and other organizations submitted proposals and an expert group was tasked to evaluate them (Psaraftis 2012). Progress towards the ultimate selection of an MBM was supposed to take place at an ISWG in March 2011 and at MEPC 62 in July 2011, which ended without a tangible outcome. Any substantial discussions on MBMs have since been put on hold.

In 2020, ICS et al. (2019) submitted a new proposal regarding the IMRB Fund to the IMO (section 3.1.2). The proposal was briefly discussed at MEPC 75 in November 2020 with diverging views among IMO Member States. The Committee concluded that more detailed consideration is necessary, especially of the impact on states. This is despite the proposal only envisaging a contribution of 2 US$/t of fuel (or 0.60 €/$CO_2$). The proposal was carried over to the next IMO meeting in June 2021 and Member States were invited to submit additional documents on the topic (IMO 2020b). However, as discussed in section 3.1.2, it is arguably an extremely weak instrument with a very low price and a short timeline. Proponents of the IMRB claim that it is not an MBM, but merely a contribution to finance R&D. While a global contribution based on fuel consumption to fund R&D could have some positive impacts, there is also the risk that it could delay more stringent carbon pricing policies.

Another proposal for a global MBM is the 'feebate' system mechanism suggested by Trafigura (section 3.1.3). The proposal envisages the recycling of at least a portion of the raised revenues back to shipping industry with a view to bridging the price gap between fossil fuels and green alternatives. However, since Trafigura does not have a formal status at the IMO, it cannot directly submit its proposal to the MEPC. A similar proposal was submitted to MEPC 76 by the Marshall and Solomon Islands (section 3.1.3).

Progress on regional carbon pricing policies, especially in the EU, will likely accelerate discussions on establishing a global market-based policy under the IMO. EU leadership could make a strong push for action at the IMO level, providing a clear proof-of-concept. This dynamic has already proven its effectiveness in the past. After the introduction of the EU MRV, the IMO DCS followed suit; the EU's Sulphur Directive was also fundamental to the IMO decision in 2016 to implement a global 0.5% sulphur cap in 2020. Considering the current progress on market-based policies under the IMO, there is little evidence that including shipping in the EU ETS could slow down the progress of possible future negotiations at the IMO.

[24] IMO – MBMs: https://www.imo.org/en/OurWork/Environment/Pages/Market-Based-Measures.aspx.

4 Conclusions and recommendations

It can be concluded that the inclusion of shipping in the EU ETS would not cause any technical barriers for the elaboration and implementation of GHG reduction policies at global level. On a political level, since the EU policy is likely to be implemented earlier than any similar MBM at global level, it may both accelerate discussions and agreements on the design of such a MBM at the IMO – as was the case with emission control areas or the IMO DCS.

Regarding the design features and appropriate administrative infrastructure to ensure high data integrity, the experiences gathered from ETS for stationary sources and aviation should be considered. The decision on the individual options often involves trade-offs between different goals which need to be taken into account:

- **Regulated entity**: Given the number of stakeholders involved in the operation of a ship (and thus the emissions), the definition of the regulated entity should strive to cover many possibilities while remaining practical. Many aspects need to be considered in this regard; a more detailed legal analysis is necessary to come up with the best definition. Currently, the definition of the regulated entity in the EU MRV Regulation (2015/757) is a solid foundation for a maritime ETS.
- **Scope**: Intra-EEA, outgoing and incoming voyages each account for roughly a third of the covered emissions. From an environmental perspective, it would be imperative to have the full scope including all emission of ships calling at EU ports. However, to avoid rejection by other countries, as experienced when the full scope was applied to aviation, 50% of in- and outgoing voyages should be covered in each case.
- **ETS type and cap**: A cap that is at least semi-open would allow regulated entities to surrender allowances from other sectors and, in this way, mitigate the volatility of allowance prices. The cap, determined through the linear reduction factor, should not be weaker than for other sectors.
- **Allocation**: Allowances free of charge have mainly been applied in sectors which face severe risks of relocating production. Since this risk is comparatively low for maritime shipping, all allowances should be auctioned.
- **Review**: To address any upcoming issues and to enable coordination with developments under IMO, the review should be delinked from the timelines for other sectors, though not for the cap.
- **Administrative issues**: Stakeholders from the shipping industry have suggested establishing a price stabilization mechanism. The concerns of the industry deserve careful consideration; it should therefore be further investigated whether such mechanism needs to be established by the regulator or whether market participants such as intermediaries would provide the same service.
- **Use of revenues**: Provided that allowances are auctioned, revenues should, to a major extent at least, be recycled to the maritime sector with a view to facilitating the accelerated uptake of sustainable alternative marine fuels and other GHG-reducing technologies.

If these features are considered in the context of incorporating shipping in the EU ETS, it would ensure that the inclusion is both environmentally effective and administratively feasible for all regulated entities. The inclusion of shipping would be an important part of addressing maritime GHG emissions in the EU alongside other policies like the FuelEU Maritime Initiative.

In this paper we have also assessed how the inclusion of shipping in the EU ETS would interact with efforts at international level under the IMO to address these emissions and how the inclusion should be designed to both ensure environmental integrity and practical feasibility for the regulated entities.

In IMO's Initial GHG strategy, 20 short-, mid- and long-term candidate measures are listed for reducing GHG emissions. Our analysis shows that most of the candidates would not interfere or work complementarily with the inclusion of maritime shipping in the EU ETS. However, policies involving some form of carbon pricing or trading of certificates might induce some overlap:

- Establishing an **International Maritime Research Board Fund**, as suggested by ICS et al., would raise 2 US$/t of fuel to finance research and development towards GHG-reducing technologies, specifically post-fossil fuels. Although it is not considered as a market-based policy by the sponsors, it could either work as a road test for carbon pricing at international level (so that the rate could later be scaled up to levels which would ensure the decarbonization of the sector) or cause the delay of more stringent policies.
- **Market-based policies** have been mentioned in submissions to the latest MEPC meeting. However, more detailed discussions on the proposals, like a levy of 100 US$/t$CO_2$, have been postponed. If such a policy involved allowance trading as under the EU ETS, it would certainly overlap but mutual recognition and/or adjustments of the EU ETS to make it compatible with the IMO design should be basically feasible. If it were implemented as a flexibility mechanism for a goal-based approach with trading of certificates, these units may not be fungible with allowances under the EU ETS.

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