Less is more: Regional shipping policy and global decarbonisation

Regulating shipping in Europe, the US and China could green 84% of the fleet

November 2022

Summary

The rise and rise of shipping emissions over the past decades stands in clear contrast to the successful policy action to reduce greenhouse gas emissions in other sectors. The Paris Agreement clearly committed states to reduce emissions in all sectors through economy-wide domestic action, but shipping was only subject to piecemeal, weak climate measures negotiated at the International Maritime Organization (IMO), until the EU announced regional legislative measures in 2021 to reduce emissions in the sector.

This paper provides new data on the value of regional action, such as that taken by the EU, to global decarbonisation. We find that while China, the US and Europe (including the European Economic Area, where the EU's shipping laws will apply and the UK) only account for 40.1% of global shipping emissions, the vast majority of the global shipping fleet call at the ports of these countries. As such, if China, Europe and the US put in place zero-emission shipping mandates, these governments alone could decarbonise 84% of the global fleet.

The results demonstrate for the first time the huge impact that national and regional policy action can have on global decarbonisation and show the path to a transition that respects differentiated capacities between the Global North and Global South. In light of this analysis, we urge countries with the administrative capacity to decarbonise shipping - including countries in the Global North and China - to put in place measures to reduce their maritime emissions, from carbon markets and pollution taxes to energy efficiency targets and zero-emission fuel standards.

1. Shipping in the global context: UN and regional initiatives

Globally, shipping is responsible for over 1000 Mt CO_2 per year, amounting to approximately 3% of total CO_2 emissions and are predicted to increase by up to 50% by mid century unless stringent measures are implemented.[1] Yet, until recently, there have been no measures to significantly abate the sector's climate impact. The IMO, the United Nations (UN) body that deals with maritime affairs, has only committed to reducing emissions by 50% in 2050 compared to 2008 and without putting in place binding measures to achieve even this inadequate aspirational target.

The Paris Agreement was supposed to address climate change in all economic sectors by setting a binding temperature goal that individual countries - not global organisations like the IMO - had to reach. However, the shipping industry has argued erroneously that it is not subject to the Paris Agreement, leading to most countries not addressing their maritime emissions. This is in spite of independent legal analysis demonstrating that the sector is indeed subject to the Paris Agreement.[2]

In recognition of its responsibilities under the Paris Agreement, the European Commission proposed measures in 2021 to address shipping's climate impact. It proposed to include shipping in its carbon market (ETS) and reduce the greenhouse gas intensity of marine fuels through the FuelEU Maritime law. Importantly, the laws recognised that Europe has responsibility for its share of 'international' emissions: the Commission proposed to regulate 50% of emissions from voyages between European and non-European ports.

2. Purpose of this analysis

The European Union's proposals have brought the issue of regional shipping decarbonisation to the fore. This analysis therefore seeks to explore the impacts of legislating zero-emission shipping in individual countries or regions. To do this, we first look at the share of shipping emissions attributable to each country. We then evaluate how many individual ships would fall under national (or regional in the case of the EU) laws if individual countries regulated their share of shipping emissions. We then discuss qualitative factors, such as the knock-on impacts of regional decarbonisation, and evaluate to what extent regional decarbonisation led by developed economies can ensure a globally equitable transition.

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[1] International Maritime Organisation (2020). 'Fourth IMO greenhouse gas study'. Retrieved at: 20Study%202020%20Executive-Summary.pdf

[2] Transport & Environment (2022). Don't sink Paris: Legal basis for inclusion of aviation and shipping emissions in Paris targets. Retrieved at https://www.transportenvironment.org/wp-content/uploads/2021/10/Briefing-paper-NDCs-legal-advice-Aviation-Shipping-Final-2021-2.pdf

2.1. Methodology

We calculate the emissions of cargo and passenger ships above 5,000 gross tonnage (GT) with a shipping emissions model developed in-house. We use ship Automatic Identification System (AIS) data provided by ExactEarth and ship characteristics from the IHS Markit "Core Ships Database". AIS files include information such as time, speed-over-ground, draught and position at hourly intervals over the course of 2019. We found AIS data for 29,928 cargo-carrying or passenger ships above 5,000 GT. These ships represent 97% of the DWT of ships above 5,000 GT which were in service in 2019, according to IHS Markit's database.

To estimate ship CO_2 emissions, we follow the methodology outlined in the Fourth IMO Greenhouse Gas Study.[3] We aggregate ship emissions by voyage, then attribute them to countries following the EU's 50% geographical scope applied to the EU ETS and FuelEU Maritime regulation. A more detailed methodology can be found in Appendix A.

3. Main findings

When looking at single countries' share of emissions per voyage, the three biggest economies, namely the EU,[4] China and the US are responsible for the most amount of emissions (Fig.1). The EU is responsible for 14.4%. China and the USA are responsible for 15.1% and 7.8% respectively. Singapore has a large number of emissions and comes in fourth with 7.19%, due to its role as a marine bunker hub. The following complete the top 10 emitting countries: Japan with 5.2%, Australia with 4.3%, Brazil with 3.9%, India with 2.8%, South Korea with 2.5% and Indonesia with 2.0%. The results show that allocating emissions per voyage - as opposed to per flag, or where the fuel was purchased - accurately reflect countries' trade patterns given that the largest economies come out top.

Nonetheless, emissions are not concentrated in a few countries. Together, China, the US and the EU do not together count for a majority of emissions, only 38.4%. In this sense, it may appear as if regional policy would have limited impact unless implemented by a majority of countries. This may pose a concern for developing countries that lack the necessary administrative capacity to implement domestic clean shipping legislation.

[3] International Maritime Organisation (2020). 'Fourth IMO greenhouse gas study'. Retrieved at: 20Study%202020%20Executive-Summary.pdf

[4] The European Union's ETS applies to European Economic Area (EEA) countries. Hence EU refers to EEA countries in this analysis.

