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Final report

The extension of the EU ETS 1 to maritime transport: market and policy mix analysis

An analysis of the new sector in the EU ETS 1

by:

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Abstract: The extension of the EU ETS 1 to maritime transport: market and policy mix analysis

This report analyses the qualitative effects and interaction of the integration of maritime transport in the EU Emissions Trading System (EU ETS 1) with other relevant policy instruments in the sector. The market analysis reveals the heterogeneity of the sector and its importance for the EU as a whole (i.e. exports and imports, employment). It is not expected that maritime transport's high share of traded goods will be impacted by the EU ETS 1 price level assumed in the impact assessment of the European Commission, which is lower than current and forecasted market prices. Nevertheless, the sector will face increasing costs, and together with other instruments (particularly the FuelEU Maritime Regulation) the transition to climate neutrality and necessary investments will be intensified. Part of the auction revenues raised via the EU ETS 1 are reinvested in the sector via the established EU Innovation Fund which, among others, provides dedicated support to accelerate the decarbonisation of the maritime sector. The design of the extension of the EU ETS 1 to maritime transport helps to reduce carbon leakage risks in the form of evasion port calls outside the European Economic Area (EEA), modal shifts, and transshipment. The environmental impact of the inclusion of maritime transport in the EU ETS 1 is deemed to be positive, especially in conjunction with other instruments and regulations of the 'Fit for 55' package.

Kurzbeschreibung: Die Ausweitung des EU-ETS 1 auf den Seeverkehr – Markt- und Policy-Mix-Analyse

Dieser Bericht analysiert die qualitativen Effekte und Wirkzusammenhänge der Integration des Seeverkehrs in den EU-Emissionshandel (EU-ETS 1) mit weiteren relevanten Politikinstrumenten des Sektors. Die Marktanalyse zeigt die Heterogenität des Sektors sowie seine Bedeutung für die EU als Ganzes (d.h. Exporte und Importe, Beschäftigung). Es ist nicht zu erwarten, dass der hohe Anteil des Seeverkehrs an den gehandelten Gütern durch das in der Folgenabschätzung der Europäischen Kommission angenommene Preisniveau im EU-ETS 1 reduziert wird, da dieses Niveau geringer ist als aktuelle und projizierte Preise. Nichtsdestotrotz wird der Sektor mit steigenden Kosten konfrontiert werden, und zusammen mit anderen Instrumenten (insbesondere der FuelEU Maritime Verordnung) werden der Übergang zur Klimaneutralität und die notwendigen Investitionen intensiviert werden. Ein Teil der Auktionserlöse aus dem EU-ETS 1 wird über den bestehenden EU-Innovationsfonds im Sektor reinvestiert, der unter anderem explizit den Hochlauf der Dekarbonisierung im maritimen Sektor unterstützt. Das Design der Integration des Seeverkehrs in den EU-ETS 1 trägt dazu bei, Carbon Leakage-Risiken in Form von Ausweichmanövern von Containerschiffen auf Häfen außerhalb des Europäischen Wirtschaftsraumes (EWR), Verkehrsverlagerungen („modal shifts“) und Güterumladungen zu verringern. Die Umweltauswirkungen der Integration des Seeverkehrs in den EU-ETS 1 werden als positiv eingeschätzt, insbesondere in Verbindung mit anderen Instrumenten und Verordnungen des Fit-for-55-Pakets.

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List of abbreviations

AFIR	Alternative Fuels Infrastructure Regulation
CII	Carbon Intensity Indicator
CoC	Certificate of competency
CH₄	Methane
CO₂	Carbon dioxide
DCS	Data Collection System
DWT	Deadweight tonnage
ECA	Emission Control Area
EEA	European Economic Area
EEDI	Energy Efficiency Design Index
EnergieStG	Energy Tax Act (Energiesteuerengesetz)
EEI	Energy Efficiency Existing Ship Index
EEZ	Exclusive Economic Zone
ESR	European Effort Sharing Regulation
ETD	Energy Taxation Directive
EU	European Union
EU ETS 1	European Union Emissions Trading System 1
FUEU	FuelEU Maritime Regulation
GHG	Greenhouse gas
GT	Gross Tonnage
HFO	Heavy Fuel Oil
IMO	International Maritime Organisation
LNG	Liquefied Natural Gas
MARPOL	International Convention for the Prevention of Pollution from Ships
MDO	Marine Diesel Oil
MEPC	Marine Environment Protection Committee
MGO	Marine Gas Oil
MRV	Monitoring, Reporting and Verification
Mt	Million tonnes
nEHS	German National Emissions Trading System
NM VOC	Non-methane volatile organic compounds
NO_x	Nitrogen oxides
N₂O	Nitrous oxide
OD	Origin-destination
PM	Particulate matter
RED	Renewable Energy Directive
RFNBOs	Renewable Fuels of Non-Biological Origin

Ro-Ro ship	Roll-on/roll-off ship
RoPax ship	Roll-on/roll-off passenger ship
SO_x	Sulphur oxides
TKM	Tonne-kilometres
TtW	Tank-to-Wake
VLSFO	Very Low Sulphur Fuel Oil
WtT	Well-to-Tank
WtW	Well-to-Wake

Summary

The shipping sector is an important sector for the European Union (EU) from an economic but also from a climate perspective. In 2022, the maritime transport emissions (of ships of 5,000 gross tonnage (GT) and above) in the EU amounted to 135.5 million tonnes (Mt) of CO₂, which corresponds to 4% of the total CO₂ emissions of the EU (EC 2024). The inclusion of this sector in EU climate regulations acknowledges the relevance of its emissions. Globally, total maritime shipping emitted 1,056 Mt CO₂ in total in 2018 (IMO 2020). Global emissions from total shipping are projected to rise up to 1,150 Mt CO₂ in 2030 and 1,300 Mt CO₂ in 2040 in business-as-usual scenarios.

The EU has set itself the goal of reducing total EU greenhouse gas (GHG) emissions by at least 55% by 2030 compared to 1990.¹ In order to achieve this goal, the EU adopted, among other measures, a revision of the rules for the European Union Emissions Trading System 1 (EU ETS 1) and extended it – besides other adjustments – to maritime transport from 2024 onwards as part of its ‘Fit for 55’ package (Directive (EU) 2023/959 2023). Before the agreement on the extension of EU ETS 1 to maritime transport and the FuelEU Maritime Regulation in 2023, GHG emissions of maritime transport were not covered by any EU legislation with the aim to reduce GHG emissions.

The extension of the EU ETS 1 to maritime transport not only required an amendment of the EU Emissions Trading Directive (Directive 2003/87/EC), but also an adjustment of the EU Monitoring, Reporting and Verification (MRV) Maritime Regulation (2015/757) (EU 2015; EU 2023). The EU MRV Maritime Regulation was agreed in 2015 with reporting starting in 2018 and applying to ships of and above 5,000 GT, transporting cargo and passengers for commercial purposes. While the EU MRV Maritime Regulation covers 100% of emissions from (maritime) voyages within and to/from the EU, the EU ETS 1 only covers 50% of emissions from all incoming and outgoing voyages (but also 100% of emissions at berth and between European Economic Area (EEA) ports).

Besides the EU ETS 1 extension to maritime transport, other legislation as part of the ‘Fit for 55’ package is also (potentially) relevant for the maritime sector: the FuelEU Maritime Regulation, the revised Alternative Fuel Infrastructure Regulation (AFIR), the proposal for the revision of the Energy Taxation Directive (ETD), and the revised Renewable Energy Directive (RED).

This report assesses the qualitative interrelationships of the inclusion of maritime transport in the EU ETS 1 through a market analysis of the sector and an analysis of other environmental policy instruments relevant for the sector. The focus is hereby on the economic and ecological impact of including maritime transport in the EU ETS 1 and the interaction with other policy measures.

Take-aways of the market analysis

The EU shipping sector plays an important role as more than a fourth of the world fleet capacity is owned by EU companies. Maritime transport accounted for the majority (70%) of the EU’s freight transport in terms of tonne-kilometres within the Exclusive Economic Zone (EEZ).

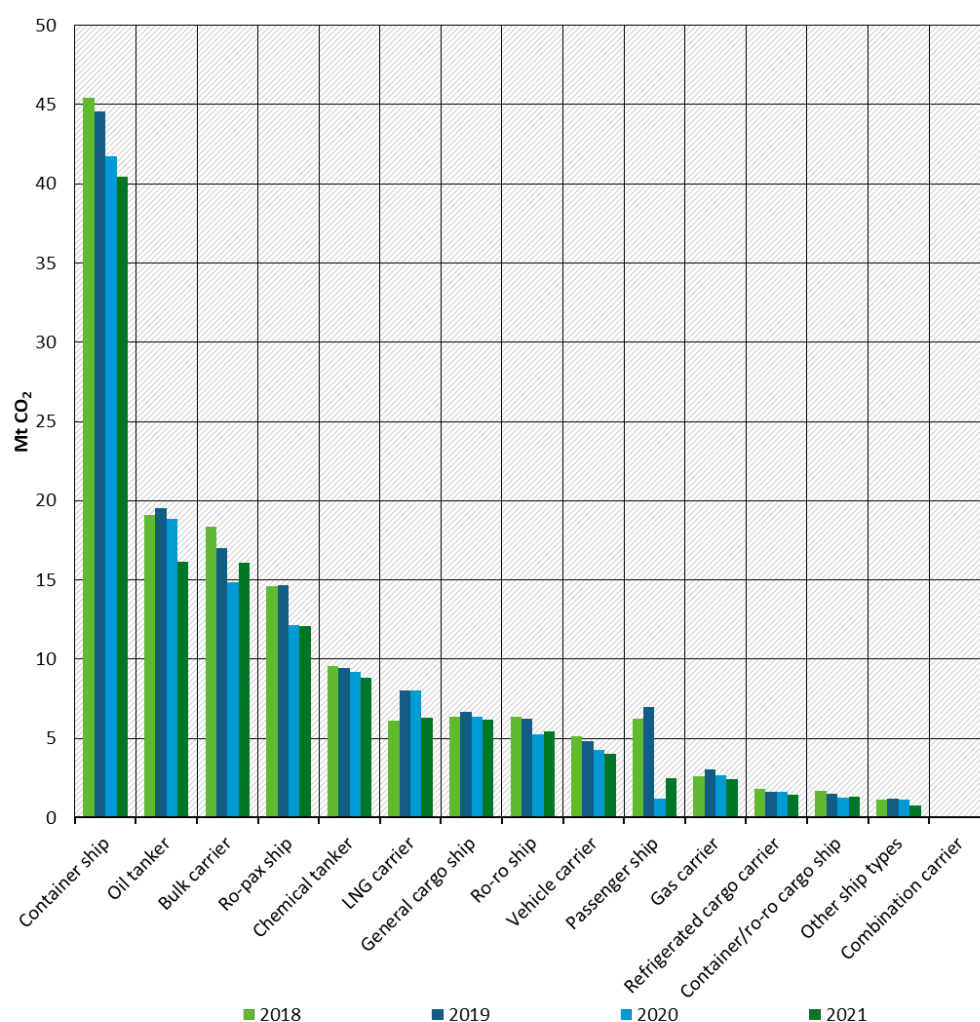
From an **economic and employment perspective**, the sector is also relevant. For example, in 2019, in the EU, directly employed were over 400,000 people in the total maritime transport sector, approximately additional 300,000 people in the shipbuilding and ship equipment/machinery sectors, and more than further 380,000 people in the ‘port activities sector’. The 2019 gross value added was estimated to amount to EUR 34.3 billion for the total EU

¹ EU 2030 climate targets: https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2030-climate-targets_en

maritime transport sector, EUR 15.6 billion for the shipbuilding and ship equipment/machinery sectors, and EUR 27.9 billion for the ‘port activities sector’. According to the European Commission, the EU is a global leader in the production of high-tech, advanced maritime equipment.

Aggregated CO₂ emissions vary highly between ship types – with container ships clearly having the highest share of the emissions in the EU fleet (Figure 1). Increased prices for maritime transport (due to the (increasing) emissions pricing of the EU ETS 1 or the cost of mitigation measures) may reduce demand for this transport mode. However, since the price elasticity of maritime transport demand could be considered low due to a lack of competitive alternatives, higher prices might be passed through and the impact on demand is likely to be small or even negligible.

Figure 1: Aggregated CO₂ emissions per ship type [Mt] of the EU fleet (EU MRV scope)



Source: EMSA – THETIS-MRV (2023)

The market analysis in this report shows that the **maritime shipping sector is a very heterogeneous sector** and the services provided by the different ships are part of many different value chains. Consequently, the composition of the fleet can be expected to vary during and over the years in a regional system like the EU ETS 1. However, as the analysis shows, there is still a relatively high degree of consistency between the reporting years, meaning that the MRV system is a good basis for tracking emissions and an indicator for activities under the EU ETS 1. The

extension of the EU ETS 1 to maritime transport currently covers **ships of 5,000 GT and above**. Ships of above 5,000 GT were estimated to account for approximately 55% of the number of ships calling at EU ports and to represent approximately 90% of the related emissions (2010 estimation). Furthermore, a review is planned to examine the possibility of extending the EU ETS 1 to **smaller ships** that means **ships below 5,000 but not below 400 GT**, after a previous respective extension of the EU MRV Maritime Regulation. More than 60% of the global fleet (by number) is smaller than 5,000 GT whereas this is the case for approximately 45% of the ships of the EU related fleet (2010 fleet estimation). The size distribution varies, however, depending on the ship type. For the ships and their activities that are not covered by the EU MRV Maritime Regulation (and currently the EU ETS 1), there is considerably less CO₂ emissions data available. Ships smaller than 5,000 GT account for approximately 15% of the total global CO₂ emissions from international shipping (2019 estimation); their share in the EU, however, amounts to only approximately 10% (2010 fleet estimation).

Compared to EU-related maritime shipping, the CO₂ emissions of **inland navigation** in Europe are relatively small. Inland navigation is a relatively energy efficient transport mode which is why the EU Commission also wants to stimulate a shift from road transport to inland navigation.² The vision of the German Environment Agency (UBA) for environmentally sustainable freight transport in Germany for 2045 also envisages a shift from road to rail and waterway.³ The inland fleet is, compared to the maritime fleet, less segmented in terms of ship types, but the number of shipping companies is comparably high, with the average company owning a small number of ships and employing a small number of people.

Take-aways of the policy analysis

The extension of the EU ETS 1 to maritime transport is implemented against the background of, on the one hand, several **existing climate-related maritime policies** and, on the other hand, other legislations, proposals, and revisions of the **'Fit for 55' package** as well as **existing and potential policies by the International Maritime Organisation (IMO)**.

At the **national level** (from a German perspective), the climate impact of shipping is not explicitly regulated. Fuels used in domestic shipping are exempt from energy tax and fossil fuels such as liquefied natural gas (LNG) are even subsidised. There are several funding programs that support the research and retrofitting of ships to run on alternative fuels, among other things. National shipping (national maritime transport and inland shipping) falls within the scope of the European Effort Sharing Regulation (ESR). In order to achieve its ESR target, Germany has introduced a national emissions trading system (nEHS) by 2021. The nEHS sets aggregated annual climate targets for the sectors not covered by the EU ETS 1, thus also for national shipping. However, the nEHS excludes commercial shipping, i.e. inland and maritime shipping, from pricing. There is thus no overlap or double burden with the EU ETS 1.

At **EU level**, there are several policies (as of end-2024) that address the climate impacts of shipping or at least interact with the extension of the EU ETS 1 to maritime transport. The EU Commission's proposal from 2021 on the extension of the EU ETS 1 to maritime transport was accompanied by an impact assessment (Budaragina et al. 2021). **The principal effects of the inclusion of maritime emissions in the EU ETS 1** were deemed to be positive with regards to the likely impact on GHG emissions, air pollution, and wider biodiversity benefits. These environmental benefits will be driven by operational changes and investments in new abatement options that have been financially incentivised by the inclusion of maritime transport

² https://transport.ec.europa.eu/document/download/be22d311-4a07-4c29-8b72-d6d255846069_en?filename=2021-mobility-strategy-and-action-plan.pdf

³ <https://www.umweltbundesamt.de/publikationen/heavy-freight-big-challenge-one-goal>

in the EU ETS 1. It has to be noted that the EU ETS 1 is part of a wider policy mix and is not the only measure to trigger emission reductions. The fact that the carbon price is expected to be significantly higher than what was assumed in the impact assessment (46 EUR/tCO₂ in 2030) could lead to higher costs and a higher risk of evasion than suggested in the impact assessment. However, this may be offset to a certain extent by faster than expected progress on decarbonisation with higher levels of investment in abatement in response to the price signal of the EU ETS 1 – which is the intention of carbon pricing. Further, to address the risk of evasion, the revised EU ETS Directive includes provisions such as excluding nearby transshipment ports⁴ and using revenues for decarbonising maritime transport.

The **integration of maritime transport in the EU ETS 1** also induces an **interaction** with the GHG mitigation efforts in the other sectors of the EU ETS 1, namely **aviation and stationary installations in the energy and industry sectors**. Except for some operational and technical efficiency measures (such as slow steaming, wind assistance, and air lubrication systems), the maritime sector is likely to rely on the purchase of allowances in the first years of the integration in the EU ETS given the current EU ETS 1 prices. According to IMO (2020), the marginal abatement costs for a complete decarbonisation of maritime transport amount to more than 400 EUR/tCO₂, mainly due to the high prices for renewable fuels of non-biological origin (RFNBOs). However, as already mentioned, carbon pricing via the EU ETS 1 is not the only policy instrument that incentivises abatement options. Other policies, like the **FuelEU Maritime Regulation**, will have a big impact on in-sector mitigation. Within the EU ETS 1, however, the bulk of emission reductions are initially rather expected to take place in other EU ETS 1 sectors. Before the adoption of the REDIII, mandates for renewable energy use only applied to road and rail transport under REDIII whereby the aviation and shipping sector could contribute to the transport sector target.

On the **global level**, policies have been adopted by the **IMO** that affect GHG emissions from international shipping worldwide and can thus also affect emissions from maritime transport covered by the EU ETS 1. For example, the IMO has adopted several mandatory policies regarding the energy efficiency of ships (Lloyd's Register 2020). Furthermore, Member States of the IMO agreed to implement a mid-term measure consisting of a technical element (a goal-based fuel standard) and an economic element (a carbon pricing mechanism yet to be defined in 2025). It has to be noted that the introduction of an emissions trading system, similar to the EU ETS 1, is unlikely at the global level based on the submissions to and discussions at the Marine Environment Protection Committee (MEPC). The ETS Directive already foresees a revision of the EU ETS 1 in case the IMO adopts a global market-based measure. If the IMO will not adopt a global market-based measure by 2028 which is in line with the goals of the Paris Agreement, the EU will review an extension of the geographical scope for maritime transport in the EU ETS 1 to more than 50% of emissions from all incoming and outgoing voyages.

The following **interaction effects** are expected of the extension of the EU ETS 1 to maritime transport:

- ▶ **FuelEU Maritime Regulation**: this provides a complementary (but stronger) incentive;
- ▶ **Energy Taxation Directive**: this generates additional (weaker) carbon pricing with different coverage;

⁴ Non-Union ports within 300 nautical miles of a member state port, with a significant share of transshipment of the total container traffic, are excluded from the port of call definition to reduce the risk of evasion (Article 3(wa), 3g) of the revised ETS directive). This concerns two ports as of October 2023: East Port Said (Egypt), Tanger Med (Marocco). Implementing Regulation (EU) 2023/2297: <https://www.ecosia.org/search?tt=mzl&q=COMMISSION%20IMPLEMENTING%20REGULATION%20%28EU%29%202023%2F2297%20>

- ▶ Alternative Fuel Infrastructure Regulation: this can provide better conditions for EU ETS 1 compliance;
- ▶ Renewable Energy Directive: this sets the fuel framework and parallel accounting of RFNBO towards goals;
- ▶ Effort Sharing Regulation: this sets reduction targets for parts of shipping not covered by EU ETS 1;
- ▶ IMO: carbon pricing mechanism (yet to be implemented): future potential overlap or double burden has to be resolved.

Outlook

The market analysis reveals the heterogeneity of the maritime transport sector as well as its importance for the EU (i.e. exports and imports, employment). Further research could examine more closely how the different shipping segments would be impacted by increasing EU ETS 1 prices, for example if different mitigation measures were incentivised in different segments and if services provided were impacted differently across segments. Although there are numerous, **smaller ships (below 5,000 GT)**, they contribute to a lesser extent to EU shipping emissions. More data from an extension of the EU MRV Maritime Regulation would allow for a more thorough impact assessment of smaller ships. Further, a detailed modelling of this segment could provide a more comprehensive picture of the environmental and economic impact of including smaller ships in the EU ETS 1.

Shipping is the dominant mode for importing goods to and exporting goods from the EU. Considering the final design of the EU ETS 1 extended to maritime transport and the accompanying impact assessment, the **risk for carbon leakage** from the EU ETS 1 can nevertheless be expected to be small (especially in the near term). However, the 2030 carbon price assumed in the impact assessment was set at only 46 EUR/t. Given that this carbon price is lower than current market prices, it is possible that the risk of carbon leakage may have been underestimated. Nevertheless, the European Commission's impact assessment expects the risk of carbon leakage in the form of evasion port calls, modal shifts, and transshipment to increase as the carbon price increases up to 2040. The risk that ships use alternative non-EU transshipment ports is significantly decreased by excluding nearby transshipment ports from the port of call definition under the EU ETS 1. If small ships are exempt, a shift towards smaller ships, at least for the purpose of short sea shipping might also occur. For the ship types/sizes that fall under the scope of the EU ETS 1, additional costs accrue, independent of the flag of the ship, leading to a level playing field on routes to/from the EEA. Only for seaborne EU exports that have to compete on markets outside the EU with non-EU products, the EU ETS 1 as a regional scheme might lead to market distortions. The impact of an **increase of the transportation costs** on freight rates and product costs can differ highly between segments and markets. In general, the impact on product prices is expected to be higher for products with a low per tonne value.

There is a large number of inland shipping companies, with the average company owning a small number of ships and employing a small number of people. The latter might be an argument for including the **inland navigation sector** in the new **EU ETS 2** (along with road transport and buildings), which entails an **upstream approach** whereby not the polluter, but rather the fuel supplier would pay the carbon costs in the first instance, thereby reducing the administrative costs.

It is not expected that the high share of traded goods in the maritime transport sector will be impacted by the EU ETS 1 price assumed in the impact assessment, which is lower than current

and forecasted market prices. Nevertheless, the sector will face increasing costs and in conjunction with other policy measures (particularly the FuelEU Maritime Regulation), the transition to climate neutrality and necessary investments will be intensified. Part of the auction revenues raised via the EU ETS 1 are reinvested via the **EU Innovation Fund** which, among others, provides dedicated support to accelerate the decarbonisation of the maritime sector. The FuelEU Maritime Regulation and the extension of the EU ETS 1 to maritime transport combined will have a significant impact on the sector's emissions. Other parts of the 'Fit for 55' package will also impact the maritime sector but to a smaller extent than these two policies. The environmental impact of the EU ETS 1 is deemed to be positive, especially in conjunction with other 'Fit for 55' legislation and proposals. Global policies, likely a goal-based marine fuel standard in combination with an economic element, are in the pipeline at **IMO**. Their exact design and thus the interaction or overlap with EU policies are still to be determined. However, the two most important new EU policies for shipping already have procedures in place in case the IMO adopts further (ambitious) measures.

Zusammenfassung

Der Schifffahrtssektor ist für die Europäische Union (EU) nicht nur aus wirtschaftlicher, sondern auch aus klimatischer Sicht ein wichtiger Sektor. Im Jahr 2022 beliefen sich die Emissionen des Seeverkehrs (Schiffe mit 5.000 BRZ und mehr) in der EU auf 135,5 Millionen Tonnen (Mt) CO₂, was 4% der gesamten CO₂-Emissionen der EU entspricht (EC 2024). Die Einbeziehung des Sektors in die EU-Klimaregulierungen erkennt die Relevanz seiner Emissionen an. Global emittierte der gesamte Seeverkehr 1.056 Mt CO₂ im Jahr 2018 (IMO 2020). In Business-as-usual-Szenarien wird projiziert, dass die globalen Emissionen des gesamten Seeverkehrs in den Jahren 2030 und 2040 jeweils auf bis zu 1.150 Mt CO₂ und 1.300 Mt CO₂ steigen.

Die EU hat sich selbst das Ziel gesetzt, die gesamten EU Treibhausgasemissionen (THG-Emissionen) bis 2030 um mindestens 55% gegenüber 1990 zu senken. Um dieses Ziel zu erreichen, hat die EU unter anderem eine Überarbeitung der Regeln des Europäischen Emissionshandelssystems (EU-ETS 1) angenommen und es – neben anderen Anpassungen – als Teil des Fit-for-55-Pakets (Directive (EU) 2023/959 2023) auf den Seeverkehr ab dem Jahr 2024 ausgeweitet. Vor der Einigung über die EU-ETS 1 Ausweitung auf den Seeverkehr und die FuelEU-Maritime-Verordnung im Jahr 2023 waren die THG-Emissionen des Seeverkehrs von keiner EU-Regulierung mit dem Ziel der THG-Emissionsminderung erfasst.

