Policy brief
Shipping in the EU ETS

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Summary

This policy brief identifies and discusses key design features for including shipping in the EU ETS and assesses modal split impacts and economic implications. The ambition has not been to provide recommendations but rather to provide an overview and brief assessment of the options that has been part of the discussion pending the final legislative proposal, including:

Covered ship categories. If shipping is included in the EU ETS the system will most likely cover the same ship categories as the shipping MRV (monitoring, reporting and verification) regulation, i.e., Ships >5000 gross tonnage. This would mean that 55% of all ships calling into EEA (European Economic Area) ports (together responsible for more than 90% of the CO_2 emission from shipping) would be covered by the scheme.

Geographical coverage. We have identified three main options: 1) EU internal routes; 2) all incoming and outgoing routes from EU/EEA ports; and 3) semi-full coverage meaning EU internal routes plus 50% of the routes to international ports. Only targeting internal-EU shipping would significantly reduce the overall shipping emissions covered but could be an easier political sell. The shipping industry has raised concerns that a 'global' scope may lead to perverse incentives, e.g. ships from international ports calling at a port just outside the EU before sailing to an EU port. However, recent estimates (Transport & Environment, 2020b) suggest that the added cost associated with port stops for the purpose of evading CO_2 prizing rarely makes economic sense.

Included Greenhouse gases. The system will initially most likely only cover carbon dioxide (CO_2) emissions from shipping.

Regulated entity. The ship owner is an obvious choice since they have the power to reduce emissions, by technical choices such as vessel form, power trains etc. However, for some categories of shipping it is common that the operators lease the ships. In these cases, operators may be a better choice as the regulated entity since they have power to reduce emissions by efficient routing, efficient loading and logistics. Choosing the fuel supplier will come with a high risk that fueling will occur outside the EU. Transport buyers could be the regulated entity since they are responsible for transporting the cargo and can choose other transport modes (substitution). However, it would be more administratively burdensome.

Allocation of allowances. Auctioning is the main method for allocating allowances in the EU ETS. Auctioning is consistent with the polluter pays principle, transparent and creates high incentives for reducing emissions. If shipping is included in the EU ETS with semi-full geographical coverage, allowance auctioning and an allowance price of 50 EUR per ton, we estimate the compliance cost to be approximately 100 EUR per ton fuel used. This can be compared to the price of fuel which is currently at 480 EUR/ton and has varied between 200 and 500 the last 12 months. If we assume that fuel costs account for one third of total transport costs, the compliance cost for shipping in the EU ETS will be less than 7% of the total transport related costs. If instead 85% of allowances are allocated for free by benchmarking under a semi-full geographical scope, assuming an allowance price of 50 EUR per ton, we estimate the compliance cost to be 15 EUR per ton fuel used (on average for the whole sector) or approximately 1% the total transport related costs.

Transport & Environment *(2020b)* has also investigated compliance costs, applying auctioning under a semi-full scope ETS design. They conclude that CO_2 costs would add only a very small

amount to the overall transport costs. For transporting a standard container (TEU) from Spain to Singapore, the CO_2 costs would represent less than 1% of the overall transport costs.

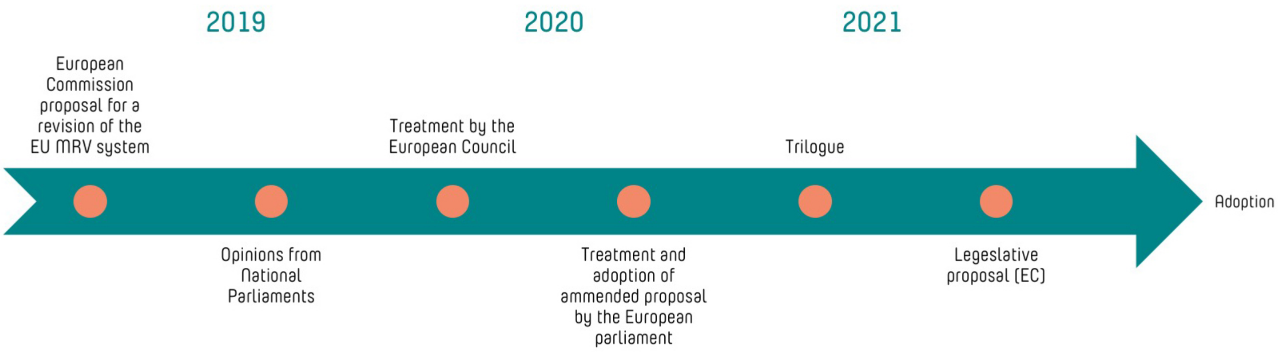
Modal shift. Senders of goods consider transport costs to be one of the most important factors when choosing transport modes. This suggests that inclusion of shipping in the EU ETS could lead to modal shifts when there are other transport modes available. In the EU, RoRo and RoPax mostly operates on routes where there is a land-based transport option and largely utilizing road based load units, such as trucks and trailers, which makes this the most exposed segment to a potential modal shift. The extent of any modal shift will largely depend on the characteristics and competition for each route, although the currently estimated cost of EU ETS is in itself not likely to cause any major modal shift. The container feeder segment is also subject to a direct modal competition with road and rail, although to a lesser extent due to more relaxed transport time requirements and the dimensions of containers which are adapted to sea transport and are less efficiently transported by road. However, port rail shuttles could potentially compete with feeder traffic from continental Europe. We expect that bulk shipping will not be particularly impacted by the introduction of EU ETS, since typical bulk freight are often heavy weight and lower value (per ton) and cannot be efficiently transported by road. Rail has a better chance at competing in this segment, although the modal shift is also expected to be low, one reason being that the market already absorbs large fluctuations in bulk transport costs. Although EU ETS is not likely to be a major cost item for shipping, it obviously adds to total costs and might in the long run incur changes in trade patterns and localization of industry and terminals.