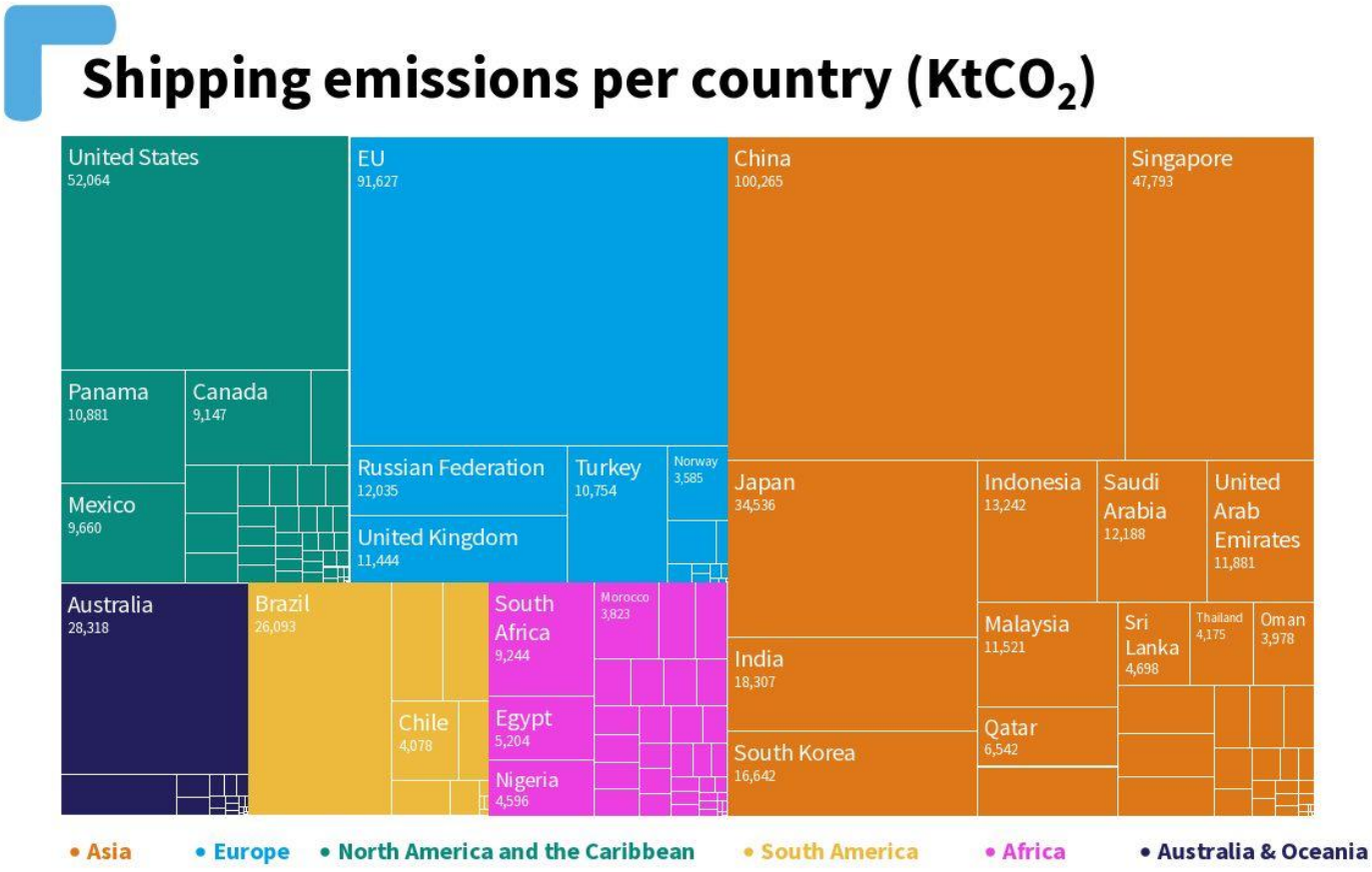

Figure 1: Global shipping emissions allocated per country based on voyages to and from each country

Looking instead at where the global shipping fleet calls provides a better representation of the impact of regional policy. Fig. 2 shows that 42% of the global fleet calls at EU ports and a total of 80% of the fleet calls at either China or the EU.[5] 53% of the fleet call either in the EU or the US, 67% call in the US or China and 75% of the fleet call in the 5 biggest Global North shipping blocs: the EU, USA, Japan, South Korea and Australia. Finally, 84% of the fleet call either in Europe (UK and the EU), the US or China. In other words, together **China, Europe and the US could decarbonise 84% of the global shipping sector if they implemented a zero emission mandate for ships calling at their ports.**

[5] This does not mean, for example, that only 38% of the global fleet calls in Chinese ports. In our analysis we first looked at ships that call in Europe, then we looked at the ships that did not call in Europe but did call in China to find a total of 80%. Ships that call in both China and Europe will therefore be included within the initial 42%.

Regional shipping laws can decarbonise the majority of global shipping without the IMO