Die Ausweitung des EU-ETS 1 auf den Seeverkehr erforderte nicht nur eine Änderung der EU-Emissionshandelsrichtlinie (Richtlinie 2003/87/EG), sondern auch eine Anpassung der EU-Verordnung über die Überwachung, Berichterstattung und Überprüfung (EU-MRV) im Seeverkehr (2015/757) (EU 2015). Die EU-MRV-Verordnung für den Seeverkehr wurde im Jahr 2015 beschlossen mit Start der Berichterstattung im Jahr 2018 und Schiffe mit 5.000 BRZ und mehr betreffend, die Fracht und Passagiere zu kommerziellen Zwecken transportieren. Während die EU-MRV-Seeverkehrsverordnung 100% der Emissionen aus (See-)Fahrten innerhalb der EU und in die/aus der EU abdeckt, deckt das EU-ETS 1 nur 50% aller Emissionen von ein- und ausgehenden Fahrten ab (sowie 100% der Emissionen im Hafen und von Seefahrten zwischen Häfen im Europäischen Wirtschaftsraum (EWR)).

Neben der Ausweitung des EU-ETS 1 auf den Seeverkehr sind auch andere Rechtsvorschriften des Fit-for-55-Pakets (potenziell) für den Seeverkehr relevant: die FuelEU-Maritime-Verordnung, die überarbeitete Verordnung über die Infrastruktur für alternative Kraftstoffe (AFIR), die Überarbeitung der Energiesteuerrichtlinie (ETD) und die überarbeitete Richtlinie über erneuerbare Energien (RED).

Dieser Bericht bewertet die qualitativen Zusammenhänge der Einbeziehung des Seeverkehrs in das EU-ETS 1 durch eine Marktanalyse des Sektors und eine Analyse der umweltpolitischen Instrumente, die für diese Sektor relevant sind. Der Schwerpunkt liegt dabei auf den wirtschaftlichen und ökologischen Auswirkungen der Einbeziehung des Seeverkehrs in das EU-ETS 1- auch im Zusammenspiel mit anderen politischen Maßnahmen.

Schlussfolgerungen aus der Marktanalyse

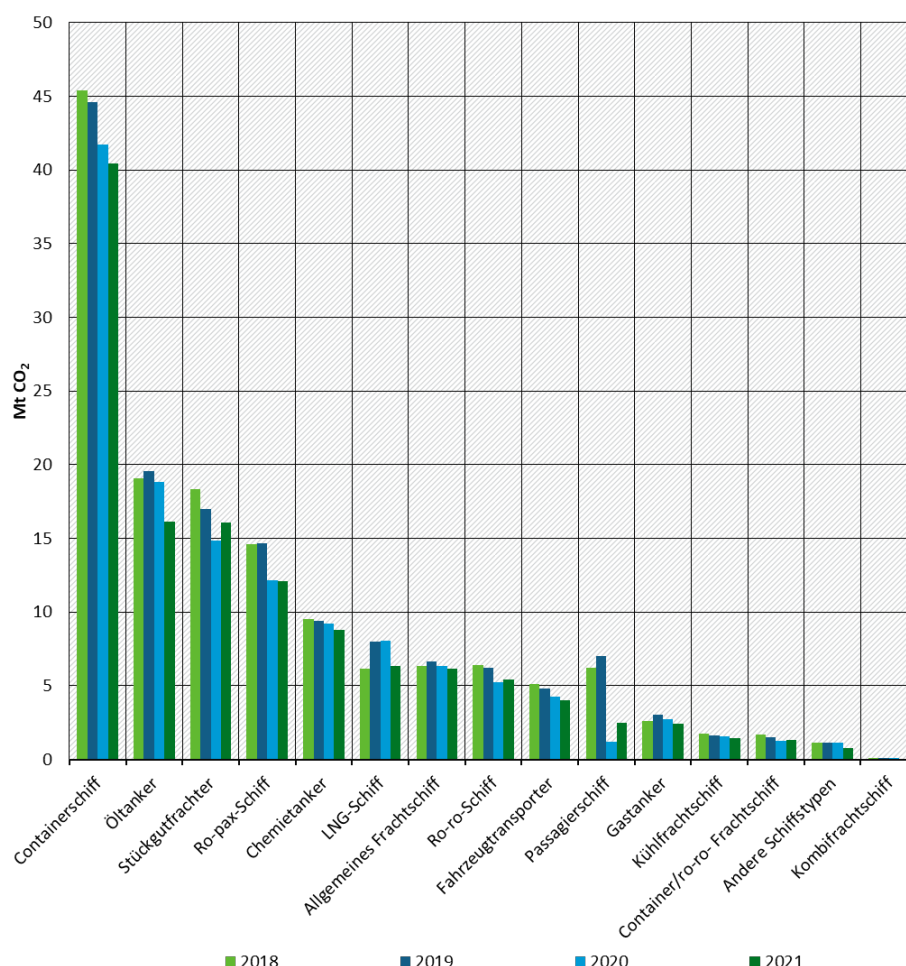
Der EU-Schifffahrtssektor spielt eine wichtige Rolle, da fast ein Viertel der Weltflottenkapazität im Besitz von EU-Unternehmen ist. Gemessen an den Tonnenkilometern innerhalb der Ausschließlichen Wirtschaftszone (AWZ) macht der Seeverkehr den größten Teil (70 %) des Güterverkehrs in der EU aus.

Auch aus **wirtschaftlicher und beschäftigungspolitischer Sicht** ist der Sektor von Bedeutung. So waren im Jahr 2019 im gesamten Seeverkehrssektor in der EU über 400.000 Personen, etwa zusätzliche 300.000 Personen in Schiffbau und Schiffsausrüstung/Maschinen, und über weitere 380.000 Personen im Zusammenhang mit Hafentätigkeiten beschäftigt. Die

Bruttowertschöpfung 2019 wurde auf 34,3 Milliarden EUR für den gesamten maritimen Sektor der EU, 15,6 Milliarden EUR für Schiffbau und Schiffsausrüstung/Maschinen, und 27,9 Milliarden EUR im Zusammenhang mit Hafentätigkeiten geschätzt. Laut der EU-Kommission ist die EU weltweit führend in der Produktion von hochtechnologischer, fortschrittlicher Schiffsausrüstung.

Die aggregierten CO₂-Emissionen variieren stark zwischen den einzelnen Schiffstypen, wobei Containerschiffe eindeutig den höchsten Anteil an den Emissionen der EU-Flotte haben (Abbildung 1). Erhöhte Preise für den Seeverkehr (aufgrund der (steigenden) Emissionsbepreisung durch den EU-ETS 1 oder der Kosten für Klimaschutzmaßnahmen) können die Nachfrage verringern. Da jedoch die Preiselastizität der Seeverkehrsnachfrage aufgrund fehlender wettbewerbsfähiger Alternativen in der Regel für gering eingeschätzt werden könnte, können höhere Preise weitergegeben werden, so dass die Auswirkungen auf die Nachfrage gering oder sogar vernachlässigbar sein dürften.

Abbildung 1: Aggregierte CO₂-Emissionen pro Schiffstyp [Mt] in der EU-Flotte (EU MRV Anwendungsbereich)



Quelle: EMSA – THETIS-MRV (2023)

Die Marktanalyse in diesem Bericht hat gezeigt, dass der **Seeschiffverkehrssektor ein sehr heterogener Sektor** ist und die Dienstleistungen der verschiedenen Schiffe Teil vieler verschiedener Wertschöpfungsketten sind. Folglich ist davon auszugehen, dass die Zusammensetzung der Flotte in einem regionalen System wie dem EU-ETS 1 während und über die Jahre hinweg variiert. Wie die Analyse zeigt, gibt es jedoch immer noch ein relativ hohes Maß

an Übereinstimmung zwischen den Berichtsjahren - was bedeutet, dass das MRV-System eine gute Grundlage und ein guter Indikator für Aktivitäten im EU-ETS 1 ist. Das auf den Seeverkehr ausgeweitete EU-ETS 1 deckt derzeit **Schiffe mit 5.000 BRZ und mehr** ab. Schiffe über 5.000 BRZ machen circa 55% der Schiffe aus, die EU-Häfen anlaufen, und verursachen rund 90% der damit verbundenen Emissionen (basierend auf 2010er Werten). Es ist jedoch eine Überprüfung geplant, um die Möglichkeit einer Ausweitung des EU-ETS 1 auf **kleinere Schiffe**, also **Schiffe unter 5.000 BRZ aber nicht unter 400 BRZ**, zu untersuchen, nachdem zuvor eine entsprechende Ausweitung der EU-MRV-Seeverkehrsverordnung erfolgt war. Derzeit ist mehr als 60% der weltweiten Flotte (nach Anzahl) kleiner als 5.000 BRZ während es in der EU bei etwa 45% der Fall sind (Schätzung basierend auf der Flotte des Jahres 2010). Die Größenverteilung variiert jedoch je nach Schiffstyp. Für die Schiffe und ihre Tätigkeiten, die nicht unter die MRV-Verordnung der EU für den Seeverkehr (und derzeit unter das EU-ETS 1) fallen, sind wesentlich weniger CO₂-Emissionsdaten verfügbar. Schiffe mit weniger als 5.000 BRZ sind für circa 15% der gesamten weltweiten CO₂-Emissionen des internationalen Seeverkehrs verantwortlich (Schätzung basierend auf dem Jahr 2019), während der Anteil in der EU nur etwa 10% beträgt (Schätzung basierend auf dem Jahr 2010).

Im Vergleich zur EU-Seefahrt sind die CO₂-Emissionen der **Binnenschifffahrt** in Europa relativ gering. Die Binnenschifffahrt ist ein relativ energieeffizienter Verkehrsträger, weshalb die EU-Kommission auch eine Verlagerung vom Straßenverkehr auf die Binnenschifffahrt anregen will.⁵ Die Vision des Umweltbundesamtes (UBA) für einen umweltschonenden Güterverkehr in Deutschland in 2045 sieht auch eine Verlagerung von der Straße zur Schiene und Binnenschifffahrt vor. Die Binnenschifffahrtsflotte ist im Vergleich zur Seeschifffahrt weniger stark nach Schiffstypen segmentiert, aber die Zahl der Schifffahrtsunternehmen ist vergleichsweise hoch, wobei das durchschnittliche Unternehmen nur wenige Schiffe besitzt und eine geringe Zahl von Mitarbeitern beschäftigt.

Schlussfolgerungen aus der politischen Analyse

Die Ausweitung des EU-ETS 1 auf den Seeverkehr wird vor dem Hintergrund einiger **existierender, klimabezogener Politiken** auf der einen Seite und anderer Politiken, Vorschläge und Revisionen des **Fit-for-55 Pakets** sowie **existierenden und potenziellen Maßnahmen der Internationalen Seeschifffahrts-Organisation (IMO)** auf der anderen Seite umgesetzt.

Auf **nationaler Ebene** (aus deutscher Sicht) sind die Klimaauswirkungen der Schifffahrt nicht ausdrücklich geregelt. Die in der nationalen Schifffahrt verwendeten Kraftstoffe sind von der Energiesteuer befreit und fossile Kraftstoffe wie Flüssigerdgas (LNG) werden sogar subventioniert. Allerdings gibt es mehrere Förderprogramme, die unter anderem die Forschung und die Nachrüstung von Schiffen unterstützen. Die nationale Schifffahrt (nationaler Seeverkehr und Binnenschifffahrt) fällt in den Geltungsbereich der europäischen Lastenteilungsverordnung (ESR). Um sein ESR-Ziel zu erreichen, hat Deutschland das nationale Emissionshandelssystem (nEHS) ab 2021 eingeführt. Das nEHS legt aggregierte jährliche Klimaziele für Sektoren fest, die nicht unter das EU-ETS 1 fallen - also auch für die nationale Schifffahrt. Allerdings schließt das nEHS die gewerbliche Schifffahrt, also die Binnen- und Seeschifffahrt, von der Preisgestaltung aus. Es gibt daher keine Überlappung oder Doppelbelastung mit dem EU-ETS 1.

Auf **EU-Ebene** gibt es (Stand Ende 2024) mehrere Politiken, die die Klimawirkung der Schifffahrt adressieren oder zumindest mit der Ausweitung des EU-ETS 1 auf den Seeverkehr interagieren. Der Vorschlag der EU-Kommission zur Ausweitung des EU-ETS 1 auf den

⁵ https://transport.ec.europa.eu/document/download/be22d311-4a07-4c29-8b72-d6d255846069_en?filename=2021-mobility-strategy-and-action-plan.pdf

Seeverkehr aus dem Jahr 2021 wurde von einer Folgenabschätzung begleitet (Budaragina et al. 2021). **Die grundsätzlichen Auswirkungen der Einbeziehung der Emissionen aus dem Seeverkehr in das EU-Emissionshandelssystem** wurden im Hinblick auf die wahrscheinlichen Auswirkungen auf die Treibhausgasemissionen, die Luftverschmutzung und die biologische Vielfalt im weiteren Sinne als positiv bewertet. Diese Umweltvorteile werden durch betriebliche Veränderungen und Investitionen in neue Vermeidungsoptionen erzielt, für die durch die Einbeziehung des Seeverkehrs in das EU-ETS 1 finanzielle Anreize geschaffen worden sind. Es ist jedoch anzumerken, dass das EU-ETS 1 Teil eines umfassenderen Politikmixes und nicht die einzige Maßnahme ist, die Emissionsreduzierungen anreizt. Die Tatsache, dass der Kohlenstoffpreis voraussichtlich deutlich höher sein wird als in der Folgenabschätzung angenommen (46 EUR/tCO₂ in 2030), könnte zu höheren Kosten und einem höheren Umgehungsrisiko führen als in der Folgenabschätzung angenommen. Dies könnte jedoch bis zu einem gewissen Grad durch schneller als erwartete Fortschritte bei der Dekarbonisierung mit höheren Investitionen in Emissionsminderungen als Reaktion auf das Preissignal des ETS ausgeglichen werden – welches die Intension von CO₂-Bepreisung ist. Um der Gefahr der Umgehung entgegenzuwirken, enthält die überarbeitete EU-ETS-Richtlinie außerdem Bestimmungen wie den Ausschluss nahe gelegener Umschlagshäfen und die Verwendung von Einnahmen für die Dekarbonisierung des Seeverkehrs.

Die **Einbeziehung des Seeverkehrs in das EU-ETS 1** führt auch zu einer **Wechselwirkung** mit den Bemühungen zur Verringerung der THG-Emissionen in den anderen Sektoren des EU-ETS 1 (**Luftverkehr und stationäre Anlagen im Industrie- und Energiesektor**). Abgesehen von einigen betrieblichen und technischen Effizienzmaßnahmen (wie z. B. Slow Steaming, Windunterstützung und Luftschmiersysteme) wird der Seeverkehrssektor angesichts der aktuellen ETS 1-Preise wahrscheinlich in den ersten Jahren der ETS-Einbeziehung auf den Kauf von Emissionsberechtigungen angewiesen sein. Laut IMO (2020) liegen die Grenzvermeidungskosten für eine vollständige Dekarbonisierung des Seeverkehrs bei über 400 EUR/tCO₂, vor allem aufgrund der hohen Preise für erneuerbare Kraftstoffe nicht-biologischen Ursprungs (RFNBOs). Die Bepreisung von Kohlenstoff durch das ETS ist jedoch, wie zuvor genannt, nicht das einzige politische Instrument, das Anreize für Vermeidungsoptionen bietet. Andere politische Maßnahmen, wie die **FuelEU-Maritime-Verordnung**, werden einen großen Einfluss auf die sektorinterne Emissionsminderung haben. Innerhalb des ETS wird der Großteil der Emissionsminderungen jedoch zunächst eher in anderen EU-ETS-1-Sektoren erwartet. Vor der Verabschiedung der REDIII-Richtlinie galten Mandate für die Nutzung erneuerbarer Energien nur für den Straßen- und Schienenverkehr im Rahmen der REDIII-Richtlinie, wobei der Luft- und Seeverkehrssektor einen Beitrag zum Ziel des Verkehrssektors leisten konnte.

Auf **globaler Ebene** hat die **IMO** politische Maßnahmen verabschiedet, die sich auf die THG-Emissionen des weltweiten Seeverkehrs und somit auch auf die Emissionen des Seeverkehrs unter dem EU-ETS 1 auswirken können. So hat die IMO beispielsweise mehrere verbindliche Richtlinien zur Energieeffizienz von Schiffen verabschiedet (Lloyd's Register 2020). Darüber haben sich die Mitgliedstaaten der IMO auf die Einführung einer mittelfristigen Maßnahme in 2025 geeinigt, die aus einem technischen Element (eine zielbasierte Kraftstoffnorm) und einem ökonomischen Element (ein (noch zu definierender) Kohlenstoffpreismechanismus) besteht. Es ist anzumerken, dass die Einführung eines Emissionshandelssystems, ähnlich dem EU-ETS 1, auf globaler Ebene unwahrscheinlich ist, wenn man die Einreichungen und Diskussionen im Marine Environment Protection Committee (MEPC) betrachtet. Die ETS-Richtlinie sieht bereits eine Überarbeitung des EU-ETS 1 für den Fall vor, dass die IMO eine globale marktorientierte Maßnahme beschließt. Sollte die IMO bis 2028 keine globale marktorientierte Maßnahme verabschieden, die mit den Zielen des Pariser Übereinkommens in Einklang steht, wird die EU

eine Ausweitung des geografischen Anwendungsbereichs für den Seeverkehr des EU-ETS 1 auf mehr als 50 % der Emissionen aller ein- und ausgehenden Fahrten prüfen.

Die Ausweitung des EU-ETS 1 auf den Seeverkehr dürfte vor allem die folgenden

Interaktionsauswirkungen haben:

- ▶ FuelEU-Maritime-Verordnung – diese schafft einen ergänzenden (aber stärkeren) Anreiz,
- ▶ Energiesteuerrichtlinie – diese generiert eine zusätzliche (schwächere) Kohlenstoffbepreisung mit unterschiedlichem Geltungsbereich,
- ▶ Alternative Fuel Infrastructure Verordnung – diese kann bessere Bedingungen für die Einhaltung des EU-ETS 1 schaffen,
- ▶ Erneuerbare-Energien-Richtlinie – diese legt den Rahmen für Brennstoffe und die parallele Anrechnung von RFNBO auf die Ziele fest,
- ▶ Lastenteilungsverordnung – diese legt Reduktionsziele für Teile der Schifffahrt fest, die nicht unter das EU-ETS 1 fallen,
- ▶ IMO Kohlenstoffpreismechanismus (noch einzuführen) – mögliche zukünftige Überschneidungen müssen gelöst werden.

Ausblick

Eine Marktanalyse zeigt die Heterogenität des Seeverkehrssektors sowie seine Bedeutung für die EU (d. h. Exporte und Importe, Beschäftigung). In weiteren Untersuchungen könnte genauer untersucht werden, wie sich eine Erhöhung der ETS-Preise auf die verschiedenen Schifffahrtssegmente auswirken würde, z. B. ob in den verschiedenen Segmenten Anreize für unterschiedliche Minderungsmaßnahmen geschaffen würden und ob die Transportarbeit in den einzelnen Segmenten unterschiedlich beeinflusst würde. Obwohl sie zahlreich sind, tragen **kleinere Schiffe (unter 5.000 BRZ)** in geringerem Maße zu den EU-Schiffsemissionen bei. Mehr Daten aus einer Erweiterung der EU-MRV-Seeverkehrsverordnung würden eine gründlichere Folgenabschätzung für kleinere Schiffe ermöglichen. Darüber hinaus könnte eine detaillierte Modellierung dieses Segments ein umfassenderes Bild von den ökologischen und wirtschaftlichen Auswirkungen der Einbeziehung kleinerer Schiffe in das EU-ETS 1 vermitteln.

Der Seeverkehr ist der wichtigste Verkehrsträger für die Ein- und Ausfuhr von Waren in die und aus der EU. Da die Schifffahrt ein so wichtiges Handelszentrum ist, kann in Anbetracht der endgültigen Ausgestaltung des EU-ETS 1 für den Seeverkehr und der begleitenden Folgenabschätzung davon ausgegangen werden, dass das **Risiko einer Verlagerung von CO₂-Emissionen** aus dem Emissionshandelssystem (insbesondere kurzfristig) gering ist. Allerdings wurde der in der Folgenabschätzung angenommene Kohlenstoffpreis für 2030 auf nur 46 EUR/t festgesetzt. Da dieser Kohlenstoffpreis unter den derzeitigen Marktpreisen liegt, ist es möglich, dass das Risiko der Verlagerung von CO₂-Emissionen unterschätzt worden ist. Dennoch geht die Folgenabschätzung der EU-Kommission davon aus, dass das Risiko der Verlagerung von CO₂-Emissionen in Form von Ausweichhäfen, Verkehrsverlagerungen und Umladungen zunehmen wird, wenn der Kohlenstoffpreis bis 2040 teurer wird. Das Risiko, dass Schiffe alternative Umschlagshäfen außerhalb der EU anlaufen, wird deutlich verringert durch den Ausschluss naher Umschlagshäfen als Hafenanläufe im EU-ETS 1 zu zählen. Wenn kleine Schiffe ausgenommen werden, könnte es zumindest im Kurzstreckenseeverkehr zu einer Verlagerung auf kleinere Schiffe kommen. Für die Schiffstypen/Größen, die unter das EU-ETS 1 fallen, fallen unabhängig von der Flagge des Schiffes zusätzliche Kosten an, was zu gleichen Wettbewerbsbedingungen auf den Routen in die/aus der EWR führt. Nur für EU-Ausfuhren auf

dem Seeweg, die auf Märkten außerhalb der EU mit Nicht-EU-Produkten konkurrieren müssen, könnte das EU-ETS 1 als regionales System zu Marktverzerrungen führen. Die Auswirkungen eines **Anstiegs der Transportkosten** auf die Frachtraten und Produktkosten können je nach Segment und Markt sehr unterschiedlich sein. Im Allgemeinen dürften sich die Auswirkungen auf die Produktpreise bei Produkten mit einem niedrigen Tonnenwert stärker bemerkbar machen.

Es gibt eine große Anzahl an Unternehmen in der Binnenschifffahrt, wobei Unternehmen durchschnittlich eine geringe Anzahl von Schiffen besitzt und nur wenige Mitarbeiter beschäftigt. Letzteres könnte ein Argument für die **Einbeziehung der Binnenschifffahrt** in das neue **EU-ETS 2** (zusammen mit dem Straßenverkehr und Gebäuden) sein, welches einen „**Upstream**“-Ansatz verfolgt bei dem nicht der Verursacher, sondern der Kraftstofflieferant in erster Linie die Kohlenstoffkosten trägt, wodurch sich die Verwaltungskosten verringern.

Es wird nicht erwartet, dass der hohe Anteil des Seeverkehrs an den gehandelten Gütern durch den Preis im EU-ETS 1, der in der Folgenabschätzungen angenommen wurde und geringer als heutige und projizierte Preise ist, beeinträchtigt wird. Der Sektor wird dennoch mit steigenden Kosten konfrontiert sein und zusammen mit anderen politischen Maßnahmen (insbesondere der FuelEU-Maritime-Verordnung) können der Übergang zur Klimaneutralität und die notwendigen Investitionen intensiviert werden. Andererseits werden Teile der Auktionserlöse aus dem EU-ETS 1 in den **EU-Innovationsfonds** fließen, welche unter anderem explizit den Hochlauf der Dekarbonisierung im maritimen Sektor unterstützt. Die FuelEU-Maritime-Verordnung und die Ausweitung des EU-ETS 1 auf den Seeverkehr werden sich zusammen stark auf die Emissionen des Sektors auswirken. Andere Teile des Fit-for-55-Pakets werden sich ebenfalls auf den maritimen Sektor auswirken, jedoch in geringerem Maße als diese beiden Politiken. Die Umweltauswirkungen des EU-ETS 1 werden als positiv eingeschätzt, insbesondere in Verbindung mit anderen Fit-for-55-Rechtsvorschriften und -Vorschlägen. Globale Maßnahmen, wahrscheinlich ein zielbasierter Kraftstoffstandard in Kombination mit einem ökonomischen Element, sind bei der **IMO** in Vorbereitung. Ihre genaue Ausgestaltung und damit die Interaktion oder Überschneidung mit der EU-Politik sind noch nicht geklärt. Für die beiden wichtigsten neuen EU-Politiken für die Schifffahrt gibt es jedoch bereits Verfahren für den Fall, dass die IMO weitere (ehrgeizige) Maßnahmen beschließt.