1. Introduction

The shipping sector has for long largely evaded climate policy, but the EU institutions are currently addressing the possibility to including shipping in the EU ETS. This policy brief provides an overview and discusses key design features for including shipping in the EU ETS and implications on function and effectiveness of the policy. This is based on lessons learned from previous emission trading systems, inclusion of aviation in the EU ETS in 2012, proposals from the EU institution (Parliament, Council and Commission), and input from the shipping industry, NGOs and academia.

The ambition to include maritime transport in the EU Emissions Trading System (ETS) to address the climate impact from shipping has been discussed for some time and the amendment to the EU ETS Directive, enforced in 2018, emphasized the need to act on shipping emissions as well as all other sectors of the economy. Clear signals in 2019 by the president of the European Commission Ursula von der Leyen made the issue a high priority. On 4 February 2019, the European Commission adopted a proposal to revise the EU system for monitoring, reporting and verification (MRV) of CO_2 emissions from maritime transport after treatment in the European Council the proposal was handed over to European Parliament. On the 16th of September 2020, the European Parliament adopted amendments requiring:

- 40% reduction in shipping CO_2 emissions by 2030 compared to 2018.
- Maritime transport to be included in EU ETS by 2022
- The establishment of a Maritime Transport Decarbonisation Fund, financed by ETS revenues, to contribute to make ships more energy-efficient, to support investment in innovative technologies and infrastructure for decarbonising maritime transport, and to protect marine ecosystems impacted by climate change.



The proposal to include shipping in the EU ETS is part of the current review of all polices with relevance for achieving the EU wide climate target. The EU commission is expected to present its legislative proposal in July 2021.

In this policy brief we assess some of the key design features when including shipping in the EU ETS (Ch 2), modal split impacts (Ch 3) and economic impact of different design options (Ch 4).

2. Assessment of key design features

In this chapter we assess some of the key design features with relevance for the effects of an inclusion of shipping in the EU ETS, including; geographical scope, regulated entity, allowance allocation mechanism, GHG coverage, links to the MRV system, starting year, design of innovation/ocean fund, and ship categories included/excluded.

Table 1 outlines the design features which we have singled out for further analysis based on proposals from the EU institution (Parliament, Council and Commission), and input from the shipping industry, NGOs and academia.

Table 1. Key design features and options with relevance for the inclusions of shipping in the EU ETS

Geographical coverage, 3 options:	a) Internal-EU: Ship emissions within and between EU/EEA (European Economic Area) member states. b) All international: Option (a) plus journeys from EU/EEA ports to the first port of call outside the EU/EEA and journeys to EU/EEA port from the last port of call outside the EU/EEA c) Semi-full coverage: Option (a) plus 50% journeys from EU/EEA ports to the first port of call outside the EU/EEA and 50% of journeys to EU/EEA port from the last port of call outside the EU/EEA. Alternatively: the Internal-EU + all inbound journeys: Ship emissions within and between EU/EEA member states plus journeys to EU/EEA ports from the last port of call outside the EU/EEA
Regulated entity, 4 options	Ship owner, ship operator, transport buyer or fuel supplier
Allowance allocation mechanism, 4 options	a) Auctioning b) Grandfathering c) Benchmarking, based on output, for instance ton-km or passenger-km (possibly one benchmark per sub-sector) d) A mix of (a), (b) and (c)
Included greenhouse gases, 1 option	CO_2, and in specific cases also CH4 [a]
Covered ship categories, 1 option	Covered[b]: • Ships above 5 000 gross tonnage • Voyages for transporting cargo or passengers for commercial purpose • Container ships, bulkers, general cargo ships, ro-ro, tankers and ferry boats Not covered: • Ships below 5 000 gross tonnage • Voyages for purposes other than transporting cargo or passengers for commercial purpose • e.g., fishing ships, war ships, wooden ships and ships not propelled by mechanical means
Time frame of implementation, 2 options	2022 or 2026

[a] The EU ETS directive mentions all six greenhouse gases, however, in the EU ETS Handbook CO_2, N_2O and PFCs are covered for selected industry sectors, but methane (CH^4) is left out
[b] i.e. the same ship categories as the shipping MRV regulation

In the following subsections we discuss how a selection of these design features fare in terms of effectiveness and feasibility.