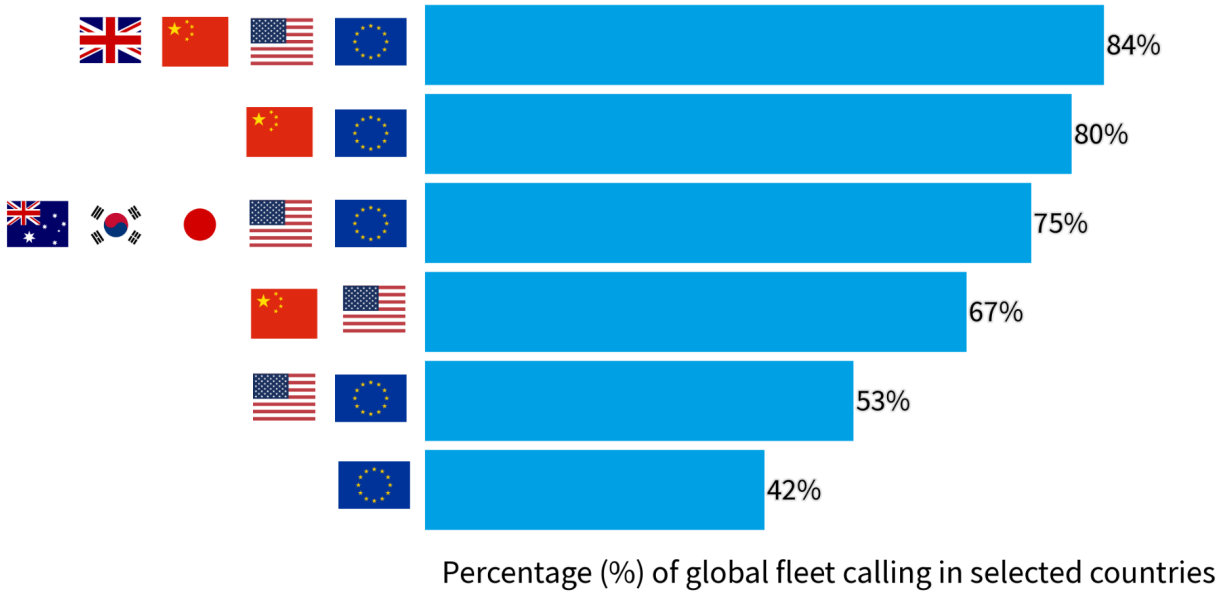

Figure 2: The percentage of the global shipping fleet that called in selected countries in 2019

It should be noted that a zero-emission mandate in these countries may not immediately lead to decarbonisation of 84% of the fleet. This relates in part to the geographical scope chosen by each jurisdiction. The European Commission, for instance, has only proposed to regulate 50% of emissions from international voyages. If the UK, China and the US replicate this approach, a significant amount of emissions would be addressed (40% as per Figure 1), but not the full 84% of the fleet that calls at those countries.

On the one hand, shipping companies could convert their ships and engines to zero-emission-ready fuels and technologies, but use 'drop-in' fossil fuels for unregulated voyages. On the other hand, mandating zero-emission shipping on this geographical scope would lead to significant knock-on effects. Not only would technical improvements on ships lead to emissions reduction throughout the world, but zero-emission technology and fuels would also receive massive investments, reducing their costs throughout the world.

Moreover, states may regulate a different geographical scope than the 50% scope proposed by the European Commission. Indeed, the EU itself regulates 100% of incoming and outgoing voyages under its Monitoring, Reporting and Verification (MRV) Regulation, while the European Parliament has proposed to regulate 100% of international voyages in the ETS from 2027 and both the European Parliament and the EU Council have proposed to regulate non-EU voyages, that is, voyages between nearby non-EU transhipment ports and other non-EU ports. 'Port state control' underpins the legality of these proposals and enables a state to, for example, impose penalties on ships calling at their ports that used a certain type of fuel any time in the previous calendar year.[6]

Turning to the impact on the Global South, the results show that developed countries can bear most of the burden without putting regulatory pressure on developing countries. If a few developed countries mandated zero-emission shipping, the Global South would avoid the administrative burden of policy implementation and enforcement.

4. Discussion

The results vindicate regional policy initiatives to decarbonise shipping and show clearly the path forward that national governments can take towards global shipping decarbonisation. Countries with administrative capacity - that is, the Global North and countries like China that have already developed an ETS - must mandate that ships calling at their ports report their emissions. The EU and UK's MRV system demonstrates the reliability of per-voyage monitoring. As the adage goes, 'what you monitor, you manage'. National pollution monitoring regulations will be the basis of global shipping decarbonisation.

Once the monitoring systems are in place, countries should implement decarbonisation measures on their share of shipping emissions (at least 50% on a per-voyage basis). These measures may take many forms: zero-emission mandates, fuel standards, subsidies for clean fuels, energy efficiency proposals, carbon pricing, carbon taxation, fuel taxation and more.

The UNFCCC will have an important coordination role in these measures. Firstly, it must urgently update its guidance to instruct states international shipping emissions within national emissions inventories. This means including shipping emissions within the Nationally Determined Contributions (NDCs) that states submit to the UNFCCC and agreeing on the 50% per-voyage scope for international shipping emissions as the accounting method. In accordance with the Paris Agreement, national accounting and reporting of these emissions will start with developed countries. The UNFCCC's role

[6] Opportunity Green (2022). 'Freedom to Regulate the High Seas'. Retrieved at: https://www.transportenvironment.org/wp-content/uploads/2022/03/Freedom-to-Regulate-the-High-Seas-Aoife-OLeary-2.pdf

should extend to facilitating knowledge-sharing as well as organising regular stocktakes to determine whether countries are reducing shipping emissions in line with the Paris Agreement targets.