1 Introduction

The European Union (EU) has set a goal of reducing EU emissions by at least 55% by 2030 compared to 1990. In order to achieve this goal, the European Commission presented a proposal to reform the European Union Emissions Trading System (EU ETS 1) and extend it to maritime transport as part of its 'Fit for 55' package in 2021. The package contained a variety of legislative proposals to increase the speed of emissions reductions in different sectors. Besides the EU ETS 1 extension to maritime transport, other legislative proposals are also relevant for the maritime sector: the FuelEU Maritime Regulation (FEUM), the revision of the Alternative Fuel Infrastructure Regulation (AFIR), the revision of the Energy Taxation Directive (ETD), and the revision of the Renewable Energy Directive (RED). A revision of AFIR and RED has meanwhile been agreed. In early 2023, the EU bodies adopted a revised version of the EU ETS 1 following the EU Commission's proposal from 2021 (Directive (EU) 2023/959 2023). Before the agreement on the EU ETS 1 extension to maritime transport and the FEUM Regulation in 2023, emissions of maritime transport were not covered by any EU legislation with the aim to reduce emissions. The extension of the EU ETS 1 to maritime transport not only required an amendment of the Emissions Trading Directive (Directive 2003/87/EC) but also an adjustment of the EU Monitoring, Reporting and Verification (MRV) Maritime Regulation (2015/757) (EU 2015). The EU MRV Maritime Regulation was agreed in 2015 and implemented in 2018. While the EU MRV Maritime Regulation covers 100% of emissions from (maritime) voyages within and to/from the EU, the EU ETS 1 only covers 50% of emissions from all incoming and outgoing voyages but also 100% of emissions at berth and within European economic area (EEA) waters. Further details of the EU MRV Maritime Regulation and the EU ETS 1 are provided in box 1 below.

Regarding inland shipping, the Central Commission for Navigation on the Rhine presented a roadmap which includes the following (CCNR 2022a): reducing greenhouse gas (GHG) emissions by 35% compared with 2015 by 2035, reducing air pollutant emissions by at least 35% compared with 2015 by 2035, largely eliminating GHG and other pollutants by 2050. Inland shipping will also be partially addressed by parts of the 'Fit for 55' package, such as AFIR and ETD.

The shipping sector is an important sector for the EU, though not a very visible one since most shipping occurs out of the public's sight. In 2022, maritime transport emissions in the EU amounted to 135.5 million tonnes (Mt) of CO₂ based on the EU MRV Maritime Regulation, which corresponds to 4% of the total CO₂ emissions of the EU (EC 2024). The EU MRV Maritime Regulation covers 100% of emissions from (maritime) voyages within and to/from the EU. Since the EU ETS 1 covers only 50% of emissions from all incoming/outgoing voyages, but also 100% of emissions at berth and within European economic area (EEA) waters, this (approximately 100 Mt CO₂) would correspond to approximately 3.5% of the total CO₂ emissions of the EU. Globally, 28.15% of the world fleet in gross tonnage (GT) were owned by European companies and 17.5% of ships in GT were EU-flagged (EMSA 2023). Further, the EU is an important trading hub and "the majority of goods transported into and out of the EU are shipped using maritime transport" (77% of the total volume of goods traded in 2019, EMSA; EEA (2021)). Including the sector in the EU climate regulations acknowledges the importance of this sector and the relevance of its emissions.

Box 1: Elements of the EU MRV Maritime Regulation and EU ETS 1

The following details are based on the final ETS and MRV amendments published in 2023 (Directive (EU) 2023/959 2023).⁶ The extension of the EU ETS 1 to maritime transport strongly builds on the EU MRV Maritime Regulation (2015/757). The regulation was implemented in 2018 and applies to commercial cargo and passenger transport ships. It requires shipping companies to report their fuel consumption and emissions for each ship on a yearly basis. With the agreed amendments, the regulation covers not only CO₂ but also methane (CH₄) and nitrous oxide (N₂O) from 2024 onwards. Emissions from ships with a GT of 5,000 and above are covered by the EU MRV Maritime Regulation on the following routes:

- ▶ 100% in the ports within the EEA,
- ▶ 100% between states of the EEA,
- ▶ 100% on routes to/from EEA ports.

A review of the EU MRV Maritime Regulation is due by the end of 2024.

The maritime sector is integrated in the existing EU ETS 1 from 2024 onwards. As in the EU MRV, only voyages for the purposes of transporting cargo or passengers for commercial purposes are included. There thus was a one-off increase in the number of emission allowances in the EU ETS 1 in 2024, amounting to 78.4 million allowances for the whole fourth emission trading period. Allocation will take place entirely via regular auctions. CO₂ emissions from ships with a GT of 5,000 and above will be covered by the EU ETS 1 on the following routes:

- ▶ 100% in the ports within the EEA,
- ▶ 100% between states of the EEA,
- ▶ 50% on routes to/from EEA ports.

The EU ETS 1 hence has a smaller scope than the EU MRV.

From 2026 onwards, CH₄ and N₂O emissions will also be covered. As in the EU MRV, only voyages for the purposes of transporting cargo or passengers for commercial purposes are included. Some ship types are excluded from the EU MRV and EU ETS 1: warships, naval auxiliaries, fish-catching or fish-processing ships, wooden ships of a primitive build, ships not propelled by mechanical means, or government ships used for non-commercial purposes (EU 2015). Starting in 2025, offshore ships and general cargo ships below 5,000 but not below 400 GT will be included in the EU MRV (EU 2015). In the EU ETS 1, offshore ships of 5,000 GT and above will be included from 2027 onwards after they have been included in the MRV in 2025. A transition phase is envisaged in which the share of verified emissions for which emission allowances must be surrendered will gradually increase, starting with 40% in 2024, 70% in 2025 and 100% in 2026. Where fewer allowances are surrendered compared to the verified emissions from maritime transport for the years 2024 and 2025, the difference in allowances shall be cancelled instead of auctioned. There are several exemptions from the surrender obligation, such as voyages from Member States to outermost regions and to small islands. A review is scheduled for 2026 on a potential extension of the ETS to include smaller ships below 5,000 but not below 400 GT.

⁶ As indicated in the last sentence of this box, this basic information on the EU MRV and EU ETS has already been summarized and published in Wissner and Cames (2021).

Shipping companies will be assigned to the Member States as competent ‘administering authorities’. If the shipping company has been registered in a Member State, that Member State is responsible. If a shipping company is not registered in any Member State, the Member State with the highest estimated number of port calls during voyages within the four previous monitoring years will be responsible. In all other cases, the member state from whose port the first voyage within this scope began or at which it arrived will be responsible. From 2025 onwards, shipping companies are required to submit the emission reports, containing aggregated emission data at company-level, by the 31st March each year to the administering authority. Emission allowances need to be surrendered by the 30th September to cover the emissions from the previous year.

Member States must use 100% of their EU ETS 1 revenues for a range of climate and social projects, among which may be measures to decarbonise the maritime sector (e.g. energy efficiency measures, sustainable alternative fuels). Via the EU Innovation Fund, part of the ETS revenues shall also be used to fund the decarbonisation of the maritime sector through special calls.

Further information on the implementation of the extension of the EU ETS 1 to maritime transport, including details of all exemptions, can be found in Wissner and Cames (2023).

The aim of this report is to analyse the (economic) impacts of the extension of the EU ETS 1 to maritime transport on the sector/market and the interlinkages with other policies considering the overall climate impacts. The report has a European focus and considers, where appropriate, the national (German) level. The first part of the report analyses the market by examining the EEA-related vessel fleet and commercially-relevant activities. The second part of the report is a policy analysis of existing shipping policies and of interactions of the EU ETS 1 with other legislations, revisions and proposals. The report concludes on the qualitative impacts and identifies research questions and gaps for a further analysis.

2 Market analysis

The aim of the market analysis is to provide information on the European Economic Area (EEA)⁷-related maritime shipping sector (2.1) and the EU-related inland navigation sector (2.2) which is relevant to the analysis of the potential inclusion of the sectors in the EU ETS 1. The market analysis is based on a literature research and a data compilation.

The market analysis begins with an introduction to the maritime shipping sector to allow for a better understanding of the sector. Subsequently, the ships sailing on routes from and to EEA ports and that are active in European waters are described in detail, with a focus on the number of ships and their CO₂ emissions. In a third section, the economic relevance of the EU maritime transport sector and sectors closely linked to the sector are analysed.

2.1 Maritime shipping

2.1.1 Introduction to the maritime shipping sector

2.1.1.1 Ship types

The shipping sector has a large number of different ship types which can be categorized in different ways. In the following, one classification is presented as an example, with a focus on only the main categories. For a detailed categorisation of ships, see for example S&P Global (2017).

- ▶ transporting vessels
 - ships that exclusively transport cargo;
 - ships that exclusively transport passengers⁸ (ferries (pax-only⁹) and cruise ships);
 - ships that transport both passengers and cargo/vehicles (Ro-pax¹⁰ vessels);
 - fish-catching vessels;
- ▶ working vessels;
- ▶ naval vessels.

There is a wide range of ships that exclusively transport cargo. Regulation (EU) 2015/757 (EU 2015) differentiates the following 15 sub-categories:

- ▶ bulk carrier;
- ▶ chemical tanker;
- ▶ combination carrier;
- ▶ container ship;

⁷ There are 30 EEA countries, which are the 27 EU countries plus Iceland, Liechtenstein, and Norway.

⁸ A ship is considered to be a passenger ship if it carries more than twelve passengers other than the master and the members of the crew or other people employed or engaged in any capacity on board a ship on the business of that ship.

⁹ 'Pax' stands for passenger.

¹⁰ A ro-pax vessel is a vessel with which vehicles/cargo as well as passengers are transported and vehicles/cargo roll on and roll off (and are not loaded/unloaded by cranes).

- ▶ container/ro-ro cargo ship;
- ▶ gas carrier;
- ▶ general cargo ship;
- ▶ LNG carrier;
- ▶ oil tanker;
- ▶ refrigerated cargo carrier;
- ▶ ro-ro ship;
- ▶ vehicle carrier;
- ▶ other ship type.

The ships are naturally categorised by means of the type of cargo that they transport since this also determines their design. Some of these ship types can, however, carry a wider range of different products than others. To give an example: crude oil carriers (falling into the oil tanker category) exclusively transport crude oil, while bulk carriers can transport a wide range of different dry bulk goods, like ore, grain, sand etc. Some ships are also designed to carry two types of goods (e.g. combination carrier, container/ro-ro cargo ship).

As with cargo-carrying ships, there is also a wide range of working vessels. These ships are used for various activities. To give a few examples of these vessels: offshore supply vessels, tugs, dredgers, patrol vessels, pilot vessels, cable layer, pipe layer, ice breaker, research vessels etc. For many working vessels, it holds that the activities at sea are relatively energy-intensive.

Overall, it can be concluded that the maritime shipping sector is very heterogenous and the transport work/work of the different ships is part of many different value chains.

2.1.1.2 Ship operation

Operational profiles

Regarding the operational profile of ships, two major categories can be distinguished, liner shipping and tramp trade. Liner shipping refers to ships that operate on fixed routes and according to fixed schedules, whereas tramp trade is characterized by ships that operate on demand. For liner shipping, mainly container ships are used. According to the World Shipping Council (2021)¹¹, only 20% of liner vessels worldwide are vessels other than container vessels. Many bulk carriers and tankers are engaged in tramp trade. This means that in a regional system, like the EU ETS 1, the composition of the fleet can be expected to vary during and over the years. In this respect, the market is less predictable compared to the aviation sector since air lines operate on routes between airports for which they have received slots.

In addition, different types of transport combinations are applied in the sector (mainly in the container sector) when it comes to long distance transport: here, either smaller ships regionally collect cargo to be loaded on a large vessel which then sails the long distance or smaller ships regionally distribute the cargo that has been unloaded from a larger vessel that has sailed the long distance. A third option is the transshipment of cargo between two larger vessels which have

¹¹ <https://porteconomicsmanagement.org/pemp/contents/part1/ports-and-container-shipping/insertion-location-transshipment-hubs/>

intersecting routes (Notteboom et al. 2022). The smaller ships that collect/distribute the cargo regionally are referred to as feeder vessels and large transshipment ports are referred to as hubs.

Responsible entities

A characteristic of the shipping market is that some ships are owned and operated by the same entity, whilst others are owned and operated by different entities. Ships can be chartered on a voyage or time basis¹² and, depending on the charter contract, the responsibilities are differently distributed between owner and charterer.

In addition, the maritime shipping sector has a small number of large shipping companies and a large number of small shipping companies: according to Clarksons Research¹³, there were approximately 4,030 EU shipping companies in 2023, 400 of which owned more than 10 ships while approximately 2,090 of which owned one ship only.

According to EMSA (2023), at individual vessel level, nearly a fifth of the world fleet is owned by EU nationals or companies. UNCTAD (2022) provides an overview of the ownership of the world fleet, ranking countries by means of the carrying capacity and the commercial value of the fleet. In both rankings, China, Greece and Japan were the top three ship-owning countries in 2022: Greece leads in terms of tonnage and China in terms of commercial value. Other EEA ship owning countries among the top 25 countries (ranked in terms of commercial value) are:

- ▶ Germany;
- ▶ Norway;
- ▶ Denmark;
- ▶ Netherlands;
- ▶ France;
- ▶ Italy; and
- ▶ Belgium.

Comparison with other transport modes

For many long-distance origin-destination (OD) combinations, shipping only competes with aviation and transportation by pipelines. Air transportation is quicker compared to sea transport, but costs are higher per tonne of cargo transported; only for goods with a relatively high value-to-weight ratio does air transportation make economic sense.

For other ODs (e.g. between two EU ports), shipping potentially also competes with road transport, train and inland shipping. But this only holds for certain types of goods, like goods transported in containers; coal, for example, is not transported by road.

Bunkering

Fuels that are used by ships are referred to as bunker fuels and ships are said to 'bunker' if they take up bunker fuels. In contrast to airplanes, ships are not required to refuel as part of each visit of a port and are thus rather flexible in terms of bunker locations, at least if time and route allow. The current market for maritime shipping bunker fuels, therefore, has few major bunkering locations in the world. Rotterdam is the major bunker location in Europe. The energy

¹² Ships can be chartered for short or long periods of time (e.g. several years).

¹³ <https://www.clarksons.net/wfir/>

transition, as part of the decarbonisation of the sector, will require the sector to use fuel types other than those currently used. Different alternative fuel types¹⁴ are considered in this context, for which different production pathways are conceivable. Most of these alternative fuels require new fuel supply chains, including new port bunkering infrastructure: the crude oil refining supply chains will be phased out and new bunkering infrastructure is required for all non-diesel like fuels which, due to their characteristics, require either compressed and/or cryonic (very low temperature) storage of the fuel.

Routes/voyages

Routes/voyages of ships sailing to and from EU ports can be categorized in different ways.

One classification of voyages distinguishes ‘domestic voyages’ and ‘international voyages’. In the EU context, these are defined as follows (EU 2004):

- ▶ ‘Domestic voyage’ means a voyage in sea areas from a port of a Member State to the same or another port within that Member State;
- ▶ ‘International voyage’ means a voyage by sea from a port of a Member State to a port outside that Member State, or conversely.”

Note in this context that there are ships that sail on both international and domestic voyages. To give an example: a large container ship coming from China might unload in one EU port and sail to another port of the same country to load.

Under the EU MRV Maritime Regulation (EU 2023), voyages are defined as the movements between two ports of calls. A port of call is thereby defined as follows:

“the port where a ship stops to load or unload cargo or to embark or disembark passengers, or the port where an offshore ship stops to relieve the crew; stops for the sole purposes of refuelling, obtaining supplies, relieving the crew of a ship other than an offshore ship, going into dry-dock or making repairs to the ship, its equipment, or both, stops in port because the ship is in need of assistance or in distress, ship-to-ship transfers carried out outside ports, stops for the sole purpose of taking shelter from adverse weather or rendered necessary by search and rescue activities, and stops of containerships in a neighbouring container transshipment port listed in the implementing act adopted pursuant to Article 3ga(2) are excluded;”

Stops of containerships in certain neighbouring container transshipment ports are excluded from the definition of a port of call in line with the EU ETS 1 Directive (Directive (EU) 2023/959 2023). Otherwise, some containerships would have an incentive to tranship in ports outside the scope to avoid EU ETS 1 compliance costs, leading to fewer emissions being covered by the system as well as a loss of market share of the transshipment ports in the Member States.

In addition, three types of voyages are distinguished:

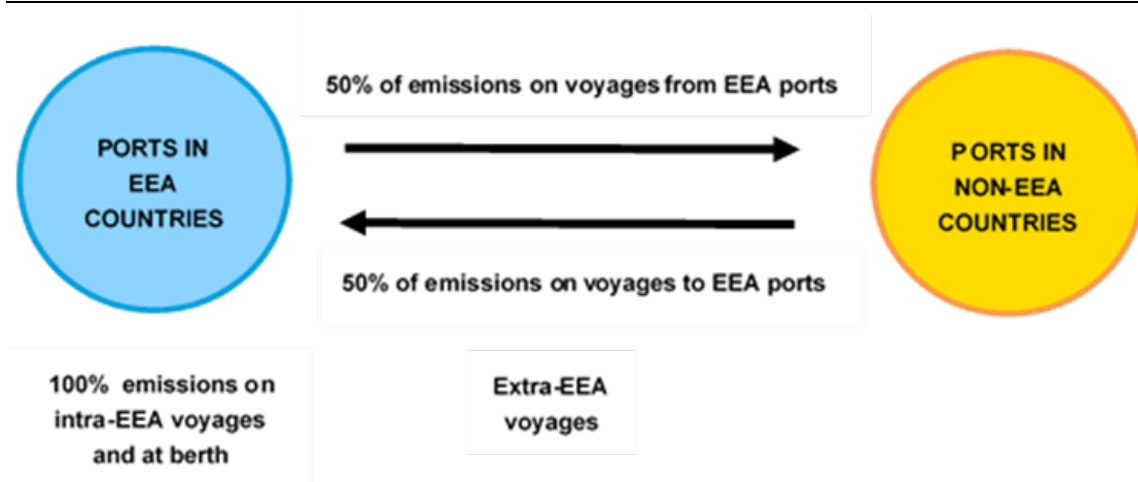
1. Intra-voyages (between calls at EEA ports);
2. Extra-EEA incoming voyages (between a port call at a non-EEA port and an EEA port) and
3. Extra-EEA outgoing voyages (between a port call at an EEA port and a non-EEA port).

While 100% of the emissions on intra-EEA voyages, extra EEA voyages and at berth in an EEA port are covered by the EU MRV Maritime Regulation, the scope in the context of the EU ETS 1 Directive differs (see Figure 2 for an illustration), by covering only 50% of the emissions on the

¹⁴ Methanol, ammonia, methane, hydrogen, diesel-like fuels.

extra-EEA voyages (while also covering 100% of the emissions on intra-EEA voyages and at berth).

Figure 2: Illustration of geographical scope of the EU ETS 1



Source: Nelissen et al. (2021)

In addition, Eurostat also works with the category ‘short sea shipping’. “In the context of EU transport statistics, it [short sea shipping] is defined as maritime transport of goods between ports in the EU (sometimes also including candidate countries and EFTA countries¹⁵) on one hand, and ports situated in geographical Europe, on the Mediterranean and Black Sea on the other hand, i.e. ports in

- ▶ EU maritime countries;
- ▶ EEA maritime countries (Iceland and Norway);
- ▶ candidate countries;
- ▶ the Baltic Sea area (Russia);
- ▶ the Mediterranean Sea area (Algeria, Bosnia and Herzegovina, Egypt, Israel, Lebanon, Libya, Morocco, Occupied Palestinian territory, Syria, and Tunisia);
- ▶ the Black Sea area (Georgia, Moldova, Russia and Ukraine).”¹⁶

Operational costs

The operation of ships is associated with various operational costs:

- ▶ costs for bunker fuels;
- ▶ port fees;
- ▶ costs for manning;
- ▶ costs for stores, spares and lubricants;
- ▶ insurance costs;

¹⁵ The European Free Trade Association consists of Iceland, Liechtenstein, Norway, and Switzerland.

¹⁶ [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Short_sea_shipping_\(SSS\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Short_sea_shipping_(SSS))

- ▶ costs for (un)scheduled repairs;
- ▶ management & administration costs.

These costs differ between ships, depending on type, size, age and trades.

Drewry Maritime Research annually publishes cost profiles of different ship types and sizes, considering all the above cost items, except for bunkering costs and port fees which highly depend on the specific trade¹⁷. Regarding the other cost items, costs for manning clearly dominate – in 2018 accounting for over 45% of the vessel operating expenses (Drewry 2018). The total of these cost items in 2018, for example, amounted to

- ▶ between USD 6,030 per day and USD 7,720 per day on average for a tanker in the 30-35,000 deadweight tonnage (dwt)¹⁸ category, depending on the age;
- ▶ between USD 4,110 per day and USD 5,360 per day on average for a dry bulk carrier in the 30-35,000 dwt category, depending on the age.

Since the costs for bunker fuels and port fees highly depend on the specific trade and the ship size and since the costs for bunker fuels also highly depend on fuel price, it is not possible to specify an average share of these cost items in the total operational costs of ships.

To nevertheless give an example: according to IMO (2020), bulk carriers between 10,000 and 34,999 dwt emitted approximately 9,930 tCO₂ on average, which corresponds to a bunker fuel consumption of approximately 3,163 tonnes. At a 2018 bunker price of USD 450 per metric tonne, this amounts to approximately USD 1.42 million for fuel expenditure on an annual basis. Based on the data published by Drewry (2018), the other operational expenses (excluding port fees) amount to approximately USD 1.73 million on average.

Carbon pricing will lead to an increase of the ships' operational costs and will have a relatively higher impact on the transport costs for those ships that have a relatively high share of fuel expenditure as part of the overall operational costs.

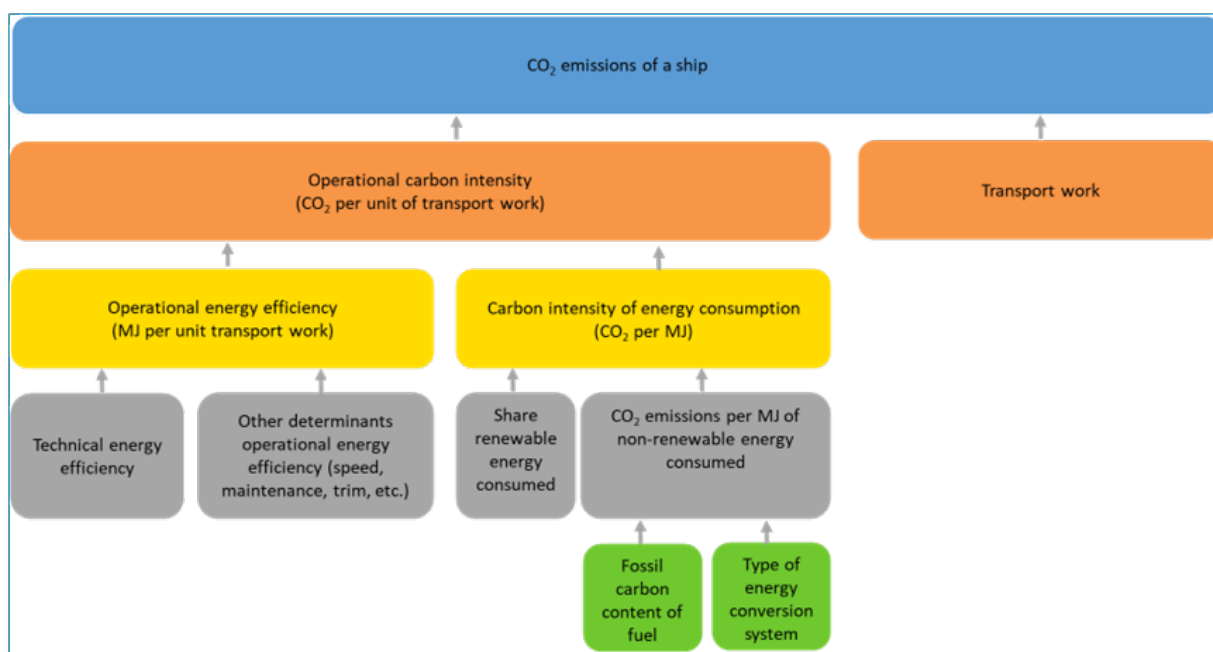
2.1.1.3 Measures to reduce GHG emissions from maritime shipping

The following figure shows the different determinants of the CO₂ emissions of maritime shipping.

¹⁷ 'Trade' encompasses the type of cargo carried, the ship type accordingly used and the route of the ship.

¹⁸ Gross tonnage (GT) measures the ship's total volume and is an indication for the overall size of the ship. In contrast, deadweight tonnage (dwt) measures the carrying capacity, considering not only cargo, but also passengers, fuel, fresh water, ballast water, provisions etc., whilst not considering the empty weight of the ship. See also: <https://safety4sea.com/cm-do-you-know-what-gt-and-dwt-measure-in-a-ship/>

Figure 3: Determinants of the CO₂ emissions of a ship



Source: Nelissen et al. (2023).

As per figure above, the total annual amount of a ship's CO₂ emissions is determined by:

- ▶ the operational carbon intensity of the ship (in CO₂ per unit of transport work¹⁹); and
- ▶ the amount of transport work.

The operational carbon intensity (in CO₂ per unit of transport work) in turn is determined by (see figure above):

- ▶ the operational energy efficiency (in MJ per unit of transport work); and
- ▶ the carbon intensity of the energy consumed to provide the transport work (in CO₂ per MJ).

The operational energy efficiency depends on the technical energy efficiency of the ship (based on the design of the ship) and other, non-technical factors like speed, maintenance, trim, etc. (Nelissen et al. 2023).

The carbon intensity of energy consumption depends on the type of fuel used for the transport work (renewable and/or non-renewable), the carbon content of the non-renewable fuel and the type of energy conversion system used (Nelissen et al. 2023).

To reduce the CO₂ emissions of a ship either technical energy efficiency measures (e.g. waste heat recovery, engine and propeller improvements) or operational energy efficiency measures (e.g. speed reduction) can be applied or alternative renewable fuels/energy sources can be used. The latter is the main lever for the decarbonisation of the sector (DNV 2023), given that the improvement of the energy efficiency of ships has its limits and that electrification works only for a very small number of ships. Currently, the use of alternative, renewable fuels is negligible and costs for using these fuels is relatively high, especially for RFNBOs. The suitability, availability and costs of different types of alternative renewable fuels (renewable e-fuels,

¹⁹ The transport work of a cargo ships is defined as the product of the volume of the cargo and the distance that the cargo is transported and thus measured in terms of tonne nautical miles.

RFNBOs and biofuels) are currently being examined. Options, among other things, are green methanol, green ammonia, green methane and green hydrogen, whereas green hydrogen is probably the fuel type with the least potential, due to the low energy density and the required storage space.

Renewable e-fuels are liquid or gaseous fuels made from renewable hydrogen (produced using renewable electricity and water electrolysis) and renewable CO₂, if required. The EU RED defines RFNBOs as liquid and gaseous fuels, the energy content of which is derived from renewable sources other than biomass. This means that RFNBOs are also renewable e-fuels; however, the CO₂ used for the production of RFNBOs must not stem from biomass. The CO₂ can, alternatively, be captured from the air or from oceanwater. RFNBOs are considered especially important since the supply of advanced biofuels can be expected to be limited, especially if the demand from other sectors like aviation will increase.

2.1.2 EEA-related fleet

In this section, the ships sailing on routes from and to EEA ports and that are active in European waters are described in detail, with a focus on the number of ships and their CO₂ emissions. Firstly, the fleet that falls under the scope of EU MRV Maritime Regulation is presented and, secondly, the other ships are presented as far as possible. In a third sub-section, we briefly go into the EU-flagged fleet.

2.1.2.1 EU MRV maritime fleet

Scope

Regulation (EU) 2015/757 (EU 2015) amended by Regulation 2023/957 (EU 2023) requires ships of 5,000 GT and above to monitor, report and verify (MRV) their CO₂ emissions and, from 2024 onwards, also their methane (CH₄) and nitrous oxide (N₂O) emissions

1. on voyages to and from EEA ports which serve the purpose of transporting cargo and or passengers for commercial purposes;
2. at berth in EEA ports.

From 1 January 2025, the Regulation also applies to general cargo ships below 5,000 GT but not below 400 GT.

Ship movements that do not serve the purpose of transporting cargo or passengers for commercial purposes are, in general, not subject to the MRV requirements. This means that certain ship types like ice breakers are implicitly exempt from the Regulation. Offshore ships are thereby the exception to the rule. From 2025 onwards, the Regulation will also apply to offshore ships of 400 GT and above, independent of the purpose of their voyage.

Other ship types are explicitly exempt from the regulation: warships, naval auxiliaries, fish-catching or fish-processing ships, wooden ships of a primitive build, ships not propelled by mechanical means, or government ships used for non-commercial purposes (see Article 2). Naturally, for both ships that are implicitly and explicitly exempt from the Regulation less data is available.

With the amendment of the regulation, a review clause was added (Article 22a) which requires the Commission to consider further expanding the scope of the regulation to ships below 5 000 GT but not below 400 GT.

Description of a fleet

For the ships that fall within the scope of the EU MRV Maritime Regulation, there is currently data available for four reporting periods, 2018 to 2022. Table 1 presents the aggregated total number of ships and CO₂ emissions reported by these ships for these reporting periods.

Table 1: Total number of ships and reported CO₂ emissions per year

	2018	2019	2020	2021**	2022**
Total number of ships*	11,617	12,061	11,695	11,969	12,744
Total CO₂ emissions (Mt)	145	147	129	127	136

*Not including ships that have reported zero emissions/fuel consumption.

**Scope deviates from previous years due to the exit of the United Kingdom from the European Union.

Source: EMSA – THETIS-MRV (2023)

To put this into perspective: the 4th IMO GHG Study (IMO 2020) estimates the 2018 CO₂ emissions of the global fleet (>100 GT) to amount to 1,056 Mt, which means that the EU MRV system covered approximately 14% of the global shipping emissions in 2018. In addition, based on the publicly available data as reported under the IMO Data Collection System (DCS)²⁰, the global 2019 CO₂ emissions of all ships of 5,000 GT and above can be estimated to amount to approximately 662 Mt; the EU MRV system covered approximately 22% of these emissions.

To date, between roughly 11,600 to 12,000 ships have reported their emissions per year under the EU MRV system. The number of individual ships that have reported in the first four reporting periods thereby amounts to 17,870 individual ships. To put this into perspective: On the global level, the IMO²¹ reported that in 2021 32,998 ships theoretically fell under the scope of the DCS,²² of which 28,171 actually reported their fuel consumption to the IMO.

Since the EU MRV Maritime Regulation does not capture the global fleet, but only the ships that are active on EEA-related routes, the fleet covered by the Regulation varies over the reporting periods. As a result, changes over the reporting periods do not necessarily reflect changes in the global fleet but might also be due to changes in the composition of the fleet. To give an indication of the change in the composition of the EU MRV fleet, Table 2 provides the number of ships that reported in exactly one/two/three or in each of the four reporting periods.

Table 2: Indication for the change of composition of the EU MRV fleet 2018-2021

Ships that have reported in...	Number of ships
...exactly one of the four reporting period	4,307
...exactly two of the four reporting periods	3,777
...exactly three of the four reporting periods	3,734
...each of the four reporting periods	6,052

²⁰ Starting from 1 January 2019, ships of 5,000 GT and above are required to record and report their fuel oil consumption on a global basis. The aim of the DCS is to inform current and future IMO measures to reduce GHG emissions from ships.

²¹ IMO (2022) – MEPC 79/6/1:

[https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC%2079-6-1%20-%20Report%20of%20fuel%20oil%20consumption%20data%20submitted%20to%20the%20IMO%20Ship%20Fuel%20Oil%20ConsumptionDatabase...%20\(Secretariat\).pdf](https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC%2079-6-1%20-%20Report%20of%20fuel%20oil%20consumption%20data%20submitted%20to%20the%20IMO%20Ship%20Fuel%20Oil%20ConsumptionDatabase...%20(Secretariat).pdf)

²² All ship types of 5,000 GT and above.

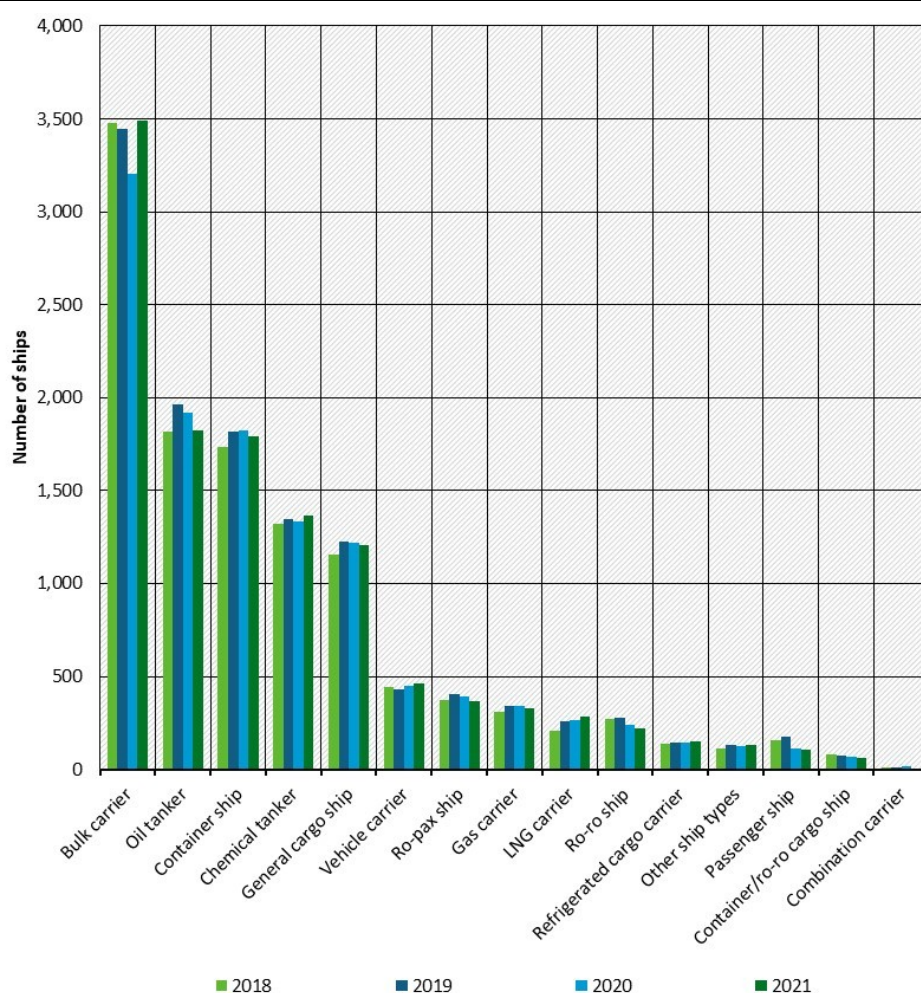
Source: EMSA – THETIS-MRV (2023)

As Table 2 shows, only 6,052 ships of the 17,870 individual ships that have submitted an emissions report to date have submitted a report in each of the four reporting periods. However, as the following analysis will show, there is still a relatively high degree of consistency between the reporting years.

Figure 4 and Figure 5 show that the aggregated number of ships and CO₂ emissions vary highly between ship types, but to a much lower degree over the years.

As for the number of ships, bulk carriers clearly stand out with a very high number of ships (approximately 3,500; between 27-31% of the total). With between 1,500 and 2,000 ships, the number of oil tankers and container ships is also relatively high. The same holds for chemical tanker and general cargo ships, though at a slightly lower level (between 1,000 and 1,500 ships).

Figure 4: Number of ships per ship type in the EU fleet (EU MRV scope)



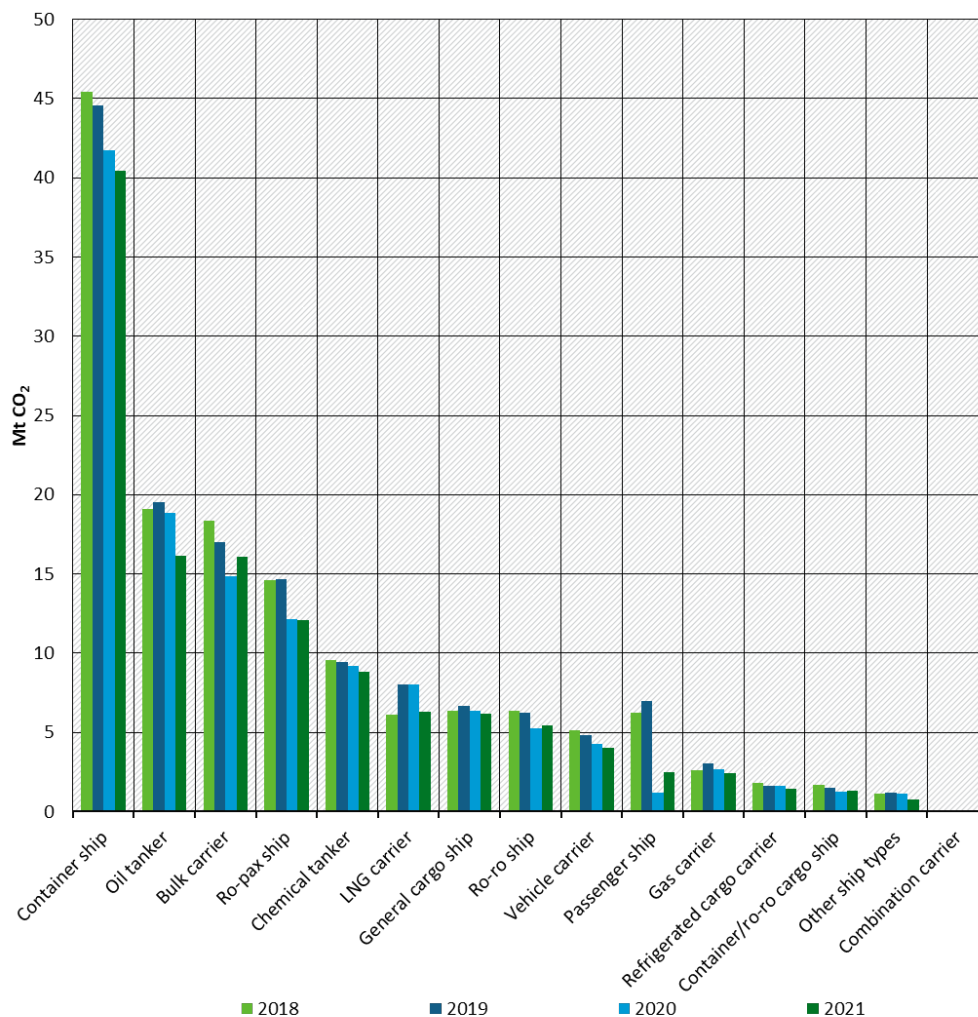
Source: EMSA – THETIS-MRV (2023)

Regarding the total annual CO₂ emissions, container ships clearly dominate (between 40 to 45 Mt or 30 to 32% of total emissions). With total annual CO₂ emissions of more than 10 Mt, the emissions for oil tankers, bulk carriers and ro-pax ships²³ are also relatively high. Figure 5 also

²³ Ships that transport passengers and vehicles.

shows that especially passenger ships were impacted by the COVID-19 pandemic in 2020 and 2021.

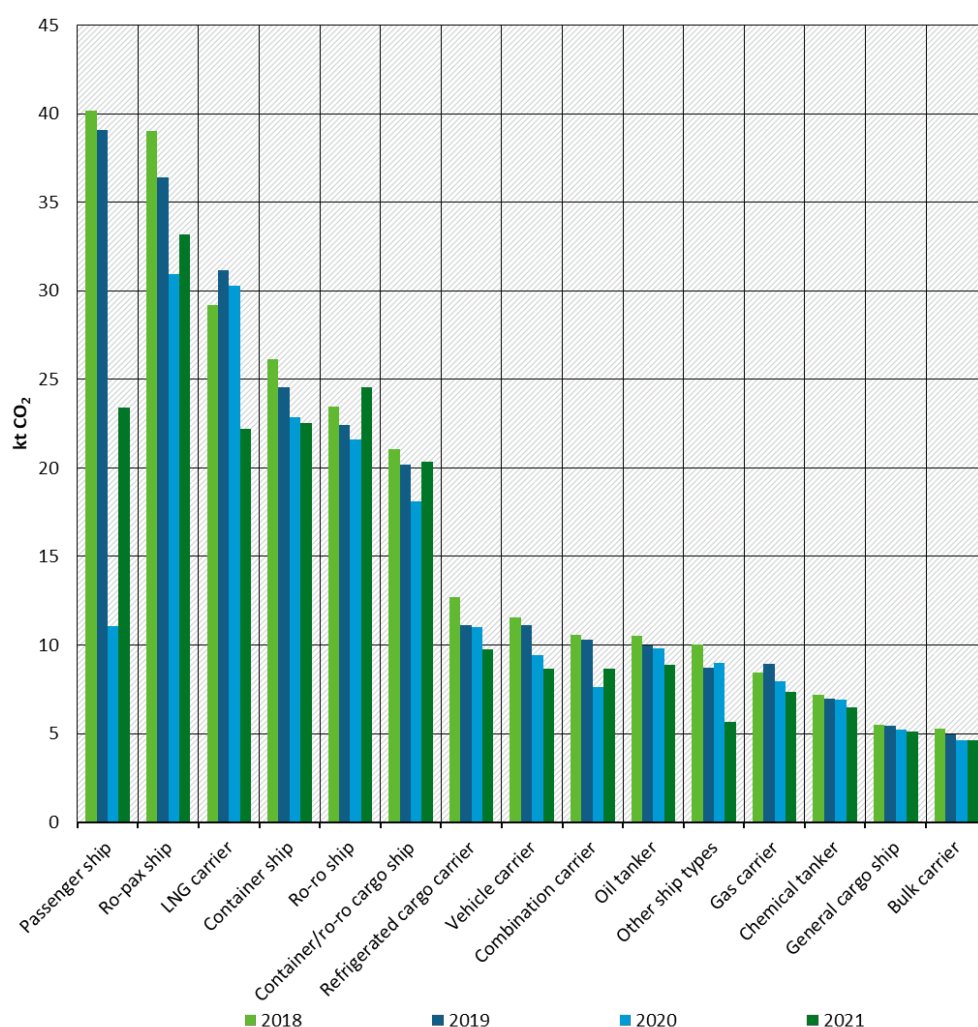
Figure 5: Aggregated CO₂ emissions per ship type [Mt] of the EU fleet (EU MRV scope)



Source: EMSA – THETIS-MRV (2023)

Figure 6 presents the average ship CO₂ emissions depending on the ship type and shows that the average emissions per ship within the scope of the EU MRV Maritime Regulation are comparatively high for passenger ships, ro-pax ships, LNG carriers, container ships, ro-ro ships as well as for container/ro-ro cargo ships. Please note that these average ship CO₂ emissions do not allow for an assessment of the average carbon efficiency of the different ship types; the CO₂ emissions have not been related to an activity of the ships (like the transport work of the ships).

Figure 6: Average per ship CO₂ emissions depending on ship type [kt] in the EU fleet (EU MRV scope)



Source: EMSA – THETIS-MRV (2023)

The distribution of the total fleet CO₂ emissions over the different types of voyages has been relatively stable over the first three reporting periods: approximately 6% of the total emissions were emitted at berth and the remaining emissions were roughly evenly distributed over the three categories of voyages: intra-EEA voyages, incoming extra-EEA voyages and outgoing extra-EEA voyages. In 2021, however, due to the exit of the United Kingdom from the European Union, the share of intra-EEA voyages decreased while the share of extra-EEA voyages increased.

The distribution of the CO₂ emissions over the different types of voyages differs between the ship types. Oil tanker and chemical tanker (approximately 10%) and especially passenger ships (approximately 25%) have a relatively high share of emissions at berth. The share of emissions on intra-EEA voyages is relatively high for passenger ships²⁴, ro-pax and ro-ro ships.

For passenger ships, ro-ro ships and especially ro-pax ships, the average emissions per ship that can be expected to fall within the EU ETS 1 scope is also relatively high (see also Nelissen et al. (2021)). Though not as high as for these three ship types, the average emissions per ship that can be expected to fall within the EU ETS 1 scope is still relatively high for container ships, LNG

²⁴ Mainly cruise ships; ferries that only transport passengers in principal also included, but these are often smaller than 5,000 GT.

carriers and container/ro-ro cargo ships. The intra-EEA emissions of LNG carriers is very low; these ships typically sail to one EEA terminal where they are fully loaded/unloaded. However, as with container ships, it can be expected that LNG carriers sail a relatively long distance between an EEA port and an extra-EEA port. In addition, container ships that sail long distances are often very large and have correspondingly high emissions.

Fuel types

The EU MRV Maritime Regulation requires shipping companies to monitor the ships' fuel consumption and the type of fuel used on a voyage basis²⁵. To calculate the according CO₂ emissions, tank-to-wake (TtW) emission factors as presented in Table 3 are applied.

Table 3: TtW CO₂ emission factors depending on the fuel type

Fuel type	t CO ₂ / t fuel
Diesel/gas oil	3,206
Light fuel oil	3,151
Heavy fuel oil	3,114
Liquefied petroleum gas (propane)	3,000
Liquefied petroleum gas (butane)	3,030
Liquefied natural gas	2,750
Methanol	1,375
Ethanol	1,913

Source: [RESOLUTION MEPC.364\(79\)](#)

TtW emissions are the emissions that stem from the use of fuels onboard ships. In contrast, a well-to-wake (WtW) emissions approach takes not only the TtW emissions of a fuel into account, but also the well-to-tank (WtT) emissions which comprise all the emissions associated with the supply of the fuel up to the tank of a ship.

However, the EU MRV data, which is published annually by the European Commission, does not specify the fuel types used by the individual ships. In the annual reports in which the European Commission presents and discusses the data reported by the shipping companies, more information about the different fuel types used by the ships of the EU MRV fleet is given. EC (2023b) shows that:

- The vast majority of ships still use conventional liquid fossil bunker fuels (very low sulphur fuel oil (VLSFO), marine diesel oil (MDO), marine gas oil (MGO)²⁶);
- LNG:
 - A small but growing fraction of the fleet uses LNG.
 - In 2021, approximately 5% of the total fuel consumed by the EU MRV fleet was LNG.

²⁵ Alternatively, direct emissions measurement can be applied.

²⁶ Regarding the emission factors as specified in Table 3: MGO is considered Diesel/Gas Oil, VLSFO, depending on the grade, either as light or heavy fuel oil and the emission factor of MDO depends on the specific blend used.

- Whereas in the past, mainly LNG carriers have used LNG for propulsion purposes, a growing number of other ship types now also use LNG.

► The use of other fuel types can be considered negligible.

For the global fleet (for the ships falling under the Data Collection System (DCS)), the amount of fuel consumed by the different ship types is published by the IMO, differentiated by fuel type. MEPC 79/6/1²⁷ shows that there are some ships in the global fleet that consume alternative fuel types, but that their share is very low: approximately 6% for LNG and 0.11% for all alternative fuel types except LNG. The latter fuel types are in descending order: 'Other' fuels (probably biofuels), propane, methanol, ethanol and butane. At this stage, it can be expected that these fuels are, at least partially, of fossil origin.

2.1.2.2 Other fleet

As explained above, the EU MRV Maritime Regulation system does not cover all ship sizes, nor all ship activities (implicitly exempting certain ship types); some ship types are also explicitly exempt from the Regulation. In this section, we analyse in more detail the ships that fall outside the scope of the EU MRV system, starting with the number of ships and subsequently analysing the CO₂ emissions.

Number of ships

Distribution of ships over size categories

According to Clarksons (2023)²⁸, the total number of ships of the global fleet is roughly evenly distributed over the three size categories relevant in the context of EU MRV/EU ETS 1: <400 GT, >=400 GT and <5,000GT, and >=5,000 GT.

As Table 4 shows, this distribution varies depending on the ship type. A very high share (>90%) of crude oil tanker, bulk carrier, combos, LNG carriers, pure car carriers, and container ships is 5,000 GT or above as well as a high share (55%-73%) of cruise ships, ro-ro vessels, LPG carriers and chemical tankers. For general cargo ships, offshore ships, dredgers, specialised tankers, multi-purpose vessels, product tankers a high share of ships (around 50%-70%) falls into the category 400 GT and above, but below 5,000 GT. And finally, the highest share of ships of other non-cargo carriers, ferries, reefers and especially of tugs is smaller than 400 GT.

Table 4: Distribution of ships over size categories and total number per ship type (global fleet)

Ship type	<400 GT	>=400GT <5,000 GT	>=5,000 GT	Total number in global fleet
Crude tanker	0%	0%	100%	2.317
Bulk carrier	0%	0%	100%	13.424
Combos	0%	0%	100%	12
LNG carrier	0%	2%	98%	733
Pure car carrier	0%	3%	97%	761

²⁷ IMO (2022): [https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC%2079-6-1%20-%20Report%20of%20fuel%20oil%20consumption%20data%20submitted%20to%20the%20IMO%20Ship%20Fuel%20Oil%20ConsumptionDatabase...%20\(Secretariat\).pdf](https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/MEPC%2079-6-1%20-%20Report%20of%20fuel%20oil%20consumption%20data%20submitted%20to%20the%20IMO%20Ship%20Fuel%20Oil%20ConsumptionDatabase...%20(Secretariat).pdf)

²⁸ <https://www.clarksons.net/wfir/>

Ship type	<400 GT	>=400GT <5,000 GT	>=5,000 GT	Total number in global fleet
Container ships	0%	7%	93%	6.012
Cruise ships	3%	24%	73%	503
Ro-ro	4%	26%	71%	837
LPG	1%	42%	57%	1.618
Chemical tanker	7%	37%	55%	4.158
General cargo ship	22%	69%	9%	16.447
Offshore	20%	66%	15%	9.110
Dredgers	22%	65%	13%	2.189
Specialised tanker	39%	56%	4%	426
Multi-purpose vessel	0%	52%	48%	3.255
Product tanker	13%	49%	38%	9.918
Tugs	84%	16%	0%	22.270
Other non-cargo carrier	68%	29%	3%	3.361
Ferries	48%	41%	11%	8.610
Reefers	40%	39%	21%	1.554
Total	31%	35%	34%	107.515

Source: Based on Clarksons (2023)²⁹

Fish-catching and fish-processing ships

Fish-catching and fish-processing ships are explicitly exempt from the EU MRV Maritime Regulation. Clarksons does not provide data on fishery vessels (vessels are therefore not included in Table 4), but all fishing vessels flying the flag of an EU country have to be registered in the EU Fleet Register³⁰. According to this public database, there are currently approximately 61,200 fishing vessels in the fleet that fly the flag of an EU country. Very few (approximately 15) of these ships are larger than 5,000 GT.

