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Third Annual Report from the European Commission on CO_2 Emissions from Maritime Transport (period 2018-2020)

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European Commission
Third Annual Report from the European Commission on CO_2 Emissions from Maritime Transport
Period 2018-2020
Climate Action

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Executive Summary

EU Regulation 2015/757 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, in the following referred to as 'EU Maritime MRV Regulation',[1] requires companies to monitor and report fuel consumption, CO_2 emissions and other key parameters for their ships when sailing to/from and between ports of the European Economic Area (EEA).

The European Commission makes the reported data, aggregated on a yearly basis, publicly available[1] and also publishes an annual report, analysing the reported data[2]. This report analyses the data for the period 2018-2020, with a particular focus on 2020 data corresponding to the the third reporting period of the EU MRV system.

In 2020, for almost 11 700 ships, an emissions report has been submitted by 1 545 companies. These ships emitted around 126.1 million tonnes of CO_2 within the scope of the EU Maritime MRV Regulation.

The analysis of the data reported for 2020 reveals structural differences between the 2020 and the two previous reporting years, reflecting the impact of two major events. First, beginning of 2020, a stricter sulphur limit for ships' fuel oil, decided by IMO, came into force and, second, the COVID-19 crisis had a significant impact on seaborne trade and maritime passenger transport.[2]

The new IMO limit on the sulphur content in the fuel oil used on board ships resulted in a significant shift in terms of fuel type used, in comparison with the previous reporting period, mainly towards light fuel oil (+197%), but could have also had an influence towards LNG (+12%) and diesel oil (+10%). In 2020, the consumption of non-conventional (non-fossil) bunker fuel remained negligible.

Due to the COVID-19 crisis not only less ships have been active within the scope of the EU Maritime MRV Regulation, but those that still have been active, have, on average, been less used, resulting in lower total CO_2 emissions for the entire fleet and lower CO_2 emissions for almost all ship types.

According to statistics from Eurostat, all inward and outward seaborne extra-EU-27 trade flows, measured in gross weight of freight handled in EU main ports, decreased in 2020 compared to 2019, with the exception of the outward flow to China which actually increased.

This trend is confirmed by the EU Maritime MRV Regulation data as all ship types, except refrigerated cargo carriers, have significantly reduced their average time spent at sea in 2020 compared to 2018 and 2019. Passenger ships such as cruise ships have been hit the hardest.

Compared to 2019, reported CO_2 emissions under the EU Maritime MRV Regulation dropped by around 14% and the number of emissions reports submitted has decreased by around 5.5%.

Compared to 2019, 2020 CO_2 emissions have been lower for almost all ship types, except for LNG and combination carriers. In absolute terms, CO_2 emissions dropped especially for passenger ships, including cruise ships, but the decrease has also been substantial for container ships, bulk carriers and Ro-pax ships.

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[1] Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC, OJ L 123, 19.5.2015, p. 55–76.

[2] The COVID-19 crisis produced an overall decrease in seaborne freight transport for EU-27, even though six EU members registered an increase in the volume of containers handled. For the details, see European Commission, 2022a.

CO_2 emissions reported for 2020 decreased on all the different types of voyages as well as at berth, but especially on intra-EEA voyages, with a decrease of around 21%.

Speed variation between 2018, 2019 and 2020 per ship type is negligible. This means that the ships per ship type have not adopted slower average operating speed.

The CO_2 reduction that can be observed for 2020 is mostly related to the economic effects of the COVID-19 crisis and not to an improvement of the efficiency of the ships captured under the EU Maritime MRV Regulation ("the fleet") or an improvement of the carbon intensity of the energy used by the ships.

The average operational efficiency of the ships that have been active both in 2020 and 2019 has not changed if measured in terms of CO_2 per distance. However, when calculated in terms of CO_2 per transport work (mass distance), for the relevant subset of ships, it shows a slight improvement (-1.5%).

The EU MRV system is a cornerstone in the development and implementation of EU policy measures to reduce GHG emissions from maritime transport. An assessment of the implementation of the EU Maritime MRV Regulation shows that, by now, implementation actors (notably shipping companies) are more familiar with the system, resulting in smoother internal procedures and better quality of the submitted data.

To achieve substantial GHG emission reductions and to eventually decarbonise the maritime shipping sector, additional policy measures are required. At European level, the European Commission has proposed a basket of policy measures as part of the 'Fit for 55' policy package to address maritime emissions. At global level, the IMO has agreed upon short term measures and is currently developing medium- and long-term measures to achieve the levels of ambition as presented in its initial strategy, which is to be revised in 2023.

The European Commission has a set of funding programmes which support, in combination with legislation, the decarbonisation of maritime transport sector. These funds include Horizon Europe, the Innovation Fund, the Modernisation Fund, Connection Europe Facility and InvestEU. These funds can provide support to decarbonisation solutions with different technology and commercial readiness level, such as alternative fuels and required energy technologies. Examples of alternative fuels in the maritime sector are biofuels, ethyl and methyl alcohols (e.g. methanol), hydrogen and ammonia. Examples of new energy technologies are fuel cells and batteries and, for innovative propulsion, wind assisted propulsion systems.

1. Introduction

This report has been prepared using data from the implementation of the EU Regulation on the monitoring, reporting and verification of CO_2 emissions from maritime transport (Regulation (EU) 2015/757). All information was extracted on 12 October 2021. Data provided or updated after this date is not reflected in this report.

For the two previousy published annual reports, related to the reporting periods 2018 and 2019, the same principle, i.e. a cut-off date has been applied. For the pupose of this annual report, however, updated data as of 12 October 2021 has been used for these two previous periods. This means that the 2018 and 2019 figures presented in this report might slightly differ from those published in the reports on 2018 and 2019 data.

1.1. The 2021 Annual Report: scope and objectives

This is the third report on CO_2 emissions data from ships entering and leaving EEA ports, collected under the monitoring, reporting and verification (MRV) system for CO_2 emissions from maritime transport adopted in 2015 (Regulation (EU) 2015/757), hereafter called the "EU Maritime MRV Regulation".

This legislation is the first step of a staged approach for the inclusion of maritime transport emissions in the EU's greenhouse gas (GHG) reductions commitments and the foundation for new policy measures that have been adopted by the Commission mid-2021 (see Section 1.3 'The Fit for 55 package and the new legislation proposed'). The EU Maritime MRV Regulation has three key objectives:

1. To collect robust and verified CO_2 emission data;
2. To provide transparency and stimulate the uptake of energy efficiency investments and behaviours;
3. To support policy discussions and implementation of policy tools.