Geographical coverage

The European Commission (2020b) in their recent (November 2020) Inception Impact Assessment indicates that the preparations for the revision of the EU ETS Directive will involve an assessment of the impact of “Including at least internal EU emissions of the maritime sector to ensure the sector contributes to the emission reductions needed [...]”. At this point it is difficult to foresee what the geographical scope of the final legislation will be. Early leaks (Shippingwatch, 2020) suggest that the EU institutions will opt for a light model at first, covering only EU-domestic shipping. But until the European Commission has presented its legislative proposal the actual coverage remains uncertain. Some observations include:

- Only targeting internal-EU shipping would significantly reduce the overall shipping emissions covered but could be an easier political sell. While the cost impact on traded goods seems to be rather small there is a risk that the introduction of a CO_2 price on emissions from either outbound or inbound journey will raise concerns over disproportional impacts on exports and imports, respectively.

- Representatives from the shipping industry has raised concerns that a ‘global’ scope risks creating perverse incentives, e.g. a ship trading across the Atlantic or through the Suez Canal could stop in a port just outside the EU before sailing to an EU port or the cargo could be unloaded and further shipped into the EU. (ECSA/IBS, 2020). However, recent estimates (Transport & Environment, 2020b) suggest that the added cost associated with port stops for the purpose of evading CO_2 prizing rarely makes economic sense. According to their estimates of the effects of a full scope maritime ETS in Greece, Spain and the Netherlands, all with major seaports in close proximity to a non-EEA port, between 5-20% of all voyages would be tempted to evade carbon pricing through an extra port call at a carbon price of 50 €/tCO_2. Since evasive behavior is more likely in these three countries, due to their geographical location, the impact for the EU as a whole can be expected to be significantly lower. Transport & Environment has also in alliance with Greek, Swedish and Italian shipowners, along with other individual shipping companies, spoken out in favor of a geographical coverage the goes beyond the EU borders[1].

[1] Open letter to the European Commission's Executive Vice-President Frans Timmermans and Commissioner Valean https://www.transportenvironment.org/sites/te/files/publications/Joint%20industry-NGO%20letter%20on%20ETS_v.3.0.%20%281%29.pdf

Geographical leakage

Carbon leakage to ports outside EU[2] is expected to be low from a Swedish perspective as the main exposed segments are short sea RoRo/RoPax and container feeder. Attempts to bypass the EU ETS for Swedish flows would imply mainly transshipment in Russian or UK ports. There are existing RoRo services between Sweden and the UK and the Benelux countries and there is a possibility for shippers to use the UK services instead of the Benelux services. However, as the freight is destined for the EU it is unlikely that the extra cost and administration in first going to the UK[3] would outweigh the costs incurred by EU ETS, as indicated by Transport & Environment (2020b). The costs and regulations associated with this should be further investigated, although this is complicated by the ongoing Brexit situation. This is also impacted by the design of the EU ETS and how large part, if any, of a voyage to/from a destination outside EU is included. However, some leakage could occur in the container segment by utilizing intercontinental container shipping directly to the UK and feeder traffic to Sweden. This would not add any significant extra transport distance and, for flows already normally transhipped to feeder in continental Europe, would not add any extra transhipment costs. A limitation here is in the capacity in the UK container ports. If only internal-EU is included in the ETS, shipping lines could have incentives to use more direct services from outside EU, instead of the liner type of services currently used for example by intercontinental container shipping that calls on several ports within EU with the same ship. However, this would significantly reduce the positive scale effects in shipping as smaller ships would need to be used, which makes this development less likely.

Looking at RoRo/RoPax in the Baltic Sea and the option to operate to Russia, only a small part of the flows is destined to Russia with a great majority intended for the EU market. Although it is possible to start more RoRo services between Sweden and Russia our preliminary estimate is that it is unlikely that the extra administration and costs involved in returning to EU by road will outweigh the costs incurred by EU ETS. Similar as in the UK option, the design and geographical coverage of the EU ETS will have an impact. The Russian enclave of Kaliningrad has the most preferred geographical location although there are currently very few ferry services operating to the region and further investigations are needed to determine if shipping services to the region is a realistic option. Intercontinental container shipping today typically calls several EU ports before arriving in the Baltic area and are thus already subject to the EU ETS. It is unlikely that the shipping lines would start utilising direct intercontinental services to Russia with the intention to use feeder traffic to Sweden as this will add in transport distance compared to, for example, call the Port of Gothenburg. However, this will of course depend on the added cost from EU ETS. A recently emerging transport choice is rail transport all the way from China to Europe to Russia, however, the volumes here are still too low to constitute any major impact and the capacity is limited.

[2] For the purpose of this discussion we have assumed that Norway will be in EU ETS for shipping as they are a member of the existing ETS and that the UK will not be a member

[3] It is worth to note that the UK government just (April 2021) announced that UK's sixth Carbon Budget will incorporate the UK's share of international aviation and shipping emissions https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035

Regulated entity

The ship owner is an obvious choice since the emissions occur from the ships. The ship owner has the power to reduce emissions, by technical choices such as vessel form, power trains etc. The ship owner is also responsible for reporting to the MRV. However, for some categories of shipping it is common that the operators lease the ships. In these cases, the operator may be a better choice as the regulated entity since they have power to reduce emissions by efficient routing, efficient loading and logistics. A disadvantage of using the operator is that they are not responsible for reporting emissions to the MRV which makes it more challenging for the regulator to check if the operator is complying.

Choosing the transport buyer as the regulated entity could be motivated since the buyer is responsible for transporting the cargo and can choose other transport modes (substitution). However, it would be more administratively burdensome if the transport buyers were the regulated entity. The ship owner or operator can normally pass on the compliance cost of being in the EU ETS to the transport buyer hereby creating incentives for substitution. If the fuel supplier is chosen as the regulated entity there is a high risk that fueling will occur outside the EU.

Allowance allocation mechanism

For emissions trading in general, there are three main principles for allocating allowances – auctioning, grandfathering and benchmarking. They differ in terms of compliance cost for the participants and what incentives they create for reducing emissions.

Auctioning has been the main principle for distributing emission allowances in the EU ETS in the latest trading period. In total, the Commission estimates[4] that 57% of the total amount of general allowances were auctioned in phase 3. However, a significant share of emission allowances have been and will continue to be allocated for free also in the upcoming fourth trading period (2021-2030). It is worth to note also that different rules apply for the aviation sector under the ETS[5]. Only 15% of the aviation allowances have been auctioned (82% granted for free to aircraft operators and 3% in a special reserve for distribution to fast-growing aircraft operators and new entrants).

Auctioning

Including shipping in the EU ETS is likely to follow the principles already in place in the EU ETS. Auctioning is the main method for allocating allowances in the EU ETS and is consistent with the polluter pays principle.. Auctioning is transparent and creates high incentives for reducing emissions.

As of today, approximately 57% of allowances are auctioned to the participants. However, 43 % of allowances are allocated for free in order to mitigate risk of carbon leakage for trade exposed firms. In the case of shipping, the share of free allocation may be determined by the leakage risk. The leakage risk will depend on the geographical scope of the trading scheme as discussed above. The leakage risk is, most likely, larger for international shipping, than for internal EU shipping.

[4] https://ec.europa.eu/clima/policies/ets/auctioning_en
[5] https://ec.europa.eu/clima/policies/ets/allowances/aviation_en

Grandfathering

Grandfathering, or emission-based allocation, means that allowances are provided free of charge to participants based on their historic emissions (or a part thereof). Grandfathering significantly reduces the costs for participants. A disadvantage is that it does not provide revenues that can be re-circulated, and it is often perceived as unfair since it rewards firms with high emissions. However, emission-based allocation does provide high abatement incentives as long as the data on which the allocation is based (historic emissions) is not updated. The reason being that even if a firm has received allowances for free it still has high incentives to reduce emissions, since it can then sell the surplus allowances with a profit. However, if emission-based allocation is updated with newer data, this would create perverse incentives for the participant to increase emissions in order to get more allowances in the future. So grandfathering cannot be updated.
This in turn creates a problem since the longer the system runs, the less relevant is the data on which the allocation was based. At the start of the EU ETS, grandfathering was the main allocation method in order to increase its acceptability among industry but has since been replaced by auctioning and benchmarking.

Benchmarking

Benchmarking, or output based allocation, means that free allowances are provided to participants based on their production (output) times a sector specific benchmark, expressed in ton CO_2/per unit of output. This means that allocation is proportional to output and not to emissions. Benchmarking preserves high incentives for emission reductions and is perceived as fairer than grandfathering since benchmarking rewards firms with low emissions per unit of output. Benchmarking can also be used to allocate allowances to new entrants in the program, which grandfathering cannot. The EU ETS applies benchmarking in sectors that are considered to be exposed to carbon leakage risk, such as producers of steel, cement and aluminium. In total, approximately 43% of the total allocation is based on benchmarking. For this purpose, 54 benchmarks have been developed for sub-sectors based on the 10% best performers in each sub-sector in terms of carbon emissions per unit of output.

With benchmarking, the allocation is determined as:

Allocation = output x benchmark,

where the unit of output can for instance be ton-km or passenger-km and the benchmark is expressed in ton CO_2-equivalents/unit of output.

Since there are different types of shipping (container ships, bulkers, general cargo ships, ro-ro, tankers, ferry boats etc) representing different sub-sectors, one may need to establish several benchmarks, one for every sub-sector. When determining benchmarks and allocation, one also needs to consider what data will be available, both for calculating the benchmarks and for determining output.

Since there is a high variation of emissions per unit transport work for different ship types and sizes, the economic impact will accordingly differ greatly if allowances are distributed based a uniform benchmark for all ship categories. This means that the impact will likely be larger for e.g. RoRo compared to bulk vessels (see Chapter 4). Further, short sea shipping operating in competition with other modes, may not be able to pass on the additional costs in the same way as e.g. deep-sea shipping (see Chapter 3). Hence, the design of the benchmarking system is very important for the actual impact.

Free allocation via benchmarking will also create incentives for abatement since allowances freed up by investments in emission reduction measures at a price lower than the carbon price can be sold and generate profit. Allocation via benchmarking could also be a way to mitigate the potential risk for leakage effects. On the other hand, free allowances would not, like in the case with auctioning, create revenues which could be used for other purposes and there is also a chance that would create incentives for increased shipping.

Included greenhouse gases

The EU ETS legislation covers all six greenhouse gases, however, in the EU ETS Handbook CO_2, N_2O and PFCs are covered for selected industry sectors, but methane (CH_4) is left out (European Commission 2015; Mellin et al, 2020). There is a chance that methane emissions from the shipping sectors will be excepted initially as well. The European Commission will deliver legislative proposals in 2021 on compulsory measurement, reporting, and verification (MRV) for all energy related methane emissions (European Commission, 2020c). The MRV legislation on energy related methane emissions will contribute to a better understanding of the problem and provide the basis for subsequent mitigation measures and possible integration in the EU ETS coverage. If shipping is included in the EU ETS already in 2021, as suggested by the European Parliament, this would suggest that the EU ETS will initially only cover carbon dioxide (CO_2) from shipping.

The use of Liquefied Natural Gas (LNG) as a maritime fuel has been increasing over the past years. Yet, the use of LNG in the maritime sector represented only 3% of the total amount of fuel consumed in 2018. It was mostly used by LNG and gas carriers. It is worth noting that while the use of LNG significantly reduces emissions of SOx and NOx, its climate impact is negatively affected by the emissions of unburnt methane (e.g. “methane slip”) (European Commission, 2020a).

Covered ship categories

If shipping is included in the EU ETS the system will most likely cover the same ship categories as the shipping MRV, i.e., ships >5000 gross tonnage (GT), including container ships, bulkers, tankers, general cargo ships, RoRo ships and ferry boats on voyages for transporting cargo or passengers for commercial purpose. Aligning the scope with the shipping MRV is sensible since the MRV already keep track of CO_2 emissions and other relevant information from all large ships loading or unloading cargo or passengers at ports in the EEA. While the cut-off at 5 000 gross tonnage means that only 55% all ships calling into EEA ports are covered these larger ships account for the vast majority of the CO_2 emissions (around 90% according to MRV data) (European Commission, 2020a).

Innovation/ocean fund

In the European parliament’s original proposal[6] the parliament called for an “Ocean Fund” for the period from 2022 to 2030, financed by revenues from auctioning allowances under the ETS, to make ships more energy-efficient and to support investment in innovative technologies and infrastructure, such as alternative fuel and green ports. 20% of the revenues under the Fund should be used to contribute to protecting, restoring and efficiently managing marine ecosystems impacted by global warming. The concept of an innovation fund has gained support, but different actors still have very different interpretation of how the fund should be structured and how it should be linked to the EU ETS.

[6] https://www.europarl.europa.eu/news/en/press-room/20200910IPR86825/parliament-says-shipping-industry-must-contribute-to-climate-neutrality

The NGO Transport & Environment (Transport & Environment, 2020b) builds on the parliament's proposal and envisages a fund which could support non-incremental investments including e.g. the deployment of sustainable hydrogen-based fuels zero-emissions vessels.

Transport & Environment also proposes, to de-risk pioneer investments and deployments, a 'contracts for difference' (CfD) support scheme in order to bridge the price gap between what it costs to produce such sustainable marine fuels and what the market is willing to pay for those fuels.