Other exempted ship types

Alongside fish-catching and -processing ships, warships, naval auxiliaries, wooden ships of a primitive build, ships not propelled by mechanical means, or government ships used for non-commercial purposes are also exempt from the EU MRV Maritime Regulation. Data on the number and size distribution of these ship are not available.

For the ships and their activities not covered by the EU MRV Maritime Regulation, there is, inherently, considerably less CO₂ emissions data available. Some industry associations estimated the CO₂ emissions of the fleet which they represent; the 4th IMO GHG Study provides estimations of all ships of 100 GT and above and impact assessments of the European Commission provide some insights:

²⁹ <https://www.clarksons.net/wfr/>

³⁰ https://webgate.ec.europa.eu/fleet-europa/index_en

- ▶ The European Dredging Association (EuDA), for example, estimated the 2018 CO₂ emissions of the EuDA seagoing fleet (approximately 750 seaworthy EU-flagged ships) for European operations to amount to 0.7 Mt and for global operations to amount to 2.1 Mt (EuDA 2020).
- ▶ In a communication of the European Commission (EC 2023a) on the energy transition of the EU fisheries and aquaculture sector, it is stated that “[a]t present, most fishing vessels rely on marine diesel for their operations, although smaller vessels may use petrol. In total, the EU [fishing vessel] fleet consumed over 1.9 billion litres of marine diesel in 2020. This fuel consumption led to direct emissions of approximately 5.2 million tonnes of CO₂.”
- ▶ According to the IMO³¹, ships smaller than 5,000 GT account for approximately 15% of the total global CO₂ emissions from international shipping.
- ▶ The European Commission’s impact assessment supporting a proposal to address maritime transport greenhouse gas emissions concluded that “setting a size threshold at 5000GT would reduce the number of ships covered by 44% while covering 90% of the EU related CO₂ emissions” (EC 2013a, p. 17). This line of argument is also found in the recital of the EU MRV Maritime Regulation, which states the following: “A threshold of 5 000 gross tonnage (GT) has been selected after detailed objective analysis of sizes and emissions of ships going to and coming from Union ports. Ships above 5 000 GT account for approximately 55% of the number of ships calling into Union ports and represent approximately 90% of the related emissions” (see Regulation (EU) 2015/757, Recital (19)).

2.1.2.3 EU-flagged fleet

Ships have to be registered (flagged) to a country. The registries are either national or open/international, the latter allowing ships to register independent of the ship owner’s nationality. For the EU ETS 1, a shipping company will fall under an administering authority in the Member State in which the shipping company is registered, which is independent of the flags that the ships of the companies are flying (see box 1 in chapter 1).

According to EMSA (2023), 15,074 of 118,055 ships³² (i.e. approximately 13%) flew the flag of an EU country in 2023. Comparing the different ship types, the share of EU-flagged ships is relatively high for ro-pax ships (29%), and passenger ships (26%) (EMSA 2023). The highest number of EU-flagged ships is, in descending order, registered in Malta, Italy, Greece, the Netherlands, and Norway (national registry), with more than thousand ships registered per country (Clarksons, 2023³³). Malta has an open registry and Norway a national and an international registry. Approximately 600 ships currently fly the German flag (Clarksons, 2023³⁴).

The flag that the ships are flying is not published by the European Commission in the context of the EU MRV Maritime Regulation, but it can be expected that the ships fly flags from all over the world.

For the ships smaller than 5,000 GT, the probability is higher that they have a home port in the EU and that they are registered in the country of the home port.

³² All types with an IMO number and GT > 100, including also fishing vessels and other ships like tugs, dredgers and service ships.

³² All types with an IMO number and GT > 100, including also fishing vessels and other ships like tugs, dredgers and service ships.

³³ <https://www.clarksons.net/wfr/>

³⁴ <https://www.clarksons.net/wfr/>

According to EMSA (2023), approximately one third of all ships that belong to owners or companies based in the EU fly a non-EU Member State flag.

2.1.3 Economic relevance

In this section, the economic relevance of the EU maritime transport sector is analysed. Firstly, the EU-related transportation work is analysed. Thus, subsequently estimations of the employment and gross value added of the maritime transport sector and the sectors closely linked to the sector are presented.

2.1.3.1 Transportation work

Cargo transport/seaborne trade

In 2019³⁵, maritime transport accounted for more than two-thirds (69.5%) of the EU's freight transport in terms of tonne-kilometres within the Exclusive Economic Zone (EEZ). Road transport accounted for 23%, while rail (5.4%), inland waterway (1.8%) and air transport (0.2%) accounted for small shares of freight transport only.³⁶

In contrast, maritime transport is, after road transport, the second most used transport method in terms of tonne-kilometres when only domestic EU and intra-EU trade are considered (EMSA 2023). In 2019, the modal split freight transport was as follows:

- ▶ Road: 52%;
- ▶ Sea: 28.8%;
- ▶ Rail: 12%;
- ▶ Inland navigation: 4%;
- ▶ Air: 0.1%.

Regarding the 2019 seaborne imports and exports between the EU and extra-EU countries, the following can be stated:³⁷

- ▶ regarding the quantity (mass) of goods:
 - the highest share of goods is imported by sea (71.3%), followed by pipelines (13.6%);
 - the highest share of goods is exported by sea (70.3%), followed by road (16.2%);
- ▶ regarding the value of the goods:
 - the highest share of goods is imported by sea (52.1%), followed by road and air (both approximately 18%);
 - the highest share of goods is exported by sea (41%), followed by air (24.7%) and road (22.9%).

³⁵ Data from 2019 was chosen based on data availability and to provide information on trade before the Covid-19 pandemic.

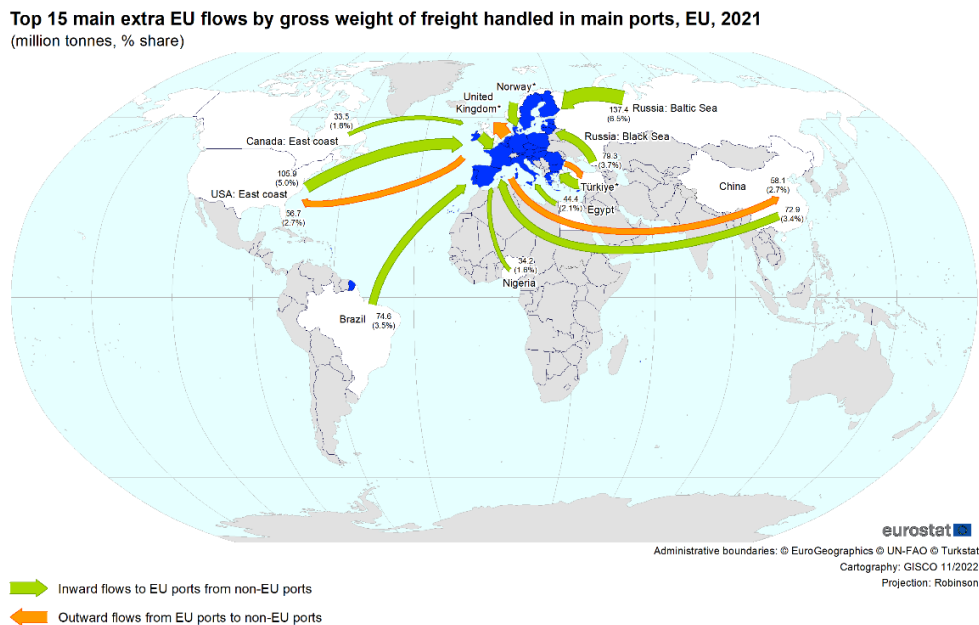
³⁶ <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20230316-2> ; for maritime shipping intra- and extra-EU trade is accounted for, but limited to activities within the EEZ.

³⁷ Eurostat (2023) - Dataset "Extra-EU trade since 2000 by mode of transport, by HS2-4-6", data code DS-058213: https://ec.europa.eu/eurostat/databrowser/view/DS-058213_custom_4673808/default/table?lang=en

Comparing seaborne imports and exports in terms of quantity with seaborne imports and exports in terms of value once again demonstrates that goods transported by sea have a comparatively low value-to-weight ratio.

The following graph shows the 15 most important extra-EU trade flows by sea in 2022 in terms of quantity.

Figure 7: Top 15 main extra EU flow 2021 (gross weight of freight handled in main EU ports)



* United Kingdom, inward: 97.4 (4.6%), outward: 119.5 (5.6%); Norway, inward: 82.0 (3.9%); Türkiye, inward: 92.2 (4.3%), outward 49.4 (2.3%)

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the European Union.

Kosovo: This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

Palestine: This designation shall not be construed as recognition of a State of Palestine and is without prejudice to the individual positions of the Member States on this issue.

Source: Eurostat (2022): <https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=218671>

This shows that in 2021, eleven of the most important routes were import routes while four were export routes (to UK, China, USA (East coast), Turkey). The five most important inward flows were, in descending order, from Russia (via Baltic Sea), the USA (East coast), the UK, Turkey, and Russia (via Black Sea).

For the second quarter of 2022, the United States was the EU's largest maritime freight transport partner, surpassing Russia, which ranked second.³⁸

Regarding the *value* of the goods that are being shipped between the EU and non-EU countries in 2019, the following top 5 products can be identified (Nelissen et al. 2021):

► Imports:

- crude oil (EUR 191.0 billion);
- petroleum oils and oils obtained from bituminous minerals (excl. crude) (EUR 64.2 billion);

³⁸ <https://ec.europa.eu/eurostat/en/web/products-eurostat-news/w/ddn-20230215-2>

- motor cars and other motor vehicles designed for the transport of < 10 people (EUR 47.2 billion);
- petroleum gas and other gaseous hydrocarbons (EUR 21.5 billion);
- telephone sets (EUR 17.0 billion);

► Exports:

- Motor cars and other motor vehicles designed for the transport of < 10 people (EUR 102.8 billion);
- petroleum oils and oils obtained from bituminous minerals (excluding crude) (EUR 64.0 billion);
- parts and accessories for specific vehicles (EUR 31.0 billion);
- specific medicaments (EUR 28.7 billion);
- specific alcohols (EUR 10.9 billion).

Passenger transport

In 2021, a total of 268 million passengers passed through ports in EU Member States (Eurostat 2022a). Information on EU-related passenger transport work in terms of passenger-kilometres is not, as far as we know, available. Eurostat provides information on the modal split for passenger transport, but for inland passenger transport only.

2.1.3.2 Employment and gross value added

Maritime transport sector

Seafarers that work on ships sailing to and from EEA ports are statistically not recorded. They can be employed by companies from all over the world. To give at least an indication, EMSA provides overviews of masters and officers that hold certificates of competency (CoCs) issued by EU Member States as well as of masters and officers that hold CoCs issued by non-EU countries recognized by EU Member States. The certificate/endorsement entitles the masters and officers to serve on board EU-flagged vessels. In 2020, approximately 317,000 masters and officers held such a CoC. approximately 60% of the certificates were issued by an EU Member State (EMSA 2022).

According to the Addamo et al. (2022), in 2019, more than 403,000 people were directly employed in the total maritime transport sector in the EU, 30% of which in the passenger transport sector, 24% in freight transport sector and 46% in services for transport. The gross value added was estimated to amount to EUR 34.3 billion.

Shipbuilding & repair and ship equipment & machinery

The global shipbuilding market is dominated by three countries, China, the Republic of Korea, and Japan. According to UNCTAD (2022), these countries held 94% of the market for the major vessel types in 2021.

The EU has specialised in segments of shipbuilding with high level of technology and added value, such as cruise ships, offshore support vessels, fishing vessels, ferries, research vessels, dredgers, mega-yachts, tugs and other non-cargo carrying ships (Addamo et al. 2022). According to the Addamo et al. (2022), the EU is a global leader in the production of high-tech, advanced maritime equipment.

Overall in the sub-sectors (shipbuilding & repair³⁹, ship equipment & machinery⁴⁰), approximately 300,000 people were directly employed in the EU in 2019, 85% of whom in shipbuilding & repair and 15% of whom in the ship equipment & machinery sector. The gross value added was estimated to amount to EUR 15.6 billion.

Ports

There is a very large number of ports in the EU. Regulation (EU) 1315/2013 specifies 328 maritime ports as part of the core and comprehensive network alone (EC 2013b).

The top 5 cargo ports in 2021 were the following ones in the Netherlands, Belgium, Germany and Spain:⁴¹

- ▶ Rotterdam (435 million tonnes of freight);
- ▶ Antwerp (216 million tonnes of freight);
- ▶ Hamburg (111 million tonnes of freight);
- ▶ Amsterdam (88 million tonnes of freight);
- ▶ Algeciras (83 million tonnes of freight).

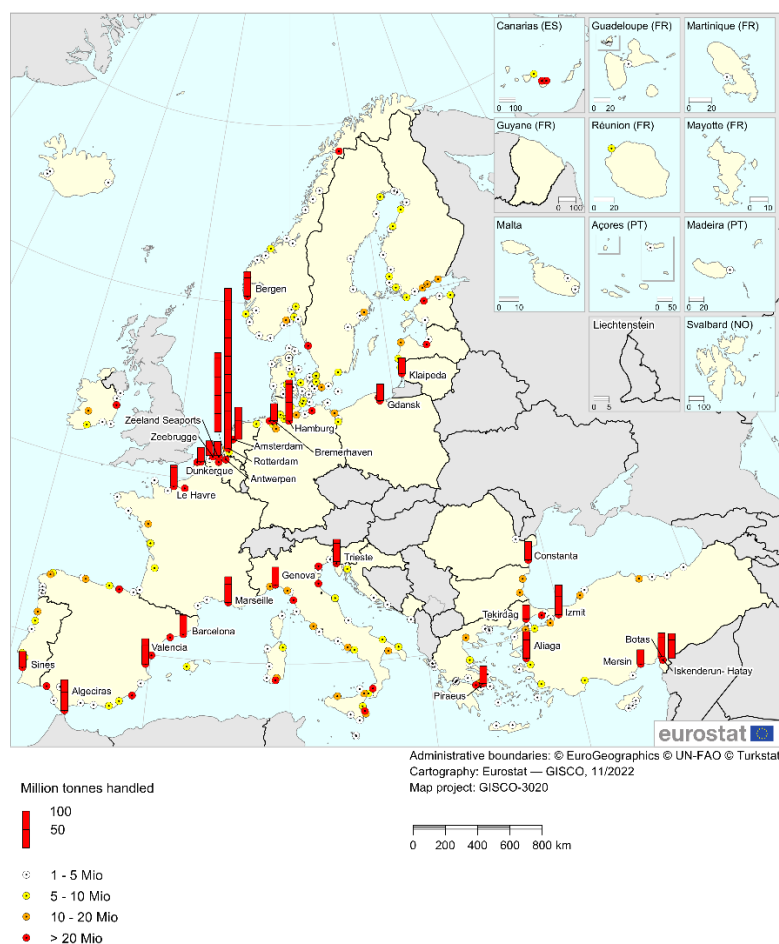
In addition, Figure 8 provides an overview of the main cargo ports in 2021.

³⁹ Shipbuilding & repair includes building of ships and floating structures; building of pleasure and sporting boats; repair and maintenance of ships and boats.

⁴⁰ Equipment & machinery includes manufacture of cordage, rope, twine and netting; manufacture of textiles other than apparel; manufacture of sport goods; manufacture of engines and turbines (except aircraft), and manufacture of instruments for measuring, testing and navigation.

⁴¹ Eurostat (2022): <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20221116-3>

Figure 8: Main cargo ports in 2021 (by gross weight of goods handled)



Note: Ports reporting more than 38 million tonnes in 2021 are named and their handling activity shown as bars.
Source: Eurostat (online data code: [mar_mg_aa_pwhd](#))

Source: [Eurostat \(2022\)](#)

The top 5 passenger ports in 2021 were the following Italian and Greek ones:⁴²

- Messina (8.3 million passengers) and Reggio Di Calabria (8.1 million passengers) in Italy;
- Piraeus, Paloukia Salaminas and Perama (each recording 5.9 million passengers) in Greece.

According to Addamo et al. (2022), in the ‘port activities sector’⁴³ in 2019, approximately 382,600 people were directly employed and the sector’s gross value added was estimated to amount to EUR 27.9 billion.

2.2 Inland shipping

For a better understanding of the inland shipping sector and the effects of a potential inclusion of the sector in an emissions trading system, the following chapter provides an introduction to the sector.

⁴² Eurostat (2022): <https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20221116-3>

⁴³ Including cargo and warehousing (cargo handling and warehousing and storage) and port and water projects (construction of water projects and service activities incidental to water transportation).

2.2.1 Waterways and ports

According to Jacobs (2022), the EU network of inland waterways stretches over 41,000 km, and connects 25 EU Member States, hundreds of cities, and industrial regions. The EU's trans-European transport network (TEN-T)⁴⁴ includes 15,000 km of these waterways. 13 EU countries share an interconnected network, with the highest density in Germany, the Netherlands, and France (Jacobs 2022). Further, two of the largest European seaports, Rotterdam and Antwerp, are connected to their hinterlands and terminals by a number of waterways (Jacobs 2022).

An area of connected waterways (which can consist of several rivers and canals) are considered to be part of a river basin⁴⁵. Two river basins in which the majority of transport work is performed are the Rhine basin (and its tributaries) and the Danube basin. The waterways of the Rhine basin cover several countries, including Switzerland, France, Germany and the Netherlands and is responsible for almost 70% of the goods transported on inland waterways in Europe. The Danube basin stretches over several countries, including Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Romania, and Ukraine. Approximately 15% of the cargo transported on European inland waterways is in the Danube area.

The remaining share of the cargo transported in Europe occurs in other waterways. The most important 'other' waterways include the Albert Canal in Belgium, the Seine and Saône/Rhône river basin in France, the Mittelland Canal, Elbe river basin, and Dortmund-Ems Canal in Germany, and the North-South corridor and Meuse in the Netherlands (EC 2015).

Independent of the use of a ship, inland waterway vessels are also classified according to the so-called CEMT classes to indicate their suitability (dimension wise) for infrastructure like locks and canals. The classification knows classes between I to VIIa, with the first class being the smallest with a maximum width of 5 metres and the VIIa class the largest with a maximum width of 34 metres (Directoraat-Generaal Rijkswaterstaat 2020). The largest inland ports in Europe are part of the TEN-T core network, of which 21 inland ports are in Germany. Duisburg is the largest inland port not only in Germany, but also in Europe.

2.2.2 Fleet characteristics

The vessels sailing on inland waterways can be grouped into the following categories, depending on the use of the vessels: passenger vessels, cargo vessels, push boats and other inland vessels. There are approximately 400 river passenger vessels in Europe which can be sorted into passenger ferries, passenger day trip/river cruise vessels. Almost 75% of the total river passenger fleet in the EU sails in the Rhine basin. Cargo vessels in turn can be grouped as dry bulk vessels, tankers (liquid cargo) and push- and tug vessels.

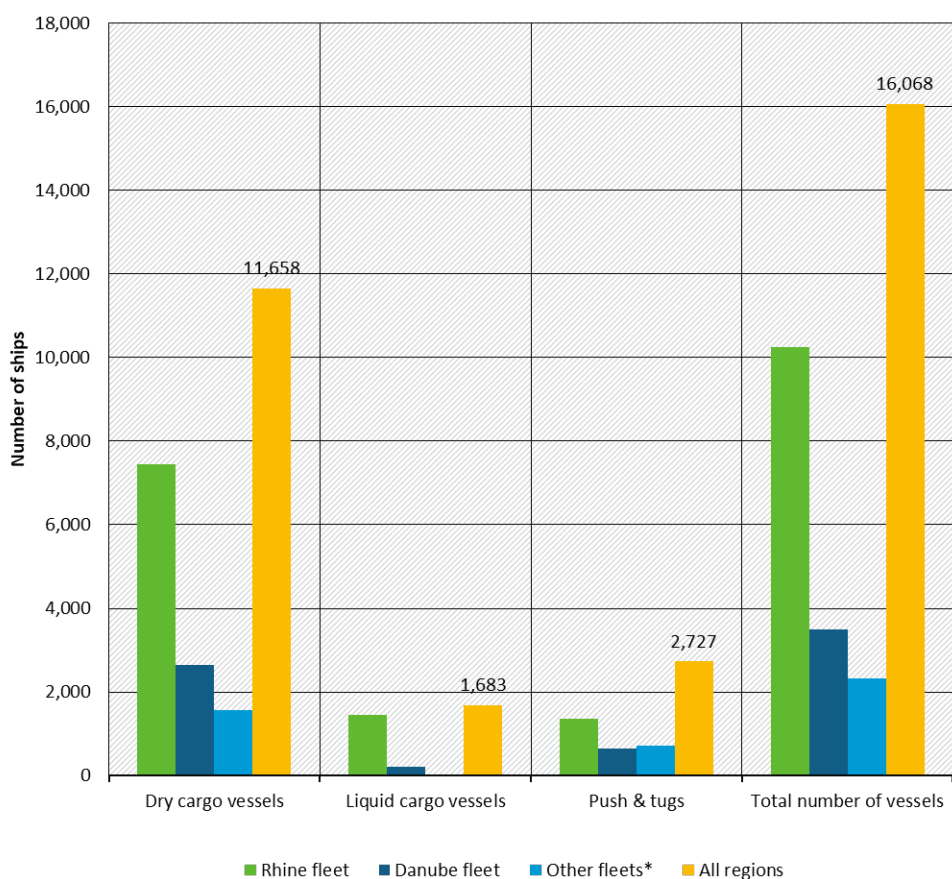
As Figure 9 illustrates, in 2021, the number of inland cargo vessels of the Rhine basin, Danube basin and other countries⁴⁶ amounted to 16,068 (CCNR 2022b). The largest share of the inland cargo vessels is active on the Rhine followed by the Danube fleet having the second largest fleet. The fleet of 'other countries' include the vessels registered and active in Poland, Czech Republic, Italy, United Kingdom, Finland and Lithuania. Data availability is best for the Rhine fleet.

⁴⁴ TEN-T = Trans-European transport network, consisting of two layers - the core and the comprehensive network. The core network includes the most important connections linking major cities/nodes and must be completed by 2030. The comprehensive network connects all regions of the EU to the core network and needs to be completed by 2050. More information here: https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

⁴⁵ A river basin is the land area that is drained by a river and its tributaries.

⁴⁶ These figures include the fleet of Poland, the Czech Republic, Italy, the UK, Finland and Lithuania.

Figure 9: Number of inland cargo vessels sorted by region

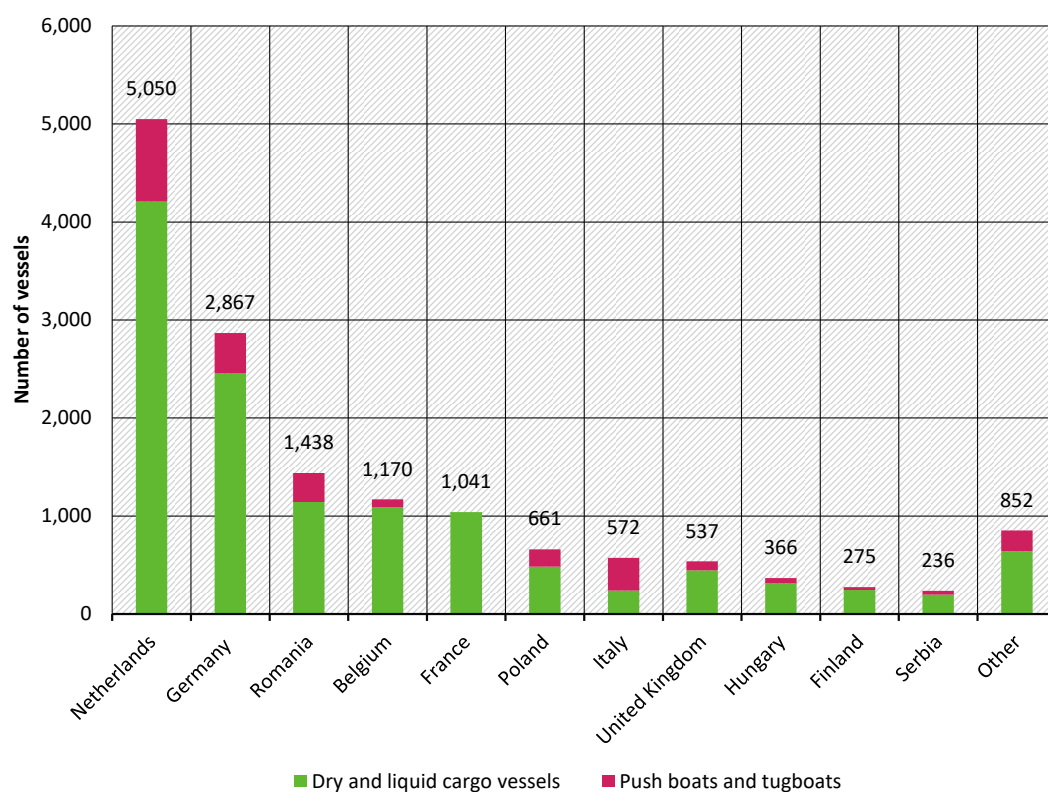


Source: CCNR (2022b)

Notes: * "Other fleet" of other countries entail: Poland, the Czech Republic, Italy, the UK, Finland, Lithuania; data for liquid cargo vessels in other countries is incomplete and thus not indicated.

In Figure 10 the number of active inland cargo vessels is presented by country. For the most part, the fleet consists of Dutch and German vessels (approximately 50% of all inland cargo vessels in Europe). The total number of inland cargo vessels across countries sums up to approximately 15,000 ships.

Figure 10: Number of inland cargo vessels sorted by country



Source: CCNR (2022b)

Fuel use and emissions

In general, inland vessels use diesel (gasoil) as the main fuel for propulsion. A limited number of tankers run on LNG. The uptake of LNG is not expected to increase since its use in inland shipping is not considered successful given the lack of growth in the share of vessels using this type of fuel. Some vessels use GTL (gas-to-liquids, a synthetic diesel oil made from natural gas), which is a synthetic fuel that can be used in the existing engines.

The total CO₂ emissions of the sector can be roughly estimated; an exact inventory has not been carried out. Since a waste deposit fee has to be paid for each litre of bunker fuel sold to inland ships navigating the Rhine and other waterways in Germany, the Netherlands Belgium France, and Luxembourg⁴⁷, the bunker fuel sold to inland shipping along these waterways is well known. In 2021, the bunker fuel sold within this scope amounted to 1.3 billion litres, corresponding to approximately 3.6 Mt CO₂. The share of transport work (goods only) as carried out by inland shipping on the different European waterways (see Figure 12 below) is used to estimate the total CO₂ emissions of the entire European inland shipping sector⁴⁸. The estimation results in approximately 4.9 Mt CO₂. Compared to the CO₂ emissions of the maritime ships that fall under the EU MRV Maritime Regulation and have been active within the scope of the EU MRV Maritime

⁴⁷ The Convention on the collection, deposit and reception of waste produced during navigation on the Rhine and inland waterways (CDNI) came into force on 1st November 2009 in Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland. It applies on the entire length of the Rhine and on all the navigable inland waterways of Germany, the Netherlands and Belgium, and on the international section of the Moselle in the Grand Duchy of Luxembourg and France as well as on certain French canals.

⁴⁸ The average CO₂ emissions per tonne-kilometres are determined for the river basins where the waste deposit fee applies, by relating the above-mentioned 3.6 Mt CO₂ to the transport work as specified for these river basins in [Der Titel "CCNR (Hg.) 2022 – Annual Report 2022 inland navigation" kann nicht dargestellt werden. Die Vorlage "Fußnote - Graue Literatur / Bericht / Report - Feld "Autor" ist leer | Feld "Institution" ist leer" beinhaltet nur Felder, welche bei diesem Titel leer sind.] (2022b).

Regulation (124 Mt CO₂ in 2021 according to the Fourth Annual Report of EC (2023b)), the CO₂ emissions of the inland fleet can be considered to be relatively low.

Inland waterway transport is one of the most energy-efficient modes of transport per tonne of goods carried, consuming on average only 17% of the energy required for road transport and 50% of the energy required for rail transport (Jacobs 2022).

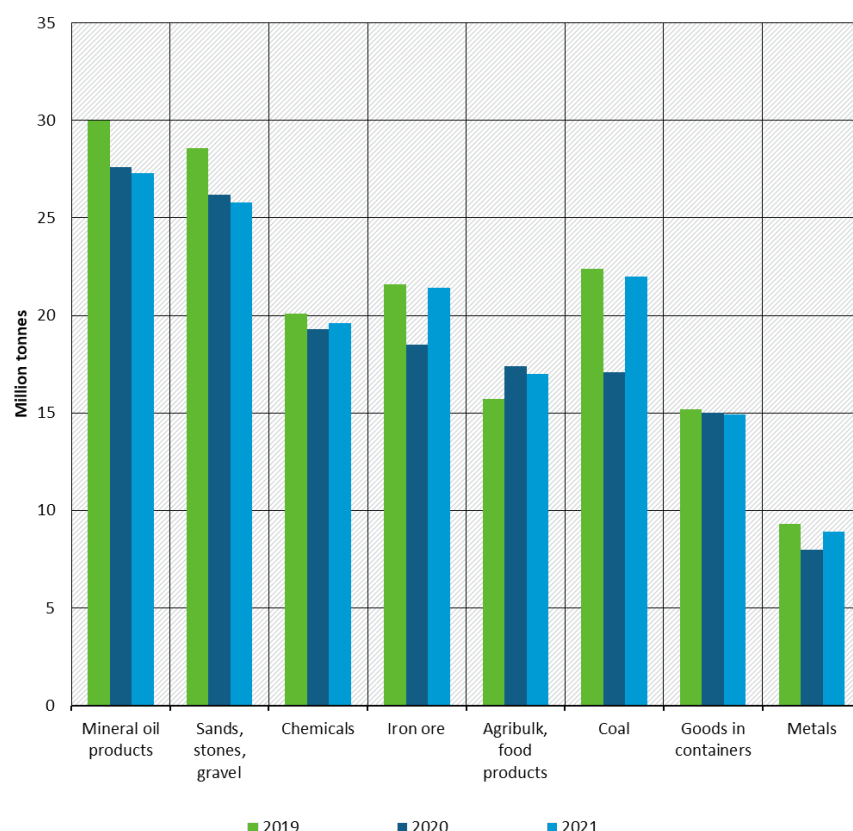
2.2.3 Transport of goods

Goods transported

The main goods transported by inland shipping are bulk goods such as coal, sand, and gravel, as well as containers and liquid bulk goods such as petroleum products.

In the Rhine basin, oil products, sands and gravels, coal, and iron ore are the largest product groups transported by weight. While some product groups show a decrease in the volume transported in the past years, coal, iron ore, metal, and chemicals showed an increase. See Figure 11 for an overview of the trends by product group.

Figure 11: Development of the volume of the different goods transported by inland navigation on the traditional Rhine



Source: CCNR (2022b)

Transport performance

The modal share of inland waterway transport in the EU transport market is stable at 6%, with the highest country shares in the Netherlands (43%), Bulgaria (31%), and Romania (28%).

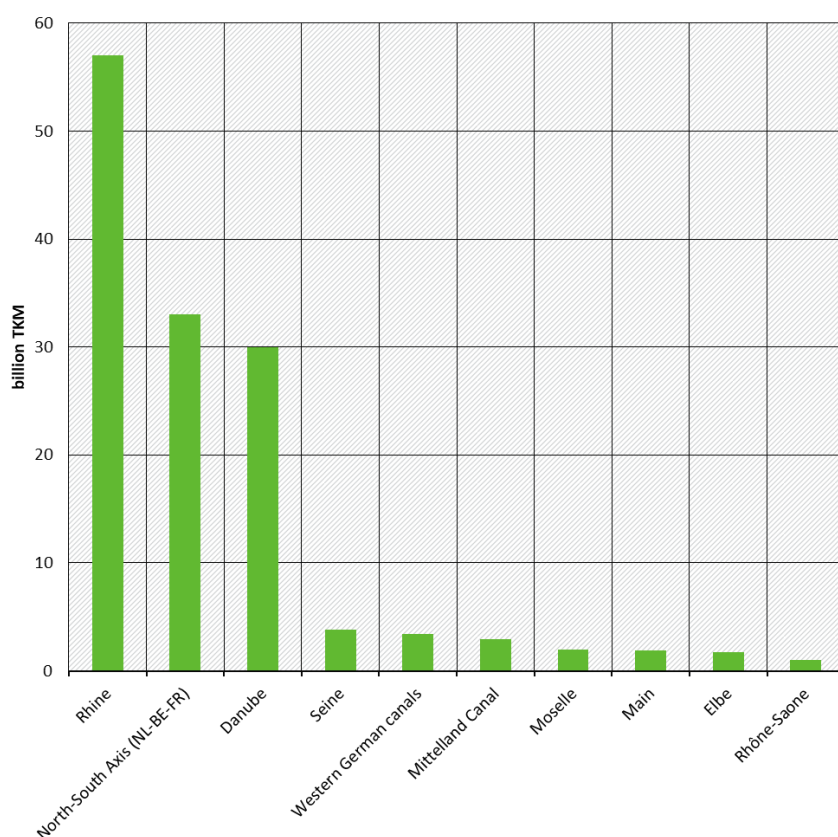
The transport work performed by the inland shipping sector in the EU amounted to 137 billion tonne-kilometres (TKM) in 2021, primarily in market segments steel, agriculture, food, and chemicals.

Most voyages of inland cargo vessels are limited to a specific river basin. A division of the TKM performance by river basin is presented in Figure 12 below. Transport performance in the Rhine basin was highest, representing 57 billion TKM in 2021. River basins with a transport performance lower than 1 billion TKM are not included in this graph; these are the Thames basin, the Main-Danube canal, Berlin area, the Po basin and the Oder-Vistula basin (CCNR 2022b).

Capacity utilisation

The capacity utilisation of the fleet gives an indication of the performance of the sector and the potential for an increase of freight transport by inland waterways as a consequence of a shift from road transport. In 2021, the dry cargo transport segment had a utilisation rate of 81%, of which vessels with a larger average carrying capacity (over 2,000 tonnes) had a slightly lower utilisation (79%). The utilisation of tanker vessels in 2021 varied widely by vessel size: the smallest vessels (<1,000 tonnes) had a utilization of 99%, the vessel size group 1,000 to 2,000 tonnes had a utilisation of 91%, while larger tanker vessels had a utilisation of merely 61%. The average utilisation of all tanker vessels is 68% as there are a higher number of vessels with a lower utilisation than with a high utilisation (CCNR 2022b).

Figure 12: 2021 transport performance of inland water navigation by river basin



Source: CCNR (2022b)

2.2.4 Market structure

Shipping companies

The latest statistics show that 5,405 inland freight shipping companies were active in Europe in 2021 (EU plus Switzerland), with 4,831 (89%) located in the Rhine riparian countries (the Netherlands, Germany, Belgium, France, and Switzerland) (Eurostat 2022b). Key figures for inland freight transport are shown in Table 5.

Table 5 also shows that the European inland shipping sector consists of many small and medium-sized enterprises. The weighted average number of vessels per company is three, considering the shares of number of companies per segment. The high number of companies with a small number of emission sources (vessels) per entity (company) can potentially lead to relatively high administrative costs should the sector be included in the EU emissions trading system. The sector would face relatively lower administrative costs if they were included in the EU ETS 2, in which the fuel suppliers are the responsible entities to surrender emission allowances.⁴⁹ In the latter case, the carbon costs would be included in the fuel price that inland shipping companies pay when bunkering their vessels.

Table 5: Inland freight transport: number of companies, vessels and people employed sorted by river basin

River basin	No. of companies	Share of companies	Total number of vessels	Vessels per company	People employed	People employed per company
Rhine	4,831	89.4%	10,256	2.1	17,787	3.7
Danube	177	3.3%	3,498	19.8	2,860	16.2
Other Europe	397	7.3%	2,314	5.8	1,896	4.8
Total	5,405	100%	16,068	3.0	55,543	4.2

Source: Data from Eurostat (2022b), distribution per river basin based on method/categorization in CCNR (2022b)

3,202 companies in Europe operate in the passenger segments river cruise, day trip on rivers, canals, and lakes, and ferries for commuter and tourist transportation.

Employment

Inland navigation employs approximately 48,000 people in total, mostly in small and medium-sized enterprises (SMEs) and as self-employed workers (CCNR 2022a). The sector lacks sufficient supply of qualified personnel and the number of employees has decreased since 2014 (CCNR 2022a). In 2020, 23,170 people were employed in inland *freight* transport, including self-employed, helping family members, and employees. Rhine riparian countries accounted for 75%, Danube countries for 15%, and companies in countries outside the Rhine and Danube regions for 10% of the people employed (CCNR 2022b).

2.2.5 Technological abatement options

Inland waterway transport has the lowest GHG emissions per TKM of the main inland transport forms (inland shipping, rail and road). There is not currently a specific emission reduction target for the GHG emissions of inland shipping in the EU. Nevertheless, the fuel mix used in the sector

⁴⁹ The Netherlands has now decided in favor of an opt-in, so that inland navigation will fall under the EU ETS 2 implementation: <https://www.maritiemmedia.nl/nieuws/scheepvaart/18078/ministerraad-besluit-ets2-gaat-ook-voor-de-binnenvaart-gelden>

needs to comply with the Renewable Energy Directive (RED), meaning that the carbon intensity by unit of fuel used in inland shipping will decline over time.

Generally, the same abatement options are available for inland shipping as for maritime shipping (section 2.1.1.3). However, some options might be more suitable for inland shipping vessels than others. This stems from the fact that inland vessels are on average smaller, have shorter distances to cover between ports and use less fuel per transported distance unit. The following technological abatement options are available for inland shipping vessels:

- **Using battery-electric propulsion:** The inland shipping market is focused on a small number of high traffic intensity routes, which is specifically suitable for ships using batteries or a system of interchangeable energy containers for propulsion⁵⁰.
- **Using climate-neutral or low-carbon fuels as in maritime shipping:** For example, drop-in capable biofuels⁵¹ (like biodiesel) are a short-term option to reduce emissions. In the long term, RFNBOs, including hydrogen, and (to a limited extent) sustainable biofuels are also an option for inland shipping. Since the routes are shorter in inland than in maritime shipping, a higher number of (inland) vessels are able to complete journeys between departure and destination ports on a full storage load of alternative fuels with lower energy density (e.g. hydrogen). Storage capacity and range pose relatively few problems compared to deep-sea vessels.
- **Applying lower sailing speed:** In some cases, a lower sailing speed could be possible practically and can result in lower emissions per transported kilometre.⁵²

In summary, there are several options for zero-emission alternative fuels and drivetrains for inland vessels in the (near) future. It is not yet clear, however, what alternative(s) the sector will materialise as the best options for achieving their emission reduction targets.

2.3 Future market structure in the face of new policies

There are many factors which could potentially change the market structure of the shipping sector as described in the previous sections. A shift in world trade patterns, the decarbonisation of energy systems, political tensions and shipping-specific policies could all influence the market structure.

The following aspects might result from 'Fit for 55' policies and could influence market structures:

- For seaborne EU exports that have to compete on markets outside the EU with non-EU products, the EU ETS 1, as a regional scheme, might lead to market distortions. To give an example: cars produced in Europe and exported to Japan might compete with cars produced in the USA which are exported to the Japanese market. The European-produced cars might lose market share if the prices of the European cars are increased due to higher transportation costs.

⁵⁰ An example of the port of Rotterdam; <https://www.portofrotterdam.com/en/news-and-press-releases/first-emission-free-inland-shipping-vessel-on-energy-containers-in-service>

⁵¹ Drop-in capable fuels are defined as fuels that can be used in existing fossil fuel propulsion systems, without alterations of the system.

⁵² <https://www.kimnet.nl/publicaties/rapporten/2015/07/06/naar-een-duurzame-zee--en-binnenvaart-in-2050>

- ▶ However, the impact of an increase of the transportation costs on freight rates and product costs can differ highly between segments and markets. In general, the impact on product prices is expected to be higher for products with a low per tonne value, e.g. coal.
- ▶ If the policies incentivise the uptake of renewable fuels and a reduction of the consumption of fossil fuels, it will affect the fuel supply chains, including those of related maritime transport.
- ▶ Market structures could change due to evasive behaviour of ships subject to the EU ETS 1. The impact assessment on the extension of the EU ETS 1 to maritime transport concluded that evasive port calls are unlikely in the short term, but that policy evasion will become more likely with higher GHG pricing towards 2050 (see section 3.2 for details). However, as other policies like the FuelEU Maritime Regulation become more stringent towards 2050, decarbonisation will also be further advanced towards 2050, lessening the importance/impact of the GHG pricing. The impact assessment also deemed modal shift unlikely and that the risk that ships use alternative non-EU transshipment ports is significantly decreased by the final, agreed text of the EU ETS 1 Directive. Non-Union ports within 300 nautical miles of a MS port, where the transshipment of containers accounts for a significant share of the total container traffic, are namely excluded from the port of call definition in the Directive to reduce the risk of evasion (section 2.1.1.2).

It is unlikely, however, that the 'Fit for 55' policies and proposals (chapter 3.3) will significantly change the current shipping market structure. Events, like the COVID-19 pandemic, can have a much larger impact on trade and thus market structures than policies.

3 Policy analysis

This chapter provides an analysis of existing policies for EU-related shipping in force before the 'Fit for 55' package, including inland shipping, in order to understand against which background the extension of EU ETS 1 to maritime transport is implemented. As a second step, the principle effects of the integration of maritime transport into the EU ETS 1 are presented based on the impact assessment accompanying the legislative proposal. As a third step, the interaction of the EU ETS 1 with other legislations, proposals and revisions of the 'Fit for 55' package and potential IMO policies is thus analysed to complement the policy analysis. The chapter takes an EU perspective and considers, if appropriate, the national (German) level. The analysed scope includes maritime transport of ships above 400 GT in line with the previous chapter and where appropriate also inland navigation.

3.1 Existing shipping policies

National level

The EU Energy Taxation Directive (ETD) is implemented in Germany as the Energy Tax Act (EnergieStG)⁵³. This law exempts (marine) fuels if used in ships from the energy tax according to § 27 of the EnergieStG. Exemptions of tax revenues in Germany amount to approximately EUR 249 million from domestic shipping and EUR 595 million from international shipping in 2020 (based on bunker fuel sales⁵⁴). Marine fuels used in commercial shipping are thus not subject to energy taxes in Germany and in the EU. To reach the target of the EU Effort Sharing Regulation (ESR), Germany implemented the national emission trading system (nEHS) in 2021. The ESR sets climate targets for all sectors not covered by the EU ETS 1 (see section 3.3.5). The ESR thereby also includes domestic shipping (i.e. inland navigation and maritime transport in national waters). The nEHS, however, exempts commercial shipping, inland and maritime, from the carbon pricing as commercial shipping is not subject to energy tax. Commercial shipping is also exempt from any reporting obligation (DEHSt 2023, p. 21). This exemption only applies to commercial shipping under the nEHS, while monitoring, reporting and surrender obligations for commercial shipping exist under the EU ETS 1. Any fuel sold to non-commercial shipping, which is subject to energy taxes, would fall under the nEHS. In Germany, the use of fossil fuels is also subsidised in the form of funding programs for retrofitting ships to LNG use and the building of LNG bunkering vessels (BMW 2017; DMZ 2022). There is no explicit policy instrument for reducing GHG emissions from commercial inland shipping in Germany, but there is, among other things, a funding program⁵⁵ which includes retrofits or newbuilds running on alternative fuels with the aim of reducing air pollution from inland navigation.⁵⁶

Policies to decarbonise maritime shipping are nowadays mostly addressed at EU and IMO levels. In addition, Germany provides funding to accelerate the transition via several investment programmes. These funding programs⁵⁷ include funding for investment in shore-side electricity

⁵³ <https://www.bgbl.de/33885050-1ec1-4b44-a303-6ebf699d0bf9>

⁵⁴ Calculation based on the applicable tax levels in the EnergieStG and the energy consumption from bunker fuel sales as reported in the National GHG Inventory.

⁵⁵ Paragraphs 3.2.1 and 3.2.2 in "Richtlinie zur Förderung der nachhaltigen Modernisierung von Binnenschiffen" : https://www.elwis.de/DE/Service/Foerderprogramme/Nachhaltige-Modernisierung-von-Binnenschiffen/Foerderrichtlinie.pdf?__blob=publicationFile&v=3

⁵⁶ <https://www.bundeshaushalt.de/static/daten/2024/soll/Bundeshaushalt-2024.pdf>, Inland shipping fuel switch, position 683 13-732; LNG shipping, position 891 62 -642, onshore power supply for maritime and inland shipping, position 892 62 -642

⁵⁷ Federal budget: https://www.bgbl.de/xaver/bgbl/start.xav#_bgbl_%2F%2F%5B%40attr_id%3D%27bgbl122s2485.pdf%27%5D_1679748389486

connections onboard, innovative ship building, LNG ships and the “climate-neutral ship” program for research and development projects. Further, national shipping might benefit indirectly through funding and activities initiated through the national hydrogen strategy and the related promotion of hydrogen and hydrogen-derived fuels (BMW 2020).

EU level

Several policies are in place or are under discussion which target the climate impact of shipping at the EU level. The ESR also includes national shipping (inland and maritime without a gross tonnage threshold). The interaction with the extension of the EU ETS 1 to maritime transport is discussed in section 3.3. Further, Regulation 13 and Regulation 14 of International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI set limits in emission control areas (ECAs) for nitrogen oxide (NO_x) and sulphur oxide (SO_x) emissions for ships in European waters (North Sea and Baltic Sea). Starting in May 2025, the Mediterranean Sea will also become an ECA for SO_x.⁵⁸ To comply with these limits, ships increasingly use exhaust gas aftertreatments and fuels with a lower sulphur content (MGO, LNG, VLSFO) instead of heavy fuel oil (HFO) (EMSA; EEA 2021). The use of these fuels in European waters influences the GHG emissions covered by the EU ETS 1, as LNG causes lower CO₂ emissions than HFO but also leads to methane slip,⁵⁹ increasing the share of methane emissions of the European fleet. However, these methane emissions will also be covered by the EU ETS 1 from 2026 onwards (see box in chapter 1). As RFNBOs burn more cleanly, emitting fewer air pollutants, ECAs theoretically indirectly set an incentive for using RFNBOs. The use of the latter in turn reduces GHG emissions and ECA are thus complementary to the extension of the EU ETS 1 to maritime transport. Further, the EU MRV for emissions from maritime transport has been in place since 2018, establishing a monitoring and reporting obligation for CO₂ emissions (see box in chapter 1).

Renewable fuels used in (national) maritime transport could be used to comply with the renewable energy targets for transport under the Renewable Energy Directive II (RED II). The RED II established mandates for the share of renewable energy in the transport sector up to 2030. While the mandates only applied to road and rail transport within the RED II, the aviation and shipping sector could contribute to the targets. This has now been revised under the RED III (section 3.3.4). As mentioned above, the European ETD allows Member States to exempt fuel used in shipping from being subject to energy taxes. The ETD is, however, under revision which includes a proposal to change this exemption (section 3.3).

Global level

ECAs also exist outside European waters (e.g. North America). There has been a global limit, outside the ECAs, on the sulphur content of fuel (0.5%) in place since 2020.⁶⁰ Similar to the ECAs in European waters, these regulations interact with the extension of the EU ETS 1 to maritime transport as ships operating in international waters might use fuels, like LNG, which have different GHG emissions to heavy fuel oil (HFO), which can in turn impact the surrender obligation under the EU ETS 1. There is no carbon pricing mechanism for maritime transport on the international level. However, there are policies adopted by the International Maritime Organisation (IMO) which influence the GHG emissions of maritime transport globally and thus also EU-related maritime transport covered under the extended EU ETS 1. An overview is provided in Table 6.

⁵⁸ <https://www.imo.org/en/MediaCentre/PressBriefings/pages/MEPC-79.aspx>

⁵⁹ Leakage of unburned methane into the atmosphere from an engine fueled with methane. Slip rate depends on the engine type. Methane is a much stronger GHG than CO₂ with a Global Warming Potential 28-36 times higher than CO₂ over a 100-year period.

⁶⁰ IMO – Regulation 14 on SO_x and particulate matter: [https://www.imo.org/en/OurWork/Environment/Pages/Sulphur-oxides-\(SOx\)-%E2%80%93-Regulation-14.aspx](https://www.imo.org/en/OurWork/Environment/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx)

The IMO set up the Data Collection System (DCS) in 2019 which requires ships to collect and report data on fuel consumption and report it to their flag state (Wissner and Cames 2022). The DCS is similar to the EU's MRV system. According to Wissner and Cames (2022), "some of the policies are of a voluntary nature like the capacity-building programme ICTP, a fund for technical cooperation on the implementation of the GHG Strategy (GHG TC Trust Fund) and national action plans". Further, the IMO has adopted several mandatory policies regarding the energy efficiency of ships (Wissner and Cames 2022):

- ▶ "The Energy Efficiency Design Index (EEDI) sets compulsory energy efficiency standards for new ships built after 2013;
- ▶ The Ship Energy Efficiency Management Plan (SEEMP) requires ships to develop a plan to monitor and possibly improve their energy efficiency;
- ▶ The Energy Efficiency Existing Ship Index (EEXI) requires every operator to improve the technical energy efficiency of existing ships. The energy efficiency level of those ships needs to improve to a level comparable to a new ship of the same type and deadweight in correspondence with the applicable EEDI;
- ▶ The Carbon Intensity Indicator (CII) regulates operational carbon intensity by requiring a linear reduction of the in-service carbon intensity of a ship (of 5,000 GT or larger) between 2023 and 2030."

These energy efficiency policies have hitherto not been able to reverse the trend of increasing emissions in the sector (Wissner and Graichen 2024). All policies are complementary to the extension of the EU ETS 1 to maritime transport and FEUM as lowering emissions for compliance with the IMO policies also reduced surrendering obligations under the EU ETS 1 and facilitates compliance with FEUM. For example, Nelissen et al. (2023) assess the CII and conclude that it is complementary to the EU ETS 1 and FEUM, but that aspects of the CII need to be revised and that further emissions reductions are necessary for the EU MRV fleet of 2019 to achieve the IMO carbon intensity target.

Market-based and fuel-related policies have gained attention again at IMO as part of a basket of mid- and long-term measures necessary to achieving the targets of the IMO GHG Strategy (Shaw and Smith 2022). IMO Member States adopted a revised GHG Strategy at the 80th meeting of the Marine Environment Protection Committee (MEPC80) in July 2023 (IMO 2023). It provides an update of the Initial Greenhouse Gas Strategy, adopted by the IMO in 2018 (IMO 2018), which has been the main framework for shipping's climate targets to date (Wissner and Graichen 2024). The revised strategy includes a new long-term goal "to peak GHG emissions from international shipping as soon as possible and to reach net-zero GHG emissions by or around, i.e. close to 2050" (IMO 2023, p. 6). The reduction pathway is underpinned by indicative checkpoints, e.g. with less obligation, for reducing the total annual GHG emissions from international shipping by at least 20%, striving for 30%, by 2030, and by at least 70%, striving for 80%, by 2040, compared to 2008 (Wissner and Graichen 2024). Further, the revised strategy foresees the uptake of "zero or near-zero GHG emission technologies, fuels and/or energy sources" (IMO 2023, p. 6) which shall represent at least 5%, striving for 10%, of the energy used by international shipping by 2030 (Wissner and Graichen 2024).

According to Healy et al. (2023), „another important decision at MEPC80 was that all reduction targets and indicative checkpoints mentioned above shall take a well-to-wake approach for GHG emissions of marine fuels and include not only CO₂ but also other relevant GHG (such as methane and nitrous oxide)". This aligns future IMO policies with the current design/scope of

EU policies, namely FEUM and the EU ETS 1. The agreement on the well-to-wake approach and inclusion of other GHGs is connected to the adoption of the IMO guidelines on the life cycle GHG intensity of marine fuels. According to Healy et al. (2023), “these guidelines are not a mandatory policy instrument but will be used for the implementation of future measures, like a fuel standard or carbon pricing mechanism”.

There are currently (as of mid-2023) many proposals for new policies, so-called mid- and long-term measures, on the table. As a first step, it was agreed at MEPC80 that there shall be a basket of measures consisting of two parts: a technical element, which shall be a “goal-based marine fuel standard regulating the phased reduction of the marine fuel’s GHG intensity, and an economic element to price GHG emissions” (IMO 2023, p. 8). Both measures will be further discussed. It is planned that they will be finalised and agreed upon in 2025 and enter into force in 2027 the earliest.

Table 6: Overview of existing relevant shipping policies

Description	Type of measure	Type of policy	Applicability	Implementation date
Germany				
Support/ funding programmes	Ship design / Fuel switch	Funding	Voluntary, ships in national waters	Miscellaneous
National emissions trading system (nEHS)	Emissions trading system	Carbon pricing	Mandatory, fuel distributors (fuel sold to non-commercial shipping)	2021
EU level				
Renewable Energy Directive	Fuel / Energy switch	Quota	Mandatory, ships in national waters	2009, latest revision 2023
Emission Control Area	Ship design / Fuel switch	Standard	Mandatory, ships in EU waters	2006/7 (SO _x) 2021 (NO _x)
Maritime Monitoring, Reporting and Verification System	Monitoring	MRV	Mandatory, EU-related commercial maritime transport	2018
IMO level				
Energy Efficiency Existing Ship Index	Ship design	Standard	Mandatory, existing ships	2023
Carbon Intensity Indicator	Ship operation	Rating / Standard	Mandatory, ships in operation	2023
Energy Efficiency Design Index	Ship design	Standard	Mandatory, newbuild ships	2013
Ship Energy Efficiency Management Plan	Ship design	Standard	Mandatory, newbuild and existing ships	2013

Description	Type of measure	Type of policy	Applicability	Implementation date
Data Collection System	Monitoring	MRV	Mandatory, all ships with IMO number > 5 000 GT	2019
Integrated Technical Co-operation Programme	Capacity building (workshops etc.)	Voluntary effort by countries	Voluntary, national/regional	2019
GHG TC Trust Fund	Capacity-building	Subsidy	Voluntary	2019
National Action Plans	Monitoring	Voluntary effort by countries	Voluntary	2019
Emission Control Area	Ship design / Fuel switch	Standard	Mandatory, global	2020 (latest)

Notes: GT = gross tonnage.

Source: Own compilation

Overall, maritime transport emissions and energy use are thus mostly regulated at EU and IMO levels. The national level is focused on funding certain aspects of the transition and keeps fossil fuels tax-free. GHG emissions from inland shipping are similarly not regulated and are instead indirectly addressed through air pollution regulations at national level.

3.2 Principal effects of the extension of the EU ETS 1 to maritime transport

A study was undertaken by Budaragina et al. (2021) to support the Commission by proposing how best to regulate GHG emissions from maritime transport in order for the sector to contribute to the GHG reduction targets of the EU. The following policy options were each assessed under three different geographical scopes:

1. inclusion of maritime emissions in the EU ETS 1 (MAR 1);
2. a separate ETS for maritime (MAR 2);
3. alternative carbon pricing policy option: levy on ship GHG emissions (MAR 3);
4. combination of an EU ETS 1 extension with standards (MAR 4).

The MAR 1 policy option is most aligned with the final decision adopted by the European Parliament and the European Council on the 16th May 2023, as from January 2024 the EU ETS 1 has been extended to cover CO₂ emissions from all large ships (of 5,000 GT and above) entering EU ports, regardless of the flag they fly. The inclusion of maritime transport in the EU ETS 1 covers 50% of emissions from voyages starting or ending outside of the EU and 100% of emissions that occur between two EU ports and when ships are within EU ports. This aligns exactly with the geographical scope titled MEXTRA50⁶¹ that was assessed within the Budaragina et al. (2021) study, which we focus on when summarising the principal effects of the MAR 1 policy option based on the outcome of the impact assessment. Table 7 provides a comparison between the assumptions for the design of the EU ETS 1 under the MAR 1 policy option and what was finally adopted in the revision to the EU ETS 1 for Phase IV. Further details of the final

⁶¹ Covering 100% of emissions from intra-EEA journeys, 50% of all extra-EEA voyages (or 100% of all incoming extra-EEA voyages, or 100% of all outgoing extra-EEA voyages) and emissions at berth in EEA ports.

agreement on the extension of the EU ETS 1 to maritime transport can be found in the box in chapter 1.

Table 7: Assumptions on EU ETS 1 design under the MAR 1 policy option compared with the finally adopted EU ETS 1 changes

	MAR 1 policy option	Final adopted decision
Coverage of GHG emissions	Two options considered: - CO₂ only – aligned with current EU MRV Maritime Regulation - CO₂ plus other GHG emissions, e.g. CH₄ and N₂O aligned with some sectors in the EU ETS 1 Impacts refer to CO ₂ only and then the share of non-CO ₂ emissions in each scenario.	CO ₂ from 1 st January 2024 and from 1 st January 2026 also CH ₄ and N ₂ O
Cap	Aligning the cap trajectory with the EU ETS 1 LRF	Aligning the cap trajectory with the EU ETS 1 LRF
Allocation	Two options considered: - Full auctioning - Mix of auctioning and free allocation based on benchmarking Full auctioning stated as preferred option with limited scope at outset.	Full auctioning
Transition period for surrendering allowances	Shipping companies have to surrender allowances for the following portion of their reported emissions: Year 1: 25% Year 2: 50% Year 3: 75% Year 4 onwards: 100%	Shipping companies have to surrender allowances for the following portion of their reported emissions: 2025: 40% 2026: 70% 2027 onwards: 100%
Revenue recycling	Establishing a centralised fund or a contribution to existing fund which will help recycle all or a significant share of generated revenue specifically into the maritime sector based on a fixed amount of auctioned allowances that MS shall dedicate to maritime transport based on the sector's contribution to the overall cap.	20 million allowances (i.e. approximately EUR 1.6 billion at a price of 80 EUR per allowance) should be deployed up to 2030 via the EU Innovation Fund to support the decarbonisation of the sector, notably through dedicated topics in future calls for proposals. ⁶²

Source: Own compilation based on impact assessment (Budaragina et al. 2021) and final adopted decision (Directive (EU) 2023/959 2023).

Given that the MAR 1 scenario is based upon an assumed carbon price in 2030 of EUR 46, which is considerably below the current market situation, the outcome of the impact assessment is likely to underestimate some of the economic impacts. The impact of FEUM (section 3.3.1) is taken into account for all policy scenarios. Budaragina et al. (2021) explain that the modelling considers the FEUM Impact Assessment specifications regarding the fuel mandates and assumes blending of the alternative fuels with fossil counterparts for all policy options. These impacts are not separately disclosed in the study. However, more general references are made throughout

⁶² https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector/faq-maritime-transport-eu-emissions-trading-system-ets_en#use-of-revenues

on the impact of the complementary policy in terms of a reduction in GHG emissions and air pollutants due to increased energy efficiency and uptake in the use of alternative fuels. The modelling also considers existing directives at the time of the publication such as RED, AFID and ETD, though no details about them are disclosed (Budaragina et al. 2021, p. 7). The relevance of these policies before the 'Fit for 55' package for the shipping sector is described in section 3.1.

The following impacts were evaluated by the Budaragina et al. (2021) study for several policy options compared to the baseline scenario:

- **GHG emissions:** Without any intervention, the CO₂ emissions from the maritime sector (international and domestic) in the baseline scenario are projected to increase from 122 Mt CO₂ in 2015 to 138 Mt CO₂ in 2030 and to 161 Mt CO₂ in 2050 as a result of an expected increase in activity over the time period (Budaragina et al. 2021, section 4.3.1). The cumulative emission reduction (in-sector) between 2020 and 2050 for the MEXTRA50 MAR 1 scenario was estimated to be 1,525 Mt CO₂ below the baseline scenario (Budaragina et al. 2021, section 4.3.1). This corresponds to a percentage change of 13% and 92% below the baseline scenario in 2020 and 2050 respectively. The cumulative in-sector emission reduction between 2020 and 2050 compared to the baseline scenario is only slightly higher under the MEXTRA100⁶³ MAR 1 scenario with an overall reduction of 1,549 Mt CO₂ (Budaragina et al. 2021, section 4.3.1). This might be due to the relatively higher out-of-sector emission reductions (buying of emission allowances) in the MEXTRA100 MAR 1 scenario than in the MEXTRA50 MAR 1 scenario (Table 4-3 in Budaragina et al. (2021)).

Given the limited availability of mature technological options to reduce emissions up until 2030, the abatement potential on top of the fuel mandates of FEUM is deemed to be relatively low. As a result, changes in the carbon price ranging up to 20 EUR per tonne would only result in marginal changes in the emissions of the maritime sector. It would require a carbon price in excess of 100 EUR for the 2030 time horizon for some uptake of biofuels to occur to achieve further CO₂ emission reductions. The study outlines that the share of non-CO₂ emissions in overall GHG emissions remains stable up to 2030 (approximately 2% in all policy options) but increases over time in scenarios in which carbon neutrality is achieved by 2050.⁶⁴ This trend is explained by the increased use of LNG as a propulsion fuel, which is associated with higher methane emissions. In the MAR 1 scenario, it was expected that the share of non-CO₂ emissions in total emissions would increase to 3.5% by 2050. However, this was subsequently updated to 15% after a refinement of the modelling approach and this underlines even more strongly the importance of addressing non-CO₂ emissions to prevent the lock-in of high emitting technologies. Indeed, this finding provides strong evidence to support the agreed inclusion of methane and nitrous oxide within the extended scope of the EU ETS 1 to maritime transport from 2026 onwards.

- **Air pollutants:** Under the geographical scope of MEXTRA50, the impact of the MAR 1 scenario on air pollution is a reduction of 6% below the baseline for carbon monoxide, 7% below the baseline for NO_x, non-methane volatile organic compounds (NMVOC) and particulate matter (PM₁₀) and 8% below the baseline for SO_x. The reduction of air pollutants relative to the baseline is only slightly higher under the more ambitious MEXTRA100 scope for the MAR 1 scenario. In absolute terms, the cumulative emission reduction of NO_x, carbon monoxide, NMVOC, PM₁₀ and SO_x between 2020 and 2050 is estimated to be 5,190 kt, 353 kt,

⁶³ Covering 100% of emissions from intra-EEA voyages, 100% of extra-EEA voyages and emissions at berth in EEA ports – following the same scope as the EU MRV Maritime Regulation (referred to as MEXTRA100)

⁶⁴ Budaragina et al. ((2021)) estimate that adding non-CO₂ GHG emissions would have a negligible effect in 2030 but in 2050 GHG emissions (in CO₂eq) would be 3.6 – 4.0% higher than CO₂ emissions (refer to the note under Table 5-8 on page 170).

180 kt, 223 kt, and 940 kt below the baseline scenario and under the MEXTRA50 scope respectively (Budaragina et al. 2021, section 4.3.3).

- ▶ **Energy use:** The extension of the EU ETS 1 to the maritime sector (MAR 1) is expected to result in an increase in energy efficiency; however, Budaragina et al. (2021) does not specifically state which measures are deployed in order to increase levels of energy efficiency in the MAR 1 scenario. Pons et al. (2021) does provide further information on the modelling approach undertaken. The abatement potential of energy-saving technologies (e.g. engine and propeller improvements) considered within the PRIMES model is based on the use of marginal abatement cost curves. The deployment of renewable energy or alternative fuels and speed reduction are additional options that are included within the marginal abatement cost curves. The annex further clarifies that due to uncertainties in costs, the retrofitting (e.g. re-purposing / upgrading an engine of an existing vessel to improve energy efficiency or to run on alternative fuels) of existing vessels is not included in the PRIMES maritime model. The rate of energy efficiency improvement is expected to especially increase after 2030, due in part to a much higher ETS price forecast for the future. Indeed, Budaragina et al. (2021) estimate that under the MEXTRA50 scope, the cumulative reduction in energy consumption between 2020 and 2050 compared to the reference scenario would be of 106 Mtoe. The cumulative reduction in energy consumption between 2020 and 2050 compared to the reference is higher under the MEXTRA100 scope, amounting to 119 Mtoe. The scenarios result in an absolute energy consumption of 43 and 42 Mtoe in 2050 respectively.
- ▶ **Biodiversity:** The results from the Budaragina et al. (2021) study in section 4.3.6 indicate that for each of the policy options considered, emissions of NO_x, SO_x and CO₂ would decline relative to the baseline scenario and therefore beneficial impacts on biodiversity are very likely across all of the policy options.
- ▶ **Evasion risk:** Evasion is defined by Budaragina et al. (2021, p. 77) as “an unintended effect of policy implementation which occurs in cases where regulated entities seek to avoid the effects of the policy measure, in order to avoid the associated costs, and benefit from less stringent GHG emission policy measures”. The EU ETS 1 covers emissions from the voyage’s starting point to the voyage’s ending point outside of the EU (or vice versa). There is thus an incentive to keep the distance between the first EU port and the non-EU port short to minimise the carbon pricing costs (as fewer emissions would fall under the EU ETS 1). The following three examples are cited by Budaragina et al. (2021) as potential evasion risks:
 - Evasion port call, whereby shipping operators engage in evasive non-EU port calls;
 - Modal shift, whereby a shift occurs from short-sea shipping to road transport;
 - Transshipment, whereby container ships use an alternative non-EU transshipment hub.

Regulated entities can potentially circumvent the EU ETS 1 as outlined above. The level of the carbon price, type of ship and ship size are all important attributes that influence the costs associated with an evasive port call (Defour and Afonso 2020). The risk of an evasive port call for a case study example is initially deemed low in the Budaragina et al. (2021) study for the MEXTRA50 MAR 1 scenario in 2030 (refer to section 4.3.5). However, there is likely to be an increase in the incentives for policy evasion across all policy options in 2040 due to the higher carbon price and lack of progress made on GHG emission reductions. Given the increase in the current carbon price compared to the lower values assumed in the modelling, it is likely that the risk of evasion could be higher than estimated. These

incentives for policy evasion are, however, likely to lessen considerably by 2050 due to the GHG reductions associated with the application of fuel mandates. Additionally, the definition of a “port of call” in the EU MRV/ETS lowers the evasion risk as cargo/passengers has to be (un)loaded in a port to be defined as port of call (see definition in section 2.1.1.2).

The risk of a modal shift to road will largely depend upon the extent to which the implementation of the policy options will affect the cost of short-sea shipping relative to road transport. According to Notteboom (2020), the use of low-sulphur fuels only has a moderate impact on the cost competitiveness of short-sea shipping routes in Northern Europe. The study highlighted the importance of efficient fleet management in order to remain cost-competitive with road transport.

Pons et al. (2021) estimate the total cost increase at Algeciras (Spain) to determine the likelihood of shipping operators changing the transshipment port as a consequence of the implementation of the policy options. For the MEXTRA50 MAR 1 scenario, the total cost increase by 2030 is calculated to increase by 3% at 1,000 nautical miles and 6% at 10,000 nautical miles (Pons et al. 2021, section 3.3.2.2). It is likely that the additional cost will increase considerably by 2040 as the carbon price continues to rise. The extent to which such an increase in total costs would result in the use of non-EU transshipment ports will depend upon both operational factors as well as the transshipment costs associated with non-EU transshipment hubs that are in close proximity.

- **Economic impacts:** The carbon price in 2030 associated with the MAR 1 scenario is modelled in PRIMES as 46 EUR/t. Pons et al. (2021) confirm that the modelling framework is in line with the Green Deal reduction objectives of the EU (i.e. the MIX scenario). The modelling has therefore considered interactions with the rest of the energy and the biomass systems to assess the feasibility and the costing of the various alternative fuels needed in the maritime sector. Expanding the geographical scope of the MAR 1 policy option to MEXTRA100 results in a higher cost burden for the maritime sector. The cost increases by approximately 7.5% above the reference for the MEXTRA50 scope and 11.7% above reference for the MEXTRA100 scope of the MAR 1 scenario respectively. This corresponds to a cumulative additional cost of between 2020 and 2050 relative to the reference of EUR 338 billion and EUR 475 billion respectively (Budaragina et al. 2021, section 4.4).
- **Social impacts:** All the policy options are likely to result in shipping activity levels remaining the same with net cost savings. However, there is a risk that a very high carbon price or tax rate could result in net additional costs or in significant evasion that could result in a decreased level of shipping activities and subsequently a potential reduction in employment in ports and distribution hubs (Budaragina et al. 2021, section 4.4).

In conclusion, the principal effects of the inclusion of maritime emissions in the EU ETS 1 were deemed to be positive with regards to the likely impact on GHG emissions, air pollution and wider biodiversity benefits. These environmental benefits will be driven by operational changes and investments in new abatement options that are financially incentivised by the inclusion of maritime transport in the EU ETS 1. However, the EU ETS 1 is part of a wider policy mix and is not the only measure to trigger emission reductions. To address the risk of evasion, the revised EU ETS 1 for Phase IV includes provisions such as excluding nearby transshipment ports,⁶⁵ which

⁶⁵ Non-Union ports within 300 nautical miles of a Member State port with a significant share of transshipment of the total container traffic are excluded from the port of call definition to reduce the risk of evasion (Article 3(wa), 3g) of the revised ETS directive). This concerns two ports as of October 2023: East Port Said (Egypt), Tanger Med (Morocco). Implementing Regulation (EU) 2023/2297: <https://www.ecosia.org/search?tt=mzl&q=COMMISSION%20IMPLEMENTING%20REGULATION%20%28EU%29%202023%2F2297%20>

allows Member States that have a high number of shipping companies to receive a larger part of allowances⁶⁶ and use revenues for maritime transport decarbonisation. The fact that the carbon price is expected to be significantly higher than that assumed in the MAR 1 scenario could lead to higher costs and a higher risk of evasion than suggested in the Impact Assessment. However, this may be offset to a certain extent by progress on decarbonisation being faster than expected, with higher levels of investment in abatement in response to the price signal of the ETS.

3.3 Interaction of the EU ETS 1 with selected EU/international policies

The integration of maritime transport in the EU ETS 1 also induces an interaction with the GHG mitigation efforts in the **other sectors of the EU ETS 1 – the aviation, industry and energy sectors**. Except for some operational and technical efficiency measures (such as slow steaming, wind assistance, and air lubrication systems), the maritime sector is likely to rely on the purchase of allowances given the current ETS 1 prices. According to IMO (2020), the marginal abatement costs for a complete decarbonisation of maritime transport are above 400 EUR/tCO₂ mainly due to the high prices for RFNBOs. However, carbon pricing like that generated by the EU ETS 1 is not the only policy instrument that incentivises abatement options. Other policies, like the FEUM Regulation, will have a big impact on in-sector mitigation. Within the EU ETS 1, however, the bulk of emission reductions are initially expected to take place in other EU ETS 1 sectors.

Like other EU ETS 1 sectors, the maritime sector can benefit from the use of EU ETS 1 revenues. Member States shall use their EU ETS 1 revenues for a range of climate and social projects, among which are measures to decarbonise maritime transport (e.g. energy efficiency measures, alternative fuels). Via the EU Innovation Fund, part of the ETS revenues generated from the EU ETS 1 (extension to maritime transport) shall be used to fund the decarbonisation of the sector through special calls (20 million allowances).

This section provides an analysis of the interaction of the EU ETS 1 with other proposals and legislation as part of the ‘Fit for 55’ package, the ESR and potential future IMO policies. An overview is provided in the following table:

Table 8: Overview of adopted shipping policies from the ‘Fit for 55’ package

Description	Type of measure	Type of policy	Applicability	Implementation date
EU Emissions Trading System 1 extended to maritime transport	Emissions trading system	Carbon pricing	Mandatory, EU-related commercial maritime transport (shipping companies)	2024
FuelEU Maritime Regulation	Fuel / energy switch	Standard	Mandatory, EU-related commercial maritime transport (shipping companies)	2025
Alternative Fuel Infrastructure Regulation	Infrastructure requirements	Standard / minimum requirement	Mandatory, EU maritime and inland waterway ports	2014, latest revision 2023

⁶⁶ Member States with more than 15 shipping companies per million inhabitants will receive 3.5 % of the additional quantity of allowances due to the increase in the cap for maritime transport.

Description	Type of measure	Type of policy	Applicability	Implementation date
Renewable Energy Directive	Fuel / energy switch	Quota	Mandatory, ships in national waters	2009, latest revision 2023
Effort Sharing Regulation	Reduction targets, no measure	Regulation / target setting	All navigation activities in EU MS, maritime and including inland waterways	2018, latest revision 2023

Source: Own compilation

The interactions are analysed based on the status of the negotiations and implementation of the proposals/policies as of July 2023. The following principal effects are expected of the extension of the EU ETS 1 to maritime transport in relation to:

- ▶ FuelEU Maritime Regulation: this offers a complementary (but stronger) incentive,
- ▶ Energy Taxation Directive (German Energy Tax Act): this generates additional (weaker) carbon pricing with different coverage,
- ▶ Alternative Fuel Infrastructure Regulation: this can provide better conditions for ETS compliance,
- ▶ Renewable Energy Directive: this sets the fuel framework and parallel accounting of RFNBO towards goals,
- ▶ Effort Sharing Regulation: this sets reduction targets for parts of shipping not covered by ETS,
- ▶ IMO carbon pricing mechanism (yet to be implemented): there is potential future overlap or double burden to be resolved.

These effects are elaborated in more detail in the following sections.

3.3.1 FuelEU Maritime Regulation (FEUM)⁶⁷

The purpose of FEUM is to accelerate the use of renewable and low-carbon alternative fuels such as RFNBOs and advanced biofuels in the sector. The regulation was agreed upon in mid-2023⁶⁸ and will set a GHG intensity limit for energy used onboard a ship from 2025 onwards. The trialogue negotiations concluded that the average GHG intensity of energy used on ships must decrease every 5 years: by 2% in 2025, 6% in 2030, 14.5% in 2035, 31% in 2040, 62% in 2045, and by 80% in 2050 compared to a reference value of 91.16 gCO₂eq/MJ. Ships can be pooled into groups of two ships or more to comply with FEUM. Further, there is a banking and borrowing mechanism which allows for using overcompliance for the following reporting period and for balancing out a current deficit with advance compliance from the following report period. Between 2025 and 2033, a multiplier of two can be used to calculate the GHG intensity of the energy used if ships use RFNBOs. This rewards the use of RFNBOs as shipping companies can achieve compliance more easily. Additionally, a RFNBO quota might be introduced under FEUM in the future: if the share of RFNBOs is less than 1% in the total fuel mix of the reporting year 2031, a 2% quota for RFNBOs shall apply from 2034 onwards. However, announcements from

⁶⁷ This section builds on content already published by Wissner and Graichen (2024).

⁶⁸ https://www.europarl.europa.eu/doceo/document/TA-9-2023-0262_EN.html

Maersk and other industry stakeholders on fuel partnerships might already fulfil this quota.⁶⁹ This indicates that the conditional RFNBO quota might not be implemented and could thus not create additional incentives for RFNBO use. FEUM is a fuel-neutral standard. Emission factors (well-to-tank and tank-to-wake) are defined in FEUM and are partially drawn from the RED. Generally, biofuels, RFNBOs and recycled-carbon fuels which do not comply with the sustainability and GHG emission savings criteria from RED are considered to have the same emission factors as the least favorable fossil fuel pathway for that type of fuel. The same applies to biofuels produced from food and feed crops as defined in RED. In contrast to the compliance with RED targets (section 3.3.4) or ReFuelEU Aviation, FEUM does not exclude, disadvantage or cap other risky or high-emissions biofuels such as waste oils and fats as well as palm fatty acid distillates (Baldino and Mukhopadhyaya 2022). In addition, fossil fuels or conventional biofuels are not completely excluded but are compliant as long as their emission factor does not exceed the limit set. The incentives for scaling up RFNBOs and truly sustainable biofuels are thus small.

The EU ETS 1 and the FEUM Regulation address the same point of regulation (shipping companies) and cover the same scope (geographical, ship type/size, GHG emission types). However, the FEUM follows a well-to-wake approach whereas the EU ETS 1 is set up with a tank-to-wake perspective (as the other EU ETS 1 sectors). An obligation to use onshore power supply or zero-emission technology in ports for container and passenger ships (with exceptions) from 2030 is also foreseen in the regulation. The interaction of this “at berth” requirement of FEUM with AFIR is addressed in section 3.3.3. A year after the publication of the FEUM Regulation, the European Commission shall present a report on the interaction and/or convergence of FEUM with the EU MRV and other legal acts and may be accompanied by a legislative proposal. In addition, a review of FEUM will be conducted starting in December 2027 in the form of a report by the European Commission including potential market distortion, developments in the alternative fuel market/shares etc. The report shall consider possible changes to FEUM regarding *inter alia* the scope (ship type, sizes, black carbon), the ambition of the GHG intensity limits and more mechanisms to promote sustainable fuel technologies. The report may be accompanied by legislative proposals.

There is a complementary interaction of the extension of the EU ETS 1 to maritime transport with the FEUM Regulation. Compliance with FEUM will lead to a reduction of surrender obligations under the ETS as they have the same scope. While the EU ETS 1 introduces the polluter-pays-principle to the maritime sector by pricing GHG emissions, FEUM provides a clear, long-term signal of the emissions that need to be reduced on a ship. Due to the slow phase-in of the FEUM Regulation, this interaction is initially rather small, but may increase in the long term with a higher ambition level of the FEUM Regulation. Also the impact assessment accompanying the ETS attests a positive interaction between the two policies by stating that “adoption of carbon pricing measures for the maritime sector, in conjunction with other measures such as the FuelEU Maritime initiative, is expected to promote energy efficiency measures and a higher uptake of sustainable fuels” (Budaragina et al. 2021, p. 5). FEUM incentivises a fuel switch by regulating the GHG intensity of a fuel or an energy source used onboard. To reduce surrender obligations under the ETS, other efficiency measures such as air lubrication and slow steaming can also be of use.

⁶⁹ Assuming fuel consumption in EU-related ships stays constant until 2031 based on the fairly constant reported fuel consumption and deriving a fuel consumption of 26.48 Mt for 2021 based on EC (2023). A 1% RFNBO quota within this scope would translate to 0.265 Mt of RFNBOs. Maersk has stated to have secured approximately 0.93 Mt of e-methanol through fuel partnerships in the 2020s (p.25 in sustainability report 2022: https://www.maersk.com/~/_media_sc9/maersk/corporate/sustainability/files/resources/2022/maersk-sustainability-yearly-report-2022.pdf).

The current price level (approximately 74 EUR/tCO₂ in May 2024) of the EU ETS 1 alone is unlikely to be sufficiently high enough to stimulate a fuel switch to climate-neutral fuels given the high prices (and current limited availability) of these fuels. Production cost estimates for RFNBOs vary in literature but all indicate a significant price gap between fossil fuels and RFNBOs (Stolz et al. 2022). A review paper by Brynolf et al. (2022) shows that carbon abatement costs (incl. vessel, fuel production and distribution costs) range between approximately 250 and 1250 EUR/tCO₂. The carbon price induced by the EU ETS 1 alone does thus not bridge this gap (approximately 74 EUR/tCO₂). However, also FEUM does not provide an immediate incentive to switch to climate-neutral fuels, because LNG and other fossil fuels will be compliant with the GHG intensity limit well beyond 2030 and even 2040 (Nelissen et al. 2022). In the short to medium term, the EU ETS 1 will likely be a main incentive to reduce emissions (e.g. via energy efficiency measures) if EU ETS 1 prices continue to increase and if the ambition of FEUM is not strengthened during the next review. According to an analysis by Springer et al. (2023), FEUM provides few incentives to use RFNBOs before 2035 due to the high GHG intensity limit. FEUM will create a stronger steering effect in the longer term as the ambition increases towards 2050 and might already impact investment decisions in the shorter term as ships built today will still be in operation in 2050. The overall stronger impact of FEUM on the use of RFNBOs up to 2050 compared to ETS prices (even though these are increasing) is also shown in the above-mentioned analysis by Springer et al. (2023).

Increased prices may also reduce demand. Literature on price elasticities of maritime transport is scarce and heterogeneous (Hof et al. 2001; Merkel et al. 2022; Ardelean et al. 2022). However, the price elasticity of maritime transport demand could be considered low due to a lack of competitive alternatives, and hence higher prices can be passed through so that the impact on demand is likely to be small or even negligible. A study by Abbasov (2022) also exemplified the negligible price increases for products in container shipping.

The complementary nature of the EU ETS 1 extension to maritime transport and FEUM is comparable to early years of the EU ETS 1 and the German Renewable Energy Sources Act (EEG). The latter two regulations provided an incentive for renewable energy production, but in different ways and to a different extent.

3.3.2 Energy Taxation Directive (ETD) ⁷⁰

The ETD is currently being revised as part of the 'Fit for 55' package (EC 2021). As noted in section 3.1, marine fuels are not subject to energy taxes at EU and national level due to the ETD. In Germany, the Energy Tax Act (EnergieStG) is the EU ETD transposed into national law. § 27 of the EnergieStG exempts fuels used in "watercraft" from energy tax, with the exception of private non-commercial shipping, the maintenance of watercraft and the manufacture of watercraft. While energy taxes are levied for other modes of transport (such as road and rail transport), shipping is exempt from energy taxation. This benefits both inland shipping and national maritime transport.

The proposal by the European Commission foresees that the ETD should be amended so that the exemption of fuels used in intra-EU maritime transport (and in inland navigation) would be phased out. Alternative fuels such as RFNBOs will be exempted from the tax for 10 years. Member States should be authorised to exempt onshore power supply in ports from tax. The proposal is still undergoing triologue negotiations. Compared to the EU ETS 1 extension to maritime transport, the ETD has a different coverage (all fuels used in intra-EU shipping and inland navigation) and thus complements the EU ETS 1. On the above-mentioned amendment,

⁷⁰ This section builds on content already published by Wissner and Graichen (2024).

the impact assessment accompanying the ETD proposal states that “[a] well-calibrated extension of the EU ETS 1 to the maritime sector and introduction of emissions trading to road transport and buildings, coupled with option 2 for the ETD would help to achieve the EU’s ambitious climate objective of 55% emission reductions by 2030 while allowing attaining the rest of the objectives of the ETD review” (EC 2021, p. 11). While the phasing out of the exemption would create a level-playing field from a taxation perspective compared to other transport sectors which are already subject to energy taxes, a study by Faber et al. (2021) suggests that the taxation of marine fuels would create an unlevel playing field compared to non-EU bunkering ports, potentially leading to a shift of bunkering to non-EU ports and making the proposal less effective. The implementation of the European Commission’s proposal on the ETD could interact with the EU ETS 1 by potentially lowering maritime emissions in the ETS slightly by incentivising measures to reduce fuel consumption. As the price signal of the EU ETS 1 is higher than that of the ETD, it can be assumed that the steering effect of the emissions pricing through the EU ETS 1 is stronger though.

3.3.3 Alternative Fuels Infrastructure Regulation (AFIR)⁷¹

The AFIR⁷² was revised as part of the ‘Fit for 55’ package and aims to ensure that alternative fuels and onshore power supply are increasingly available for maritime transport in EU ports.

The AFIR requires that TEN-T⁷³ core and comprehensive maritime ports are equipped to provide shore-side electricity to seagoing container, ro-ro passenger⁷⁴ and passenger ships (above 5,000 GT when moored at the quayside) by 31st December 2029. The requirement relates only to ports which fulfil certain activity requirements (e.g. number of port calls varying for each ship type). The timing of the infrastructure requirements matches with the FEUM obligation to use onshore power supply from 2030 onwards (section 3.3.1).

For inland navigation, TEN-T core inland waterway ports need to deploy at least one installation providing shore-side electricity to inland waterway vessels by 31st December 2024. TEN-T comprehensive inland waterway ports need to provide this by 31st December 2029.

Regarding alternative fuels, an “appropriate number” of liquefied methane bunkering options (via various modes) shall be ensured at TEN-T core maritime ports by 2025. Although liquefied methane equals fossil LNG today and in the foreseeable future, the reasoning given in the AFIR is that fossil methane needs to be phased out soon and infrastructure can also be used for bio- or e-methane. However, the extent to which bio- and e-methane will play a role in the future maritime fuel mix is questionable because there will likely be a high demand for bio- and e-methane from other sectors and there remains the issue of methane slip from marine engines (Pavlenko et al. 2020; Searle et al. 2018). In respect to other alternative fuels (such as hydrogen or ammonia), there are no binding targets set out in the AFIR. Only in the national policy frameworks shall an overview be provided on the status, perspective and planned initiatives regarding alternative fuels in maritime transport (and other sectors that are difficult to decarbonise). The European Commission should review this regulation with a view to adopting

⁷¹ This section builds on content already published by Wissner and Graichen (2024).

⁷² https://www.europarl.europa.eu/doceo/document/TA-9-2023-0261_EN.html

⁷³ TEN-T = Trans-European transport network, consisting of two layers - the core and the comprehensive network. The core network includes the most important connections linking major cities/nodes and must be completed by 2030. The comprehensive network connects all regions of the EU to the core network and needs to be completed by 2050. More information can be found here: https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

⁷⁴ Defined in AFIR as ships with facilities to enable road or rail vehicles to roll on and roll off the vessel which carry more than 12 passengers.

additional mandatory targets for the maritime sector in regard of alternative fuels depending on the market development.

The main difference to the FEUM Regulation is that the latter sets targets for shipping companies to use compliant fuels and shore-side electricity but FEUM does not mandate the infrastructure in EU ports. AFIR sets mandatory targets for the provision of the infrastructure. For both the EU ETS 1 and FEUM, the AFIR makes alternative fuels increasingly available, and thus facilitates the mitigation of emissions within the sector (reducing the need to buy emission allowances). However, AFIR also promotes the prolonged use of fossil LNG which is compliant with FEUM requirements well beyond 2030 (section 3.3.1) and can reduce CO₂ emissions and thus surrender obligations within the ETS. While FEUM and the extension of the EU ETS 1 to maritime transport do not (currently) address inland navigation, AFIR already includes targets for inland waterway ports. The maritime sector also indirectly benefits from other infrastructure requirements in AFIR (e.g. decarbonisation of heavy-duty road and rail transport) as these facilitate a zero-emission transport of alternative fuels and goods to/from ports.

3.3.4 Renewable Energy Directive (RED)⁷⁵

In the trialogue process, an agreement was reached regarding the revision of the RED (RED III). The RED III foresees that every Member State shall contribute to increasing the share of renewable energy in the EU's overall energy consumption to 42.5% by 2030 with an additional 2.5% indicative top-up that would allow a 45% share to be achieved.⁷⁶ RED provides sector-specific sub-targets. For transport, Member States can choose between fulfilling a binding target of a 14.5% reduction of GHG intensity from the use of renewables by 2030 or a binding share of at least 29% of renewables within the final consumption of energy in the transport sector by 2030. The directive also prescribes a sub-target of 5.5% for advanced biofuels and RFNBOs in the share of renewable energies supplied to the transport sector. Within this target, there shall be a minimum share of 1% of RFNBOs. Member States with maritime ports shall additionally “endeavour” to ensure that as of 2030 the share of RFNBOs in the total amount of energy supplied to the maritime sector is at least 1.2%. Although not binding, the latter would impact the conditional implementation of an RFNBO quota within FEUM and contribute to reducing surrender obligations of shipping companies under the ETS. Additionally, advanced biofuels and RFNBOs used in aviation and maritime transport will be counted 1.2x and 1.5x towards the target, which incentivises the use of these fuels in maritime transport.

Generally, RED transport targets have to be achieved by the transport sector as a whole⁷⁷ including maritime transport. Alternative fuels counting towards the target hence do not necessarily have to be deployed in maritime transport – especially as the willingness to pay for expensive advanced biofuels and RFNBOs is higher in road transport. Further, maritime transport's contribution is restricted: the amount of renewable energy to be supplied to the maritime sector can only contribute up to 13% of the total energy consumption of the Member State to the RED transport sector target. For Cyprus and Malta, this threshold amounts to only 5%. This limitation shall apply until 2030.

The RED and the EU ETS 1 are thus linked via the use of alternative fuels in maritime transport, both for the reduction of the surrender obligation in the EU ETS 1 and for target fulfilment of the RED. The RED differs from FEUM as RED requires a specific share of alternative fuels in

⁷⁵ This section builds on content already published by Wissner and Graichen (2024).

⁷⁶ <https://www.consilium.europa.eu/en/press/press-releases/2023/03/30/council-and-parliament-reach-provisional-deal-on-renewable-energy-directive/>

⁷⁷ There is no longer any differentiation between the sectors contributing to the denominator and to the numerator of the renewable share targets, deleting the optional contribution of maritime transport and aviation.

transport whereas FEUM sets a GHG intensity limit (which can be fulfilled by biofuels, RFNBOs or even fossil LNG alike depending on their WTW GHG emission intensity). Further, the RED incentivises the uses of advanced biofuels and RFNBOs in maritime transport on the one hand (via multipliers) but limits the sector's overall contribution on the other hand. However, any advanced biofuels and RFNBOs used in maritime transport to comply with FEUM in turn help to achieve the RED targets. As further incentives are created through other 'Fit for 55' elements besides the EU ETS 1 extension to maritime transport, like the revised RED, the likelihood of in-sector emission reductions of shipping increases.

As RED is a directive, it has to be transposed into national legislation. In Germany, RED was implemented via the greenhouse gas quota, which so far only refers to road transport and fuels in rail transport. This will need to be amended now.

3.3.5 Effort Sharing Regulation (ESR)⁷⁸

The ESR also covers shipping, but is different to the above policies as the ESR only sets reduction targets for non-ETS sectors and not the policy instruments to achieve these targets. The EU ETS 1, in contrast, is a concrete policy instrument but (indirectly) sets reduction targets through the cap. Table 9 provides an overview of the ESR and EU ETS 1 coverage.

Table 9: Comparison extension EU ETS 1 to maritime transport and ESR

Criterion	EU ETS 1 (as of 2024)	ESR
Geographical scope	Maritime transport only 100% at berth, 100% in EU waters, 50% of voyages to/from third countries	All navigation activities in EU MS, maritime and including inland waterways
Size	5,000 GT and above	No restriction
Ship types	Only commercial cargo and passenger transport, excluding: warships, naval auxiliaries, fish-catching or fish-processing ships, wooden ships of a primitive build, ships not propelled by mechanical means, or government ships used for non-commercial purposes.	All types, excluding military activities.
Emissions in 2019 (EU)	100 Mt CO ₂	17 Mt CO ₂ eq
Overlap	Domestic maritime shipping (meaning in national waters) > 5 000 GT	
Not covered	Emissions of ships <5,000 GT in international waters	

Source: Own compilation

There is a small overlap between the ESR and the EU ETS 1 concerning ships of 5,000 GT and above which sail in national (EU) waters. At the moment, this overlap does not represent a double burden as ships of this size only have to surrender obligations under the EU ETS 1. The revised ESR⁷⁹ continues to cover domestic shipping (e.g. all shipping in national waters – inland and maritime shipping). In contrast to aviation activities falling under the EU ETS 1, (national)

⁷⁸ This section builds on content already published by Wissner and Cames (2023).

⁷⁹ Regulation (EU) 2023/857, Recital 9: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0857>

maritime transport is not excluded from the ESR (Article 2(1)). The overlap is small as many ship types that fall within domestic shipping (such as small ferries, motorboats and ships not serving commercial transport) are not covered by the EU ETS 1. Avoiding this overlap by, for example, reducing the scope of the ESR by only deducting the domestic emissions that are covered by the EU ETS 1 is difficult as the EU MRV Maritime Regulation considers domestic emissions as intra-EEA emissions and does not allow the disaggregation of navigation emissions per EEA countries.⁸⁰ If Member States, however, implement policy instruments to achieve the ESR targets, like the German nEHS, a double burden might be created. In Germany, since the nEHS currently exempts commercial maritime transport, there is thus no overlap or double burden with the EU ETS 1.⁸¹ If the exemption were abolished, there would be an overlap with a view to ships engaged in maritime transport in national (i.e. German) waters. Furthermore, there will be a change to or convergence of the nEHS and the newly agreed EU ETS 2 in 2027 or 2028. Austria implemented a national carbon pricing scheme similar to the nEHS which imposes an obligation on fuel distributors (Art.9 in ÖkoStRefG 2022). National shipping is exempt, however. Other EU Member States also have carbon pricing mechanisms in the form of dedicated carbon taxes or energy taxes with a CO₂ component.⁸² Shipping is excluded from these taxes/levies. Further, emissions from ships smaller than 5,000 GT sailing in international waters are not currently covered by either the EU ETS 1 or the ESR. A potential further extension of the extended EU ETS 1 to these smaller ship sizes (see, for example, box in chapter 1) could fill this regulatory gap.

3.3.6 Future IMO policies

There will likely be a basket of policies adopted at IMO in the next few years. As described in section 3.1, the basket of measures will include a technical element similar to FEUM and a carbon pricing mechanism (yet to be defined). Several proposals and designs/combinations are currently being discussed at the MEPC. The following combinations of measures have received the most support by countries (Smith et al. 2024):

- ▶ A WtW-based global fuel standard with a flexibility mechanism plus an additional GHG levy (or other form of carbon pricing),
- ▶ A GHG levy (different designs) and a WtW-based global fuel standard only if the fuel standard includes a flexibility mechanism, and
- ▶ A TtW-based global fuel standard with a flexibility mechanism (no additional carbon pricing beyond the flexibility mechanism).

An emissions trading system, similar to the EU ETS 1, is unlikely at the global level based on the submissions to and discussions at MEPC. A comprehensive impact analysis (CIA) on the discussed measures is expected to inform the negotiations in mid-2024. Further, the MEPC has already agreed on a “IMO net zero framework” which sets out the structure for the future MARPOL amendment regarding the mid-term measures (Smith and Frosch 2024). The selected policy measures will likely be adopted at MEPC 83 (spring 2025), and the associated regulations will enter into force in the first half of 2027 (Smith and Frosch 2024).

The selected measures will overlap with the EU ETS 1 extension to maritime transport and FEUM for ships operating in international waters.

⁸⁰ Compare impact assessment p.77: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021SC0611>

⁸¹ Note that the two policies regulate different entities: the ETS obliges shipping companies and the nEHS obliges fuel distributors.

⁸² <https://www.oecd.org/tax/tax-policy/carbon-pricing-background-notes.pdf>

A good prerequisite is the agreement at IMO on a well-to-wake approach and the inclusion of relevant GHGs (CO₂, methane, and nitrous oxide) for future IMO measures which are in line with the design of FEUM and the EU ETS 1. FEUM and the technical standard at IMO might be complementary, for example, if ships compliant with FEUM have the advantage of being compliant with a potentially weaker global standard. Further, the FEUM Regulation prescribes that it should be ensured that technical specifications for maritime transport adopted in context of FEUM are consistent with international rules adopted by the IMO.

The interaction between a carbon pricing element of IMO and the integration of maritime transport in the EU ETS 1 might be more complex depending on the design of global policy. The IMO policy will have a global coverage and is thus well-suited to addressing emissions of a global sector. However, even if the enforcement at global level will be sufficiently stringent, it is unlikely that the global levy is higher than the carbon price under the EU ETS 1. The EU already established a process (e.g. required reports and reviews of regulations) in case the IMO adopts further measures and strengthens its overall ambition. However, any changes to the EU ETS 1 are subject to IMO policies being more ambitious or in line with the goals of the Paris Agreement – so that the overall mitigation impact can be maintained. If the IMO does not adopt a global market-based measure by 2028 which is in line with the goals of the Paris Agreement, the EU will review the EU ETS 1 with a view to extending the geographical scope of the EU ETS 1 to more than 50% of emissions from all incoming/outgoing voyages. While the legal text of the EU ETS 1 does not yet describe the exact options available to avoid a double burden of the EU ETS 1 and an IMO policy, several options can be conceived:

- ▶ deduction of a global levy from the surrender obligation under EU ETS 1 on international voyages,
- ▶ reimbursement of a global levy from the EU ETS 1 revenues,
- ▶ decreasing the scope of the EU ETS 1 to intra-EEA voyages as international voyages would be covered by the IMO policy (similar to EU ETS 1 coverage for aviation).

There are certainly ways to administratively ensure that the co-existence of shipping in the EU ETS 1 and a global carbon pricing does not induce double burdening of ship operators. However, the detailed design of such regulation can only be elaborated when the global policy is adopted.

4 Conclusion

The legislation from the 'Fit for 55' package extending the EU ETS 1 to the maritime sector impacts this important sector of the EU. Shipping is crucial for transport and trade from and to the EU and provides a significant source of employment and thus value creation. However, the shipping sector is also important from a climate perspective. In 2022, the maritime transport emissions (of ships of 5,000 GT and above) in the EU amounted to 135.5 Mt of CO₂, which corresponds to 4% of the total CO₂ emissions of the EU (EC 2024). The inclusion of this sector in EU climate regulations acknowledges the relevance of its emissions.

The shipping sector is quite heterogeneous which makes an impact assessment complex. Further research could examine more closely how the different shipping segments would be impacted by increasing EU ETS 1 prices, for example if different mitigation measures were incentivised in different segments and if services provided by different ships were impacted differently across segments. Although there are numerous smaller ships (below 5,000 GT), they contribute to a lesser extent to EU shipping emissions. More data from an extension of the EU MRV Maritime Regulation would allow for a more thorough assessment of the impacts on smaller ships. Further, a detailed modelling of this segment could provide a more comprehensive picture of the environmental and economic impact of including smaller ships in the EU ETS 1.

The main take-aways hence are:

- ▶ Shipping is the dominant mode for importing and exporting goods in and out of the EU.
- ▶ The largest impact of the 'Fit for 55' package on the maritime sector will be the combined effect of the FEUM Regulation and the EU ETS 1.
- ▶ Although in-sector emission reductions are expected in the long term, the EU ETS 1 will incentivise significant out-of-sector reductions (purchasing emission allowances) particularly in the near term.
- ▶ Additional costs accrue through the EU ETS 1 extension. The impact on transportation costs on freight rates and product costs can differ highly between segments and markets. In general, the impact on product prices is expected to be higher for products with a low per tonne value.
- ▶ Carbon leakage from the EU ETS 1 extension to maritime transport can be expected to be small (especially in the near term) as the risk of using alternative non-EU transshipment ports is significantly decreased by the final agreed text of the EU ETS Directive. In the long term, the carbon leakage risk is expected to increase with rising EU ETS 1 prices.
- ▶ EU ETS 1 prices will have to increase in the future to bridge the gap between fossil fuels and RFNBOs and to incentivise the associated emission reductions. Part of the auction revenues raised via the EU ETS 1 are reinvested into the Innovation Fund which, among others, provides dedicated support to accelerate the decarbonisation of the maritime sector.
- ▶ The EU ETS 1 extension to maritime transport is currently being implemented at national (German) level.
- ▶ Although small ships (below 5,000 GT) contribute to a lesser extent to EU shipping emissions than ships above 5,000 GT, further examinations regarding their inclusion in the EU ETS 1 should be made.

- ▶ The emissions of inland navigation in Europe are relatively small compared to EU-related maritime shipping. Inland navigation is a relatively energy-efficient transport mode, which is why the EU Commission⁸³ and the German Environment Agency⁸⁴ want to promote a shift from road transport to inland navigation.
- ▶ While the EU and IMO have implemented policies which directly or indirectly influence emissions from maritime transport, policies reducing emissions from commercial inland shipping on the national (German) level are lacking (except for funding programmes). The inland fleet is, compared to the maritime fleet, less segmented in terms of ship types, but the number of shipping companies is comparably high, with the average company owning a small number of ships and employing a small number of people. The latter might be an argument for including the inland navigation sector in the new EU ETS 2 (together with road transport and built environment), which entails an upstream approach.
- ▶ Global policies, likely a fuel standard and a market-based measure, are currently being prepared at IMO. The interaction or a potential overlap with the EU ETS 1 will have to be examined once further measures are adopted by IMO.

⁸³ https://transport.ec.europa.eu/document/download/be22d311-4a07-4c29-8b72-d6d255846069_en?filename=2021-mobility-strategy-and-action-plan.pdf

⁸⁴ <https://www.umweltbundesamt.de/publikationen/schwere-lasten-grosse-aufgabe-ein-ziel>

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