Finally, there is a role of the IMO to play, but only once the uptake of green technologies and fuels has reached a critical mass (i.e. over 60% of fuel consumed). Developed countries that have taken shipping measures - so therefore have the regulatory and technical knowledge - should then codify a phase-out date for fossil fuels, setting global standards for zero-emission shipping.

5. Recommendations

- Developed nations must urgently put in place **per-voyage monitoring regulation for shipping emissions;**
- Countries should then **implement decarbonisation legislation** on their share of shipping emissions (at least 50% of incoming and outgoing voyages);
- The **UNFCCC** must clarify its guidance to state **unambiguously that international shipping is part of the Paris Agreement**, instruct nations to **report shipping emissions to the UNFCCC on a per-voyage basis** and organise **regular stocktakes on shipping decarbonisation**;
- Once shipping decarbonisation reaches critical mass, **the IMO should codify a global phase-out date** for shipping pollution.

Further information

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Appendix A: Methodology

The analysis on the global shipping fleet was conducted using ship automated identification system (AIS) data that includes time, speed-over-ground, draught and position information at hourly intervals over the course of 2019. The AIS data was obtained from ExactEarth, pre-treated by UMAS and the ICCT, and provided to T&E. Ship characteristics were acquired from the IHS Markit "Core Ships Database". We calculated ship CO_2 emissions with an in-house model which follows the methodology outlined in the Fourth IMO Greenhouse Gas Study[7], with the following key steps:

1. EEZ and ECA flags allocation
2. Port detection
3. Operational phase assignment
4. Voyage allocation
5. Emission calculation

We selected ships using the same criteria as the EU MRV, i.e. all cargo-carrying and passenger ships above 5000 gross tonnage (GT). Therefore, the initial dataset of 73,515 ship AIS files[8] was first filtered to cargo-carrying and passenger ships (45,542 ships), then to ships above 5,000 GT (29,928 ships). The selected ships represent 93% of in-service deadweight tonnage (DWT) in 2019 according to IHS Markit's database and 97% of the in-service DWT of ships above 5,000 GT.

We compared the results for global fleet emissions with IMO Fuel Oil Data Collection System (DCS) results. IMO has enacted a mandatory data collection and reporting system for vessels of 5,000 GT and above covering international voyages from 2019[9]. An analysis by Lloyd's List on IMO DCS 2019 data showed that 26,555 vessels emitted a total of 614 Mt[10]. While this value is comparable to our total of 665.4 Mt for 29,928 ships, which cover both domestic and international trips, the distribution of emissions in terms of different ship segments can be examined in Table 1. The highest difference between the two analyses for the ship type percentage distribution in total emissions is observed to be for the ro-ro passenger ships where our results assign a share of almost twofold for this ship type in

[7] IMO. (2020). Fourth IMO GHG Study 2020. International Maritime Organization (IMO): London.
[8] Corresponding to Type 1 and 2 vessels as defined in the Fourth Greenhouse gas study
[9] IMO MEPC 76/6/1. (2021). 'ENERGY EFFICIENCY OF SHIPS: Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption Database in GISIS (Reporting year: 2019)'. Retrieved at: https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC%2076-6-1%20-%202019%20report%20of%20Fuel%20Oil%20Consumption%20Data%20submitted%20to%20the%20IMO%20Ship%20Fuel%20Oil%20Consumption%20Database%20in%20GISIS.pdf
[10] Lloyd's List. (2021). 'Shipping's 'big three' account for almost 80% of CO2 emissions'. Retrieved at: https://lloydslist.maritimeintelligence.informa.com/LL1136035/Shippings-big-three-account-for-almost-80-of-CO2-emissions#:~:text=THE%20global%20shipping%20fleet%20emitted,by%20the%20International%20Maritime%20Organization

comparison to IMO DCS values. This can be explained with the fact that we include domestic voyages where trips by ro-ro passenger ships are more prevalent.

IMO DCS ship type	IMO DCS - share of total emissions	T&E - share of total emissions	T&E - ship count
Bulker	27.55%	21.75%	10761
Tanker	21.15%	24.37%	7401
Container	29.91%	27.79%	4934
Cruise	3.51%*	4.48%	295
Ro-ro passenger ships	1.58%	3.14%	722
LNG carrier + Gas carrier	7.94%	8.86%	1340
General cargo	3.26%	4.05%	2913
Vehicle carriers	3.13%	2.85%	791
Refrigerated cargo	0.71%	0.99%	286
Ro-ro cargo ships	1.21%	1.68%	472
Combination carrier	0.06%	-	-
Other liquids tanker	-	0%	13
Total CO_2 emission (Mt)	**614**	**665.4**	

Table 1: Distribution of emissions for different ship segments for T&E calculations and its comparison with IMO DCS reporting (ships of 5000 GT and above).
For comparison purposes ship type names were adjusted to the IMO DCS ship type and size categories in Lloyd's List analysis
** Cruise segment for IMO DCS covers "cruise passenger" and "passenger" ship percentages in Lloyd's List analysis*

We then aggregated ship emissions by voyage and then attributed them to countries following an "EU-like" half-scope MRV approach, meaning each country got assigned 100% of emissions from domestic voyages and port stops, and 50% from international voyages arriving at or departing from their ports (Fig.3). Emissions from voyages starting before Jan 1st, 2019, whose departure couldn't be deduced from 2019 AIS data and voyages ending after Dec 31st, 2019, whose arrival couldn't be deduced, were fully assigned to arrival and departure country, respectively. To obtain the number of ships that make a port call in each country, unique IMO values were counted per individual country.

The model was validated by comparing the emissions reported by ships under the EU MRV to the calculated values. Total calculated MRV full scope emissions were 1.3% below reported total, with good agreement on the main ship type totals (4.2% underestimation for container, 8.5%

overestimation for oil tankers, 15.4% underestimation for bulk carriers and 3.5% underestimation for ferry/Ro-pax).

Part of the difference between the EU MRV and emissions allocations as part of this analysis can be attributed to the difficulty of assigning a "port call" via the AIS data. The problem is not about the detection of the port, but rather the legal/policy consequences of ships stopping at ports. Specifically, under the EU MRV if a vessel makes a stop at a port to bunker fuel, that does not count as a "port call" under the legal definition of a "voyage" under the EU MRV. Therefore, ships include the preceding or the following legs of the journey to the EU-related voyages which has implications on the total emissions. It is very difficult to interpret from AIS which port stops are for refuelling and which stops are for cargo/passenger operations. As a result, given that refuelling stops could not be excluded from the voyage attribution in this analysis, there are some small differences between the EU MRV and this analysis. This also explains why Singapore is responsible for a huge share of emissions while the country plays a minor role in global production and trade.

Attribution of global shipping emissions to individual port states

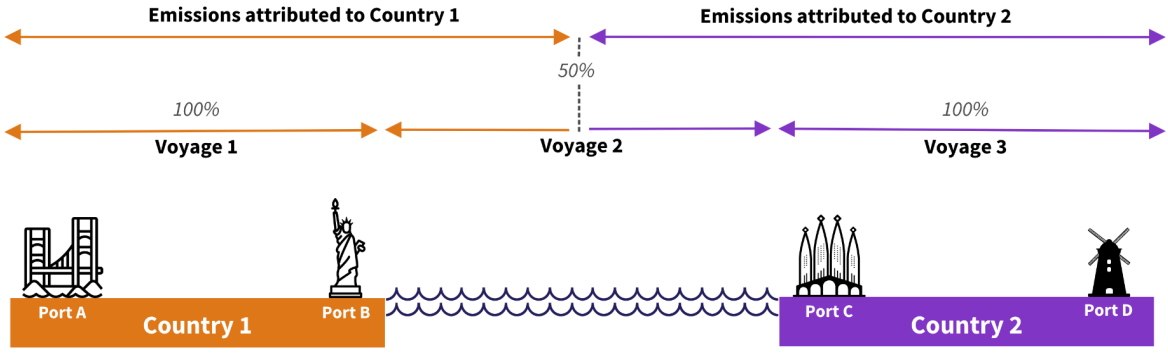

Figure 3: Attribution of global shipping emissions to individual port states