Following the European parliament's proposal to include shipping in the EU ETS, the International Chamber of Shipping (ICS) has proposed a different approach – a levy-refund system[7] on a global level (see also IMO, 2019). The system consists of two parts: 1) a $2 carbon levy[8] is placed on marine fuel purchases; and 2) revenues from the levy is placed in a fund and used for research and development of zero-carbon marine fuels. The ICS proposes that the system is managed by IMO.

A number of issues deserve attention:

- The price level of the levy is important since it determines the incentives for reducing emissions and revenues for the fund. A levy of 2 dollars (translates into carbon cost of approximately 0.6 €/ tCO_2) appears very modest in comparison to the price of EUAs (European Union Allowance), which currently exceeds 40 €/ tCO_2.

- Placing the obligation on fuel sales would create a leakage risk unless all international shipping is included.

- There are legal, administrative and governance aspects where there are concerns and diverging views.

The European Community Shipowners' Associations (ECSA) have proposed a system which would allow smaller ship owner or ship operator to trade directly with the fund based on a fixed price (average price of EUA in the previous year). ECSA also stresses that revenues from a Maritime EU ETS should be earmarked for R&D and innovation projects for low- and zero-carbon fuels[9].
The use of a fund to provide a price stabilization mechanism and to lower the administrative burden is also put forwards in recent open letter to the European Commission's Executive Vice-President Frans Timmermans and Commissioner Valean signed by an alliance of Greek, Swedish and Italian shipowners, along with other individual shipping companies and the NGO Transport and Environment[10].

[7] https://www.argusmedia.com/en/news/2162449-imo-to-consider-fuel-levy-to-develop-zerocarbon-fuels
[8] Would for marine gasoline (MGO) with an emission factor of approximately 3 tCO2/t fuel translate into a carbon cost of 0.7 $/ tCO2 or 0.6 €/tCO2
[9] ECSA webinar on "Is the EU ETS the best way to decarbonise shipping?
https://www.ecsa.eu/sites/default/files/publications/Presentation%20Framework%20Conditions.pdf
[10] Open letter to the European Commission's Executive Vice-President Frans Timmermans and Commissioner Valean https://www.transportenvironment.org/sites/te/files/publications/Joint%20industry-NGO%20letter%20on%20ETS_v.3.0.%20%281%29.pdf

3. Modal split impact

The potential of a modal transfer from shipping to other transport modes due to EU ETS should be viewed in the light of the general competition and characteristics in the freight market. We look at three segments: RoRo and RoPax, the container segment and the bulk segment.

The short sea shipping RoRo and RoPax segment is likely to be most impacted as they have a direct competition with road transport. Freight is typically intermodal cargo, meaning that it is adapted to road transport, for example semi-trailer or trucks. This makes intermodal transfer easy from a technical point of view. Road transport is thus the main competitor. Furthermore, the physical dimensions and weight limits of the load units are set by the road transport system, meaning that the weight and volume utilization in road transport is good. In a European perspective, RoRo and RoPax mostly operates on routes where there also is a land-based transport option. This is for example the case between southern/western Sweden and continental Europe. In contrast, RoRo and RoPax across the Baltic sea would be less affected as the land-based transport option, although they exist, add significantly in transport distance. However, it is also possible that a transfer can take place from the (from a freight perspective) less efficient RoPax ferries to RoRo ferries.
In a long-term perspective, this could lead to changes in routes and sailing schedules. The impact will be greatest on the RoRo segment, while the impact on RoPax, and in particular cruise ferry, segments are more difficult to estimate as these have several streams of revenue, for example passenger tickets, restaurants and on-board shopping. The shipping line can thus choose where to allocate the added costs from the EU ETS. The competition with other transport modes will probably play a significant role, where the least price sensitive revenue stream is likely to bear the greatest cost. This would likely be different for different routes and even for different departures.

The container feeder segment is also subject to a direct modal competition with road and rail, although to a lesser extent. Container shipping have an advantage in that the dimensions (length, weight etc.) of the containers are adapted to sea transport and are less efficiently transported by road. On road, the containers do not offer a good match with the allowed maximum dimensions and are also unnecessarily sturdy and heavy. However, it should be noted that the ongoing trend towards allowing longer and heavier trucks might impact this potential modal transfer. The main competitor to the container feeder segment is rail as the operations are well aligned with the structure of the rail system. Intercontinental container shipping connects to one of the main hub ports in continental Europe or to Gothenburg from where there is already a well-developed system with intermodal rail shuttles, bringing the container to inland terminals, so called Dryports.
The larger intercontinental ships bring large volumes to one geographical point (the port) which aligns well with the structure of rail transport, which also works best with large volumes from one point. A cost increase in the container feeder segment could thus lead to some modal transfer to intermodal rail transport. However, this is constrained by a limited capacity in the rail network around the ports and the inflexibility of the rail system requiring some time and investment to start up new routes and terminals. Intercontinental container shipping will likely not be affected, although the choice of main ports in EU could be affected with a preference towards using "early" ports with the EU in continental Europe and transship to rail for the transport towards Scandinavia, instead of operating the largest intercontinental container ships all the way to Sweden.

Regarding bulk, we estimate that inclusion of shipping in the EU ETS will not have a significant impact on modal transfer. The main reason is the characteristics for the transported goods which is difficult to transfer in a cost-efficient way by road. Important segments such as iron ore, oil, and agricultural products are bulky and often heavy weight which cannot be efficiently transported by road. Rail has a better chance at competing in this segment as rail is better suited at transporting large volumes of bulky and heavy goods than road. However, the added costs from EU ETS is not expected to be large enough to cause any significant modal transfer to rail. A significant share of the bulk shipping is also traded on the spot market, where it is already subject to large price variations. The Baltic Dry Index (an index of average prices paid for the transport of dry bulk materials across more than 20 routes) fluctuates significantly, indicating that the overall modal transfer impact of the EU ETS will be low in relation to the fluctuations already absorbed by the market. A higher average transport cost, however, might well impact the competitiveness within the raw-material intensive industry and thus sourcing of material and the location of production facilities.

Looking at the important characteristics for modal choice, several studies have concluded that price is the most important factor (Flodén et al. 2017). Typically, the modal choice is made in two stages. First, the main transport characteristics offered are evaluated to determine if the transport offer is trustworthy. Can the transport company be trusted? Will the goods be properly delivered? After that, the choice of transport is almost entirely made on price. Shipping is often marketed as an environmentally good choice, something that probably will be enhanced by the EU ETS. However, the environmental factors are still often given a low impact in the transport customers' modal choice although its importance is increasing. The environment is considered as something that the transport operator should manage properly, but the transport customer is rarely, or only to a limited extent, willing to pay extra for it.

Larger flows are also more commonly managed as own-account transport, meaning that the sending company also performs the transport themselves. One example is the forest company SCA that operates several vessels. This highlights further a difference between the bulk shipping segment and the RoRo/RoPax segments. Bulk shipping typically constitutes fewer senders who are more actively engaged in the transport and more often deals directly with the shipping operators. Although there are some large, dedicated RoRo flows with similar characteristics as in bulk shipping, the RoRo and, in particular, RoPax segments typically caters to a large number of smaller shippers. RoRo and RoPax shipping often constitutes smaller transport volumes per shipment and a larger number of senders. For instance, a single semi-trailer could contain consolidated shipments from a large number of senders. This puts a greater responsibility on the transport operator or forwarder in charge of managing the transport chain. The transport operators and forwarders in this segment typically have their background and main operations in the road transport segment and utilise RoRo/RoPax as a part of an intermodal transport chain. This indicates that the barrier for these actors to switch to all-road transport are relatively low.

4. Economic impact of different design options

The different design options for the inclusion of shipping in the EU ETS system, along with the price of emission allowance units, determine to a large extent the economic impact on the maritime sector from this development, especially ship operators that will be required to surrender adequate emission allowances for their operations. The exact impact depends on complex relations of supply and demand for maritime services, but in this analysis, we assume that the inclusion of shipping into the EU ETS will increase marginal costs of maritime transport services, ultimately affecting the freight rates. Increased freight rates could, in turn, have an impact on demand for shipping services, but the magnitude of this impact depends on the price elasticity of demand for shipping.
Two design features seem to have a large impact on the direct costs for the maritime sector from its inclusion in the EU ETS: geographical coverage and allowance allocation mechanism.

Assuming that the total amount of emission allowances is auctioned and ship operators need to surrender allowances for all the emissions from their vessels, the direct costs for the maritime sector would be significant and could potentially incentivize investments and/or a shift to alternative fuels in contrast to the case of free-allocating a large percentage of these allowances. By linking this additional cost of CO_2 pricing to current fuel prices, a better understanding of its economic impact on the maritime sector can be provided. It needs to be mentioned here that this analysis is based on relatively rough estimates related to the MGO fuel and the emission allowance unit prices.

To calculate the increase in fuel price from the inclusion of CO_2 pricing, it is necessary to consider the emission factor of the fuel as well as the emission allowance unit price. Given the current price of emission allowance units that has been around EUR 35 since the beginning of 2021 and the target of the European Green Deal for net zero emissions in the EU before 2050, the emission allowances price can be expected to increase in the near future and, in this analysis, we assume two different scenarios of emission allowance price: 35 and 70, considering the short-term horizon of the inclusion of shipping in the EU-ETS. The emission factor of marine gas oil (MGO) fuel that is widely used in European waters after the international sulphur fuel limits is about 3 ton CO_2 per ton of fuel. This means that, in case all emission allowances are being auctioned, the additional cost in MGO fuel price will vary between EUR 105 per ton MGO, and EUR 210 per ton, depending on the emission allowance unit price. Given that the current price of MGO is around EUR 480 per ton, the MGO price could be 22% to 43% more expensive compared to the current price. This can be compared to the price fluctuations which has varied between 200 and 500 EUR per ton the last 12 months.

Alternatively, in case 85% of these emission allowances are allocated for free in the introduction phase and only 15% are being auctioned (following the example of aviation), allowances for about 0.45 ton of CO_2 per ton fuel of MGO would be included in the fuel price increase from the inclusion of CO_2 cost. The additional cost in MGO fuel price would vary between EUR 15.75 euros and 31.5 per ton fuel depending on the emission allowance unit price. This would mean an increase of about 3.3% to 6.7% in the current price of MGO. The impact on MGO fuel price from the inclusion of CO_2 cost depends largely on the amount of emissions allowances that will be auctioned in the EU ETS.

Geographical coverage is, as mentioned earlier, also an important design feature that impacts the cost increase for the maritime sector from its inclusion in the EU ETS. It is worth mentioning here that the overall emissions from shipping, included in the EU MRV system, for the year 2019 accounted for 145 Mton CO_2, while one third of these emissions (48 Mton CO_2) came from intra-European voyages. Including only emissions from intra-European voyages in the EU ETS would lead to reduced environmental benefits. Based on the analysis of the EU MRV data, different designs of geographical coverage have a large impact and represents a particularly important parameter for deep sea segments (containerships, oil tankers, bulkers, chemical tankers, general cargo carriers) that are engaged in distant voyages and operations within the EEA consist only the first/last leg of their voyage. Short sea shipping segments (RoRo and RoPax vessels) mostly operate within the EEA and face similar increased costs from the inclusion of CO_2 pricing irrespective of the geographical scope of the system.

Besides geographical coverage, different emissions allocation methods will have a differentiated impact on different maritime segments due to their distinct technical and operational characteristics. Following previous experience from the extension of the EU ETS to include aviation, it is possible that a similar approach will be followed for the allocation of emission allowances for the maritime sector: benchmarking based on emissions per transport work (emissions per nautical mile). Assuming that allowances will be allocated on the basis of a uniform benchmark for all ships, irrespective of segment and size, the impact on different maritime segments will differ significantly depending on their emissions per transport work. Less energy-efficient maritime segments (such as RoRo and RoPax) would be penalized in contrast to bulk shipping that would be favoured if a uniform benchmark for the allocation of emissions allowances is introduced.

In case of proceeding with benchmarking as allowance allocation method, to be effective and fair a climate policy for the abatement of CO_2 emissions from the maritime sector should reward energy efficient shipping operations taking into account the technical and operational features of the various segments, differentiated benchmarks should be established for each segment to ensure their equal treatment and avoid competition distortion among them. Under such a scheme, the shipping companies would have additional incentives to improve their energy efficiency and invest in green technologies to equal the additional cost of emission allowances.

Shipping carbon costs in perspective

*Assuming full auctioning with a semi-full geographical coverage, an allowance price of 50 EUR per ton and an emission factor of 3 tons CO_2/ton marine fuel, the cost increase will be 0.67*50*3 = 100 EUR per ton fuel used. This can be compared to the price of fuel which is 480 EUR/ton and has varied between 200 and 500 the last 12 months. If fuel costs account for 1/3 of total transport costs[11], and no measures are taken to reduce emissions, the cost increase would be 7%. If emission reduction measures are implemented the cost increase would be lower than 7% of total transport costs. Considering 85% of emission allowances free-allocated and an allowance price of 50 EUR per ton, under a semi-full geographical coverage, the cost increase would equal to 15 EUR per ton fuel used corresponding to approximately 1% of total transport costs.*

Transport & Environment (2020b) offers another estimate: "CO_2 costs would add only a very small amount to the overall transport costs. For transporting a standard container (TEU) from Spain to Singapore under a semi-full scope ETS design, the CO_2 costs would represent less than 1% of the overall transport costs."

The effects on the price of final consumer goods transported by ship is also likely to be marginal. Transport & Environment (2020a) has shown that if the added costs associated with a carbon price of 50 EUR per ton were passed on to final consumers proportionate to each products' share of CO_2 in shipping: "the price increase on these consumer goods would be insignificant. For example, a kg of banana from Ecuador or an iPad from China would respectively cost Belgium consumers about 0.55% and 0.0005% more (all else being equal)."

[11] See Jivén et al., 2020. Consequences of speed reductions for ships – An impact study for shipping companies and Swedish business.

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