The legislation requires shipping companies to track and report key information about CO_2 emissions, fuel consumption and other relevant information. This data is then checked by independent verifiers accredited by national accreditation bodies. The Commission subsequently publishes the verified data and drafts an Annual Report on CO_2 emissions from maritime transport. A detailed description of the MRV process ("The MRV system – Steps of the MRV process") can be found in Annex 2.

Throughout the entire process, transparency is key. The first sets of MRV data, corresponding to 2018 and 2019 have contributed to an enhanced understanding of the climate impact of the shipping sector regarding CO_2 emissions. The published raw data represents a valuable asset to universities and research organisations, public authorities and other market actors for analyses and studies on the maritime sector and its environmental performance.

The present report covers the first three compliance cycles, i.e., 2018, 2019 and 2020 emissions. It builds on the previous reports and allows for a comparison of data from these reporting years. The main objective of the present report is to examine trends in emissions and energy efficiency characteristics over the three available reporting cycles. This new report also complements the previous one by analysing the energy efficiency of the ships that have reported both in 2019 and 2020 in more detail.

The scope of the EU Maritime MRV Regulation

The monitoring, reporting, and verification obligation applies to ships above 5 000 gross tonnage (GT) loading or unloading cargo or passengers at ports in the European Economic Area (EEA). The Regulation is flag-neutral, which means that ships must monitor and report their emissions regardless of their flag.

Despite limiting the monitoring requirements to large ships, the Regulation covers around 90% of all CO_2 emissions, whilst only including around 55% of all ships calling into EEA ports. For proportionality and subsidiarity reasons, military vessels, naval auxiliaries, fish-catching or fish-processing ships are excluded from the Regulation.

The Regulation covers CO_2 emissions produced when a ship carries out a voyage from or to a port in the EEA when transporting goods or passengers for commercial purposes. For instance, it covers emissions from a ship that goes from Rotterdam to Shanghai and the emissions produced when a ship sails from Shanghai to Rotterdam.

However, if a ship departs from Shanghai for Rotterdam and makes a stop at another port (e.g., port "A" which is nearer to the EEA) for cargo or passenger operations, only the emissions related to the last leg of the voyage (in this case port A to Rotterdam) will be reported in the system. Voyages that take place within the EEA are also covered, such as a ship travelling from Le Havre to Rotterdam, or domestic voyages, e.g.: from Ghent to Antwerp. Emissions occurring when the ship is securely moored or anchored at a port whilst loading, unloading or hoteling are also covered.

1.2. Context

1.2.1. 2020: IMO's stricter sulphur limit, the COVID-19 crisis and their impact on maritime transport

The reporting year 2020 was marked by two major developments: IMO's stricter sulphur limit for ships' fuel oil came into force and the COVID-19 pandemic. While the first led to a change of the bunker fuels used by the maritime shipping sector, the second meant lower levels of seaborne trade and sea passenger transport. The data reported under the EU Maritime MRV Regulation for the year 2020 clearly reflect these developments.

Indeed, the impact of the new IMO sulphur regulation is clear: compared to 2019, the consumption of heavy fuel oil decreased significantly while the use of light fuel oil increased significantly; also the consumption of diesel oil and LNG increased compared to 2019.

The impact of the COVID-19 crisis can easily be seen in 2020 figures as well. Total emissions and fuel consumption are also clearly lower than in 2019. In fact, the reported 2020 CO_2 emissions have been lower for almost all the ship types, except for LNG and combination carriers. Passenger ships, including cruise ships, have been affected most, but the CO_2 emissions decrease has also been comparably high for container ships, bulk carriers and Ro-pax ships. This effect is a combination of both the facts that less ships have been active within the scope of the EU Maritime MRV Regulation and that the ships that have been active have been less active. The fleet CO_2 emissions decreased on all the different types of voyages as well as at berth, but especially on intra-EEA voyages.

1.2.2. The EU 'Fit for 55' package proposals

On 14 July 2021, the Commission proposed the 'Fit for 55 package', a set of legislative proposals aiming at delivering the EU's 2030 climate objectives. This corresponds to the concretization into policies of the strategy adopted in December 2019, the European Green Deal, aiming to transform the EU into a modern, resource-efficient and competitive economy, and to achieve climate neutrality by 2050. The 'Fit for 55 package' fully reflects the new EU intermediate objective to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels.

The 'Fit for 55 package' represents the most comprehensive set of climate proposals as it covers many different sectors and topics such as energy, taxation, forestry or transport. Regarding the latter, it notably aims at ensuring that maritime transport contributes to the increased EU climate effort and to the Paris Agreement commitments. This is of particular relevance as CO_2 emissions from waterborne transport represent 3-4% of total EU CO_2 emissions (European Commission, 2021c) and as the demand for waterborne transport services is expected to grow further in the future.

This is why, last July, the Commission proposed a series of measures to address the maritime transport's climate impact and foster the transition towards green shipping. The most relevant measures for the waterborne sector include:

1. A proposal to extend the European emissions trading scheme to maritime transport for the ships above 5 000 GT [3], thereby creating a CO_2 price signal, fostering the reduction of GHG emissions in a flexible and cost-effective manner, and generating revenues to tackle climate change and encourage innovation;
2. A proposal to boost demand for marine renewable and low-carbon fuels (the FuelEU Maritime initiative)[4], by setting a maximum limit on the greenhouse gas content of energy used by ships calling at European ports, based on a technology-neutral approach and by encouraging zero-emission technology at berth;
3. A proposal to boost alternative fuel distribution (the Regulation on Alternative Fuels Infrastructure - AFIR)[5], which would set, among others, mandatory targets for shore-side electricity supply at maritime and inland waterway ports;
4. A proposal to accelerate the supply of renewables in the EU, through a revision of the Renewable Energy Directive (RED)[6] which increases the current EU-level target of 'at least 32%' of renewable energy sources in the overall energy mix to at least 40% by 2030, with a focus on sectors where progress has been slower to date – including (maritime) transport;

[3] Proposal for a Directive amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union, Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and Regulation (EU) 2015/757 (COM(2021) 551 final).

[4] Proposal for a Regulation on the use of renewable and low-carbon fuels in maritime transport and amending Directive 2009/16/EC (COM/2021/562 final).

[5] Proposal for a Regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council (COM/2021/559 final).

[6] Proposal for a Directive amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (COM/2021/557 final).

5. A proposal to revise the existing Energy Taxation Directive (ETD)[7] which aims at aligning the taxation of energy products with EU's climate objectives and removing outdated exemptions such as for the intra-EU maritime transport sector.

This 'basket of measures' reflects the objective to reduce GHG emissions by addressing the various barriers to the decarbonisation of the sector (technological barriers, economic barriers, etc.), and through two complementary angles: first, the improvement of energy efficiency (i.e. using less fuel) and, second, the greater use of renewable and low-carbon fuels (i.e. using cleaner fuels). These measures will allow the creation of a virtuous ecosystem for such cleaner fuels, as it boosts at the same time fuel demand, distribution, and supply. In addition, the Commission will continue supporting research and innovation towards the decarbonisation of maritime transport, in particular through Horizon Europe and the Innovation Fund.

At the time of writing this report (April 2022), the 'Fit for 55' proposals are under discussion within the Council and the European Parliament: these proposals are expected to be adopted by co-legislators by the end of 2022.

In parallel, the Commission is committed to support ambitious progress at international level through the further implementation of the IMO Strategy for GHG emission reductions.

1.2.3. Action at IMO level

In April 2018, IMO's Marine Environment Protection Committee (MEPC) adopted the 'Initial IMO Strategy on Reduction of GHG Emissions from Ships' (MEPC 72/17/Add.1, Annex 11).

The strategy aims to phase out GHG emissions from international shipping as soon as possible in this century. In addition, the initial strategy sets the ambitions to:

1. improve the carbon intensity of shipping by at least 40% by 2030, relative to 2008, and pursue efforts to improve it by 70% by 2050; and
2. reduce the GHG emissions of shipping by at least 50% by 2050, relative to 2008.

A revision of the initial strategy is scheduled for 2023 and the European Union is committed to and advocates higher levels of ambition to be set in the revised strategy.

To achieve the levels of ambition, short-, medium- and long-term policy measures will be developed as part of the strategy.

Two specific short-term measures have been adopted by MEPC 76 in 2021:

1. A ship energy efficiency rating scheme based on the Carbon Intensity Indicator (CII) will be implemented for ships already subject to the IMO Data Collection System (DCS) requirements (5 000 GT and above). Ships that will rate D or E for three consecutive years, will be required to submit a corrective action plan, to show how the required index would be achieved (IMO, 2021). In addition, administrations, port authorities and other stakeholders are encouraged to provide incentives to ships rated as A or B (IMO, 2021).
2. The Energy Efficiency Existing Ship Index (EEXI) will require existing ships of 400 GT and above to meet technical standards comparable to the Energy Efficiency Design Index (EEDI) requirements that already apply for newbuild ships.

[7] Proposal for a Council Directive restructuring the Union framework for the taxation of energy products and electricity (recast) (COM/2021/563 final).

The amendments to MARPOL Annex VI required for the implementation of the two measures will enter into force on 1 November 2022, with the requirements for EEXI and CII certification coming into effect from 1 January 2023. The first annual reporting would then be completed in 2023, with the first rating given in 2024 (IMO, 2021).

The medium- and long-term GHG reduction measures are still to be developed at this stage, with a GHG fuel standard proposed by the European Union and different potential market based measures currently being discussed.

2. CO_2 emissions and related fuel consumption from the monitored fleet

Main findings

In 2020, for almost 11 700 ships, an emissions report has been submitted. These ships emitted in 2020 around 126.1 million tonnes of CO_2 within the scope of the EU Maritime MRV Regulation.

The impact of the COVID-19 pandemic on the maritime shipping sector cleary shows:

- Compared to 2019, reported CO_2 emissions dropped by 14.1% and the number of emissions reports decreased by 5.4%.
- Compared to 2019, 2020 CO_2 emissions have been lower for almost all ship types, except for LNG and combination carriers. In absolute terms, CO_2 emissions dropped especially for passenger ships, including cruise ships, but the decrease has also been high for container ships, bulk carriers and Ro-pax ships.
- CO_2 emissions reported for 2020 decreased on all the different types of voyages as well as at berth, but especially on intra-EEA voyages.

The new IMO 2020 sulphur limit for ship's fuel oil was responsible for a clear shift towards light fuel oil (+197%), but could have also had an influence towards LNG (+12%) and diesel oil (+10%).

The consumption of non-conventional (non-fossil) bunker fuel remained negligible.

2.1. Fleet: emissions and number of ships

In 2020, for almost 11 700 ships an emissions report has been submitted by 1 545 companies and the total CO_2 emissions of the EU MRV fleet amounted to around 126.1 million tonnes of CO_2 (see Figure 1: Total number of ships for which emissions report has been submitted; 2018-2020 and Figure 2: Reported total fleet CO2 emissions; 2018-2020).

While the number of ships and the reported CO_2 emissions where rather stable in the first two reporting periods 2018 and 2019, the number of ships and especially the emissions have decreased significantly in the 2020 reporting period. Compared to 2019, the reported CO_2 emissions dropped by 14.1% and for 5.4% fewer ships an emissions report has been submitted. This clearly reflects the impact of the COVID-19 pandemic on the maritime shipping sector which will be discussed in more detail in Section 2.3.

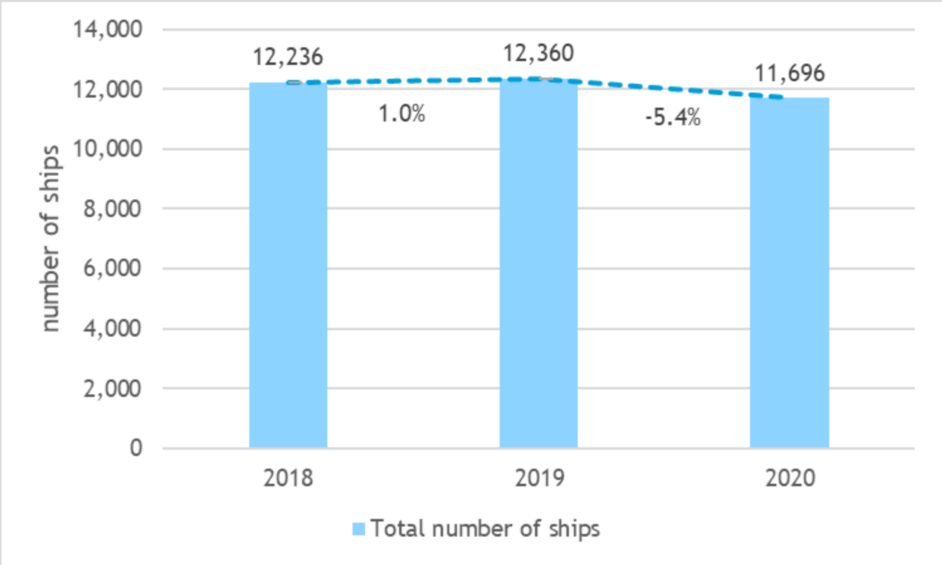

Figure 1: Total number of ships for which emissions report has been submitted; 2018-2020

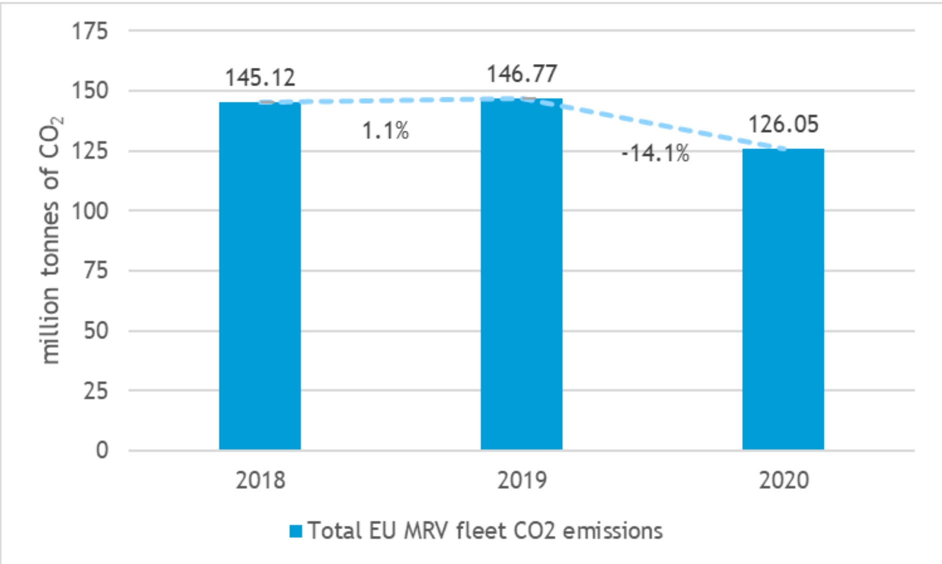

Figure 2: Reported total fleet CO2 emissions; 2018-2020

Compared to 2019, the fleet CO_2 emissions reported for 2020 decreased on all the different types of voyages as well as at berth, but especially on the intra-EEA voyages, with a decrease of around 21% (see Figure 3: 2018 to 2020 fleet emissions per voyage type and at berth).

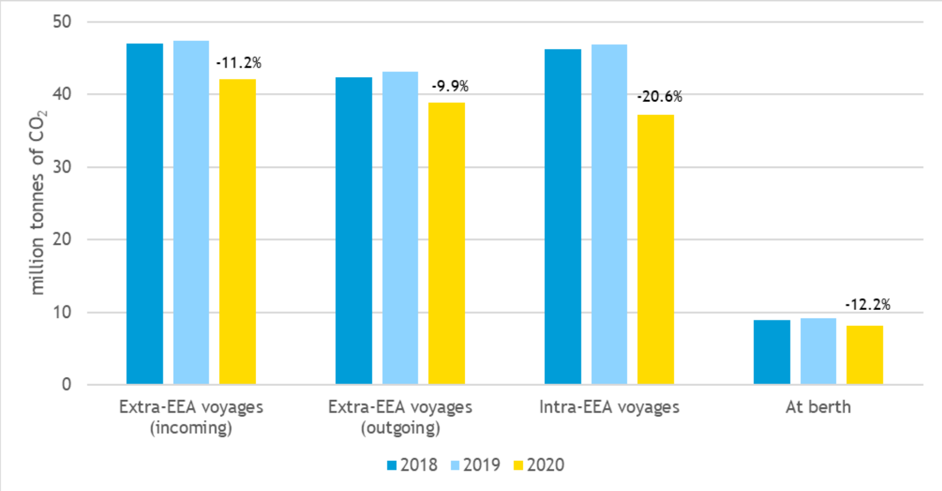

Figure 3: 2018 to 2020 fleet emissions per voyage type and at berth

2.2. Ship types: emissions and number of ships

As illustrated by Figure 4: Total emissions per ship type; 2018 to 2020; descending 2020 order and Figure 5: Ship types' share in fleet CO2 emissions; 2020, in 2020, container ships had the highest proportion in the fleet CO_2 emissions (2020: 33%) and were, together with the emissions of oil tankers, responsible for almost half (47%) of the 2020 fleet emissions. With CO_2 emissions above 10 Mt respectively, the contribution of bulk carriers and Ro-pax ships has been relatively high too.

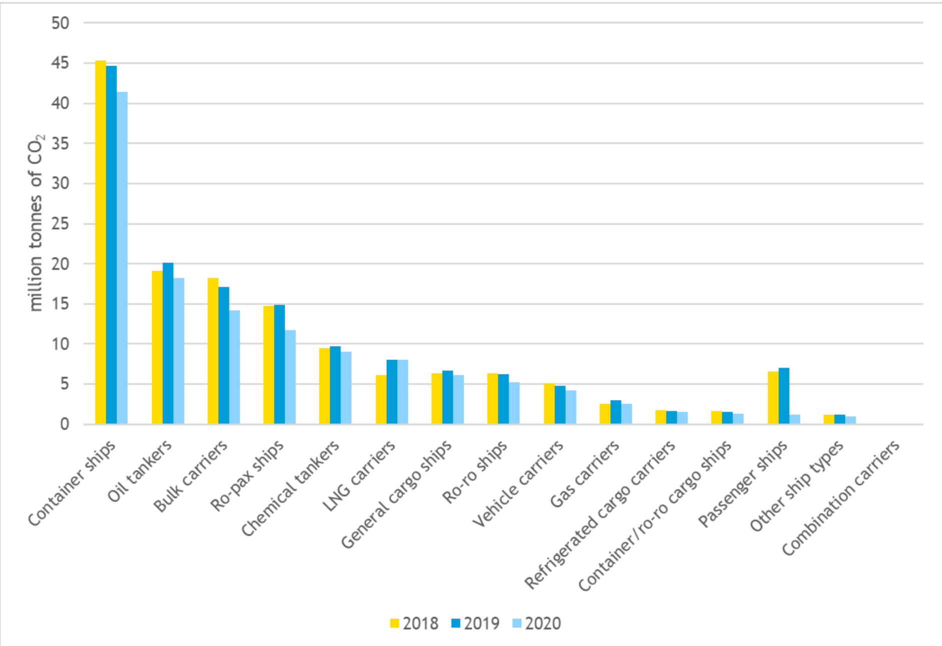

Figure 4: Total emissions per ship type; 2018 to 2020; descending 2020 order

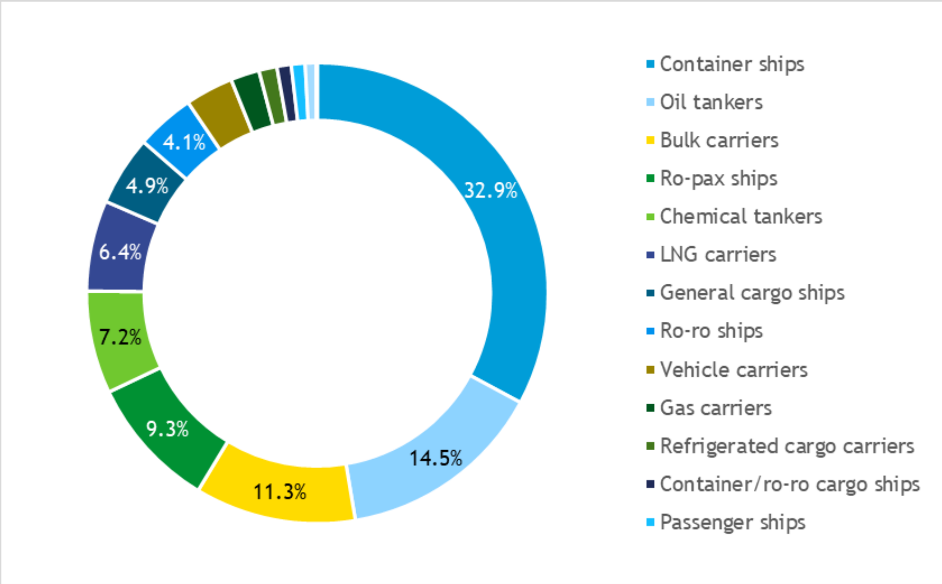

Figure 5: Ship types' share in fleet CO2 emissions; 2020

Comparing 2020 and 2019 CO_2 emissions, the impact of the COVID-19 pandemic is clear. As Figure 6: Change of emissions per ship type in absolute terms; 2020 versus 2019; descending 2019 emissions order illustrates, compared to 2019, 2020 CO_2 emissions have been lower for almost all the ship types, except for LNG and combination carriers. Passenger ships, including cruise ships and (non-Ro-pax) ferries, have been heavily affected by the crisis and stand out with almost 6 Mt less emissions in 2020. The drop in CO_2 emissions has also been relatively high for container ships, bulk carriers and Ro-pax ships, with roughly 3 Mt less emissions respectively.

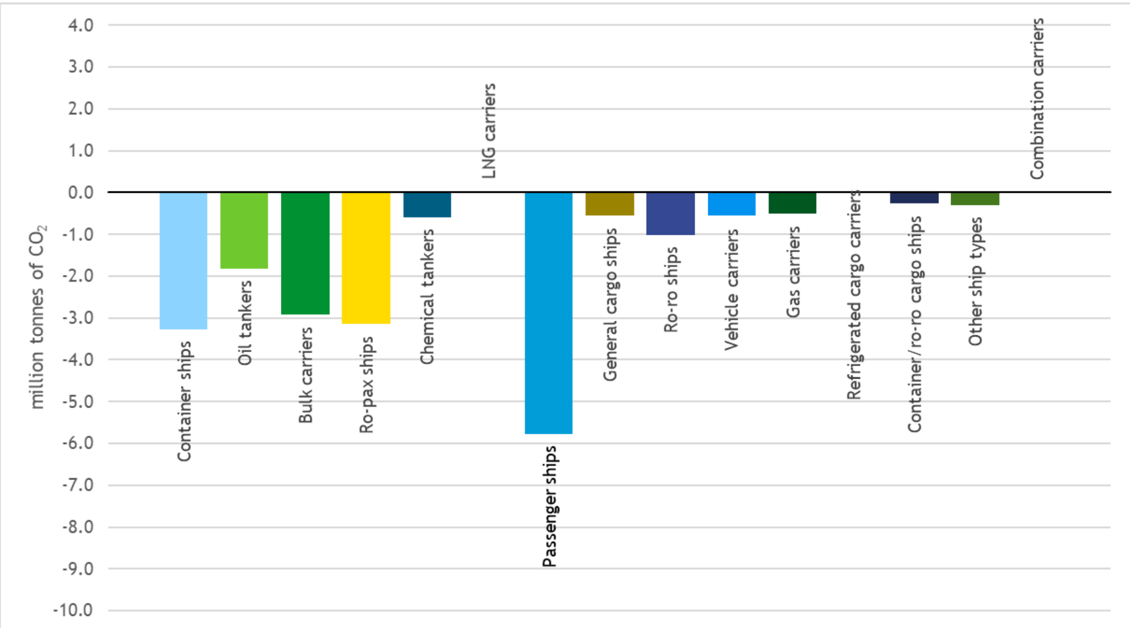

Figure 6: Change of emissions per ship type in absolute terms; 2020 versus 2019; descending 2019 emissions order

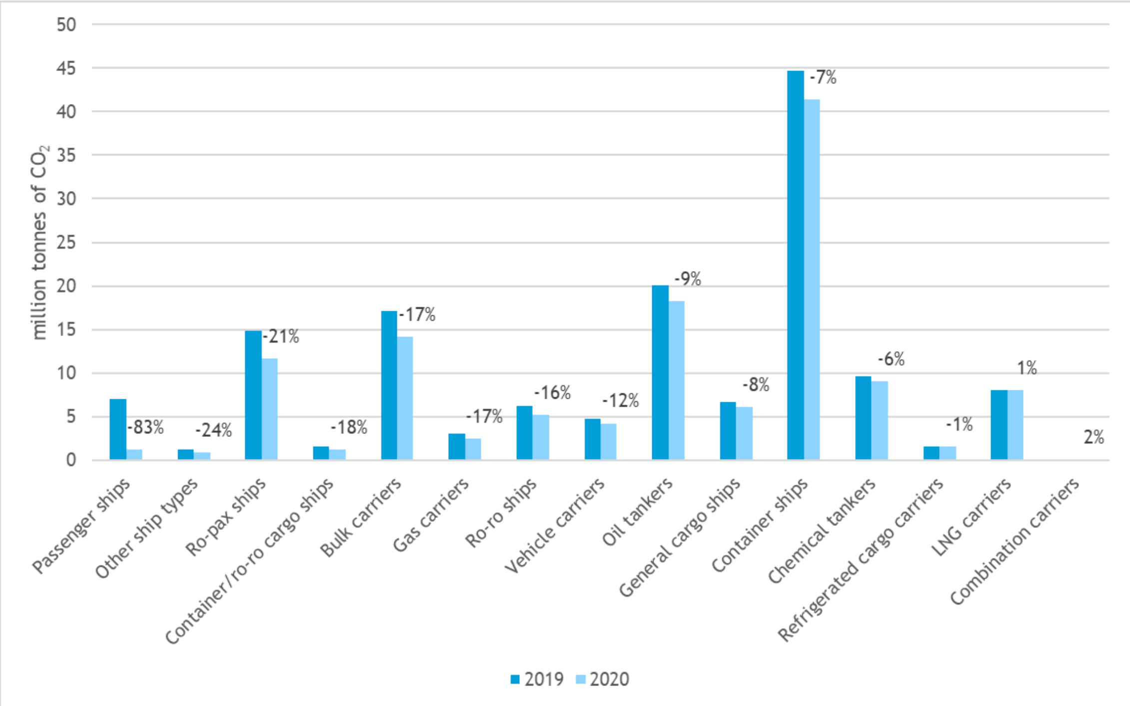

Figure 7: Total emissions per ship type; 2019 and 2020; increasing order by relative change

With a 83% reduction in CO_2 emissions, the decrease for passenger ships was also the greatest in relative terms (see Figure 7: Total emissions per ship type; 2019 and 2020; increasing order by relative change), followed by 'Other ship types' (-24%) and Ro-pax ships (-21%). The CO_2 emissions of container/Ro-ro cargo ships, bulk carriers and gas carriers decreased to a comparable extent by between 18% and 16%. While the decrease of the CO_2 emissions of the container ships is relatively high in absolute terms, it is low in relative terms (around 7%), reflecting the container ships' high share in the 2019 emissions.

Regarding the number of ships per ship type for which an emissions report has been submitted, five ship types are dominating (see Figure 8: Number of ships per ship type for which an emissions report has been submitted; 2018 to 2020; 2020 compared to 2019): bulk carriers, oil tankers, container ships, chemical tankers and general cargo ships together account for around 82% in 2020. And these ship types have, in terms of numbers, been dominant in the previous two years too.

Compared to 2019, the number of ships for which an emissions report has been submitted in 2020 has decreased for almost all ship types, but mainly for bulk carriers, oil tankers and passenger ships (see Figure 8: Number of ships per ship type for which an emissions report has been submitted; 2018 to 2020; 2020 compared to 2019). In relative terms, the decrease has been highest for passenger ships (-38%), Ro-ro ships (-14%) and Other ship types (-13%).

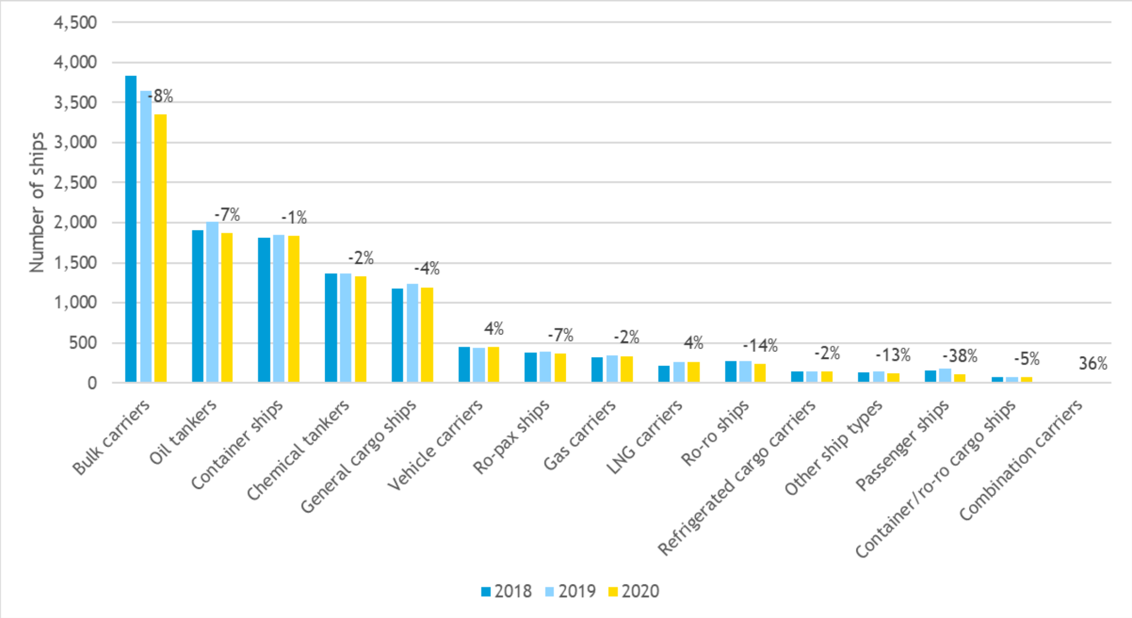

Figure 8: Number of ships per ship type for which an emissions report has been submitted; 2018 to 2020; 2020 compared to 2019

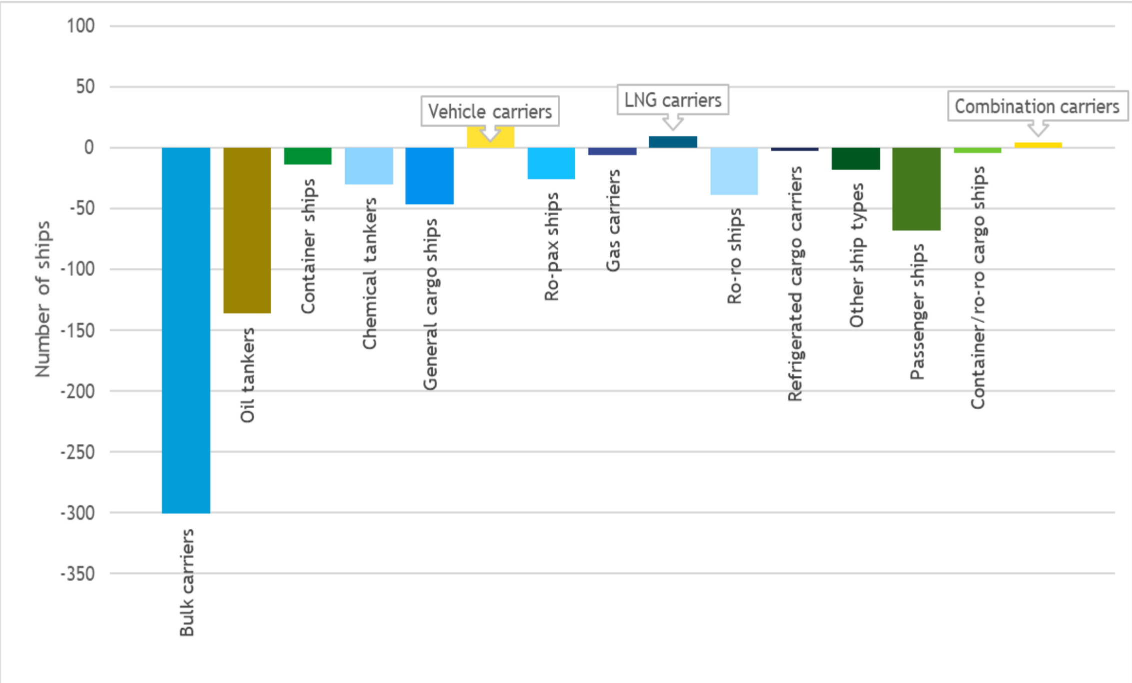

Figure 9: Change of number of ships per ship type for which an emissions report has been submitted; 2020 versus 2019

Figure 10: Change of emissions per ship type, differentiated by type of voyage; 2020 versus 2019; ship types sorted by change of emissions allows to determine the ship type and the type of voyage for which the reported CO_2 emissions decreased most in 2020 compared to 2019.

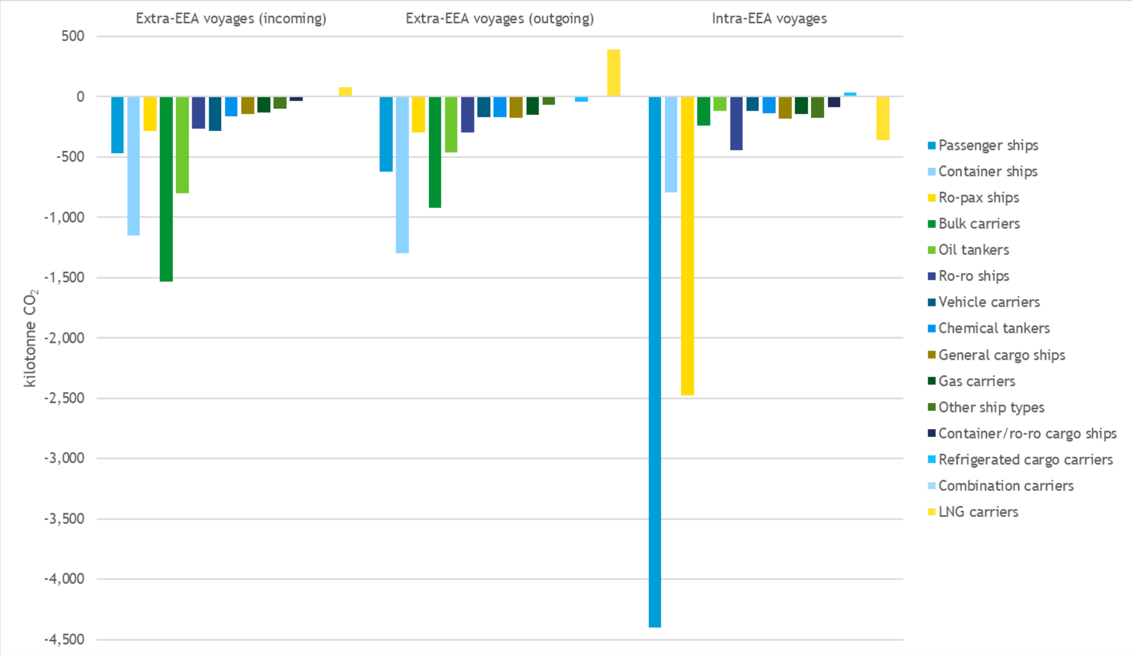

Figure 10: Change of emissions per ship type, differentiated by type of voyage; 2020 versus 2019; ship types sorted by change of emissions

Looking at the five ship types whose emissions has decreased most in absolute terms (the first five ships listed in legenda of Figure 10: Change of emissions per ship type, differentiated by type of voyage; 2020 versus 2019; ship types sorted by change of emissions), it becomes clear that the emissions of passenger ships and Ro-pax ships dropped most on intra-EEA voyages, that the emissions decrease of container vessels is more balanced across the voyage types, but highest on outgoing extra-EEA voyages and that the emissions of bulk carriers and oil tankers decreased most on incoming extra-EEA voyages.

As already discussed above, the CO_2 emissions on intra-EEA voyages decreased most. The emission reduction of passenger and Ro-pax ships cleary stand out here. Container ships have also reported significantly less emissions for intra-EEA voyages, but the decrease is by far less than for passenger and Ro-pax ships.

2.3. Analysis of 2020 CO_2 emissions

In principle, the annual reported fleet CO_2 emissions can vary over time due to four main factors:

1. More/less ships have been active within the scope of the Regulation;
2. The ships active within the scope of the Regulation have been more/less used;
3. The ships active within the scope of the Regulation have been more/less energy efficient;
4. The ships active within the scope of the Regulation have used energy carriers that are more/less carbon intensive.

Out of these four factors, the last three all have an impact on the average per ship emissions within the scope of the Regulation.

Passenger ships, container ships, Ro-pax ships, and bulk carriers showed, in absolute terms, the largest decrease of the per ship type CO_2 emissions between 2019 and 2020.

Analysing this emissions decrease for these four ship types (see also Table 1), it can be concluded that:

1. for container ships, the change of the average per ship emissions is clearly the dominating factor – all other things being equal (to 2019), the decrease of the number of reporting ships can only explain 10% of the emissions decrease;
2. for passenger ships and Ro-pax ships, both factors – drop in number of reporting ships and drop in average per ship emissions – play a role, with the drop in the average emissions being the dominant factor; and
3. for bulk carriers, both factors play a roughly equal role for the reduction of the emissions.

Table 1 Analysis of 2020 CO_2 emissions decrease

Ship types featuring highest decrease of absolute CO_2 emissions compared to 2019

Ship type	Change of number of reporting ships compared to 2019	Change of average per ship emissions compared to 2019
Container ship	-1%	-7%
Passenger ship	-38%	-72%
Ro-pax ships	-7%	-15%
Bulk carrier	-8%	-10%

Then, from the three factors listed above, the decreased activity of the ships is probably the most important factor that explains the ship types' lower average per ship emissions. The average 'time spent at sea' of all four ship types decreased between 2019 and 2020. With a 70% drop, the decrease of the average 'time spent at sea' was highest for passenger ships. For the other three ship types, the drop was comparable, ranging from 14 to 18%.

Both the drop in the number of ships that have been active within the scope of the Regulation as well as the drop in the ships' average emissions within the scope of the Regulation due to lower activity can, at least partially, be attributed to the COVID-19 crisis.

EMSA, (2021) has analysed the impact of the COVID-19 pandemic on the EU-28 maritime sector in 2020, considering not only the ships and their activity within the scope of the EU Maritime MRV Regulation.[8]

[8] The scope of the EU MRV Regulation is limited to ships above 5 000 GT and activities serving the purpose of transporting cargo or passengers for commercial purposes, EMSA has analysed the development of the seaborne trade by means of customs data reported by EU-28 Member States and the development of traffic by means of data from the Union Maritime Information and Exchange System (SafeSeaNet), partially combined with LRIT and MARINFO data, both not limited to the EU MRV scope.

Regarding the number of ship calls, EMSA, (2021) concludes that, compared to 2019, the number of total ship calls decreased mainly in the second and third quarter of 2020: In the second quarter around 27% and in the third quarter around 9% fewer ships called at EU ports. And while a decrease in the number of ship calls between 2019 and 2020 was found for all ship types, the cruise ships, passenger ships and vehicle carriers are the ship types for which the decrease was highest, with a drop of ship calls of around 86%, 39% and 22% respectively.

Regarding seaborne trade, EMSA, (2021) concludes that EU seaborne trade seems to have declined more significantly than global seaborne trade in 2020. While world seaborne trade (in tonnes) is estimated to have declined by 3.6% across 2020, for EU-28 it is estimated to have declined by 9.3% across 2020, corresponding to around 226 million tonnes of commodities. The most significant decline in trade volumes (in tonnes) was in imports into the EU from non-EU states, which decreased by around 12% in 2020, followed by intra-EU trade (around 7% less) and then exports from the EU to non-EU states (around 4% less).

In terms of absolute volumes (tonne), 2020 EU-28 seaborne trade dropped, compared to 2019, mostly for oil (around 127 Mt), dry bulk (around 63 Mt) and containerised goods (21 Mt); and in terms of relative volumes (tonne), seaborne trade dropped most for cars & vehicles (around 18%), oil (around 16%), dry bulk (around 8%) and gas (7%).

It should finally be noted that the ships' decrease of 2020 CO_2 emissions cannot be attributed to Brexit: indeed, the scope of the EU MRV Regulaton has not been changed during the transitional period, ending on 31 December 2020 (European Commission, 2020).

2.4. Fuel consumption

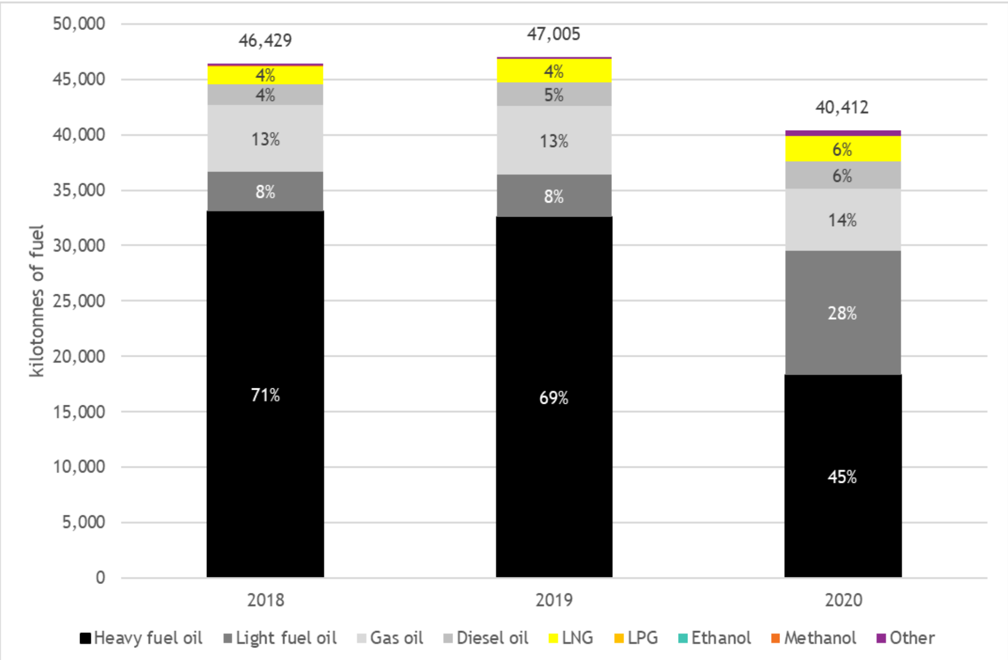

Figure 11: 2018 to 2020 total fuel consumption of EU MRV fleet and shares per fuel type

In 2020, as indicated by the length of the bar in Figure 11: 2018 to 2020 total fuel consumption of EU MRV fleet and shares per fuel type, the EU MRV fleet consumed in total around 40.4

million tonnes of fuel within the geographical scope of the Regulation. This is around 14% less than in 2019. Around 5.5% of the 2020 total fuel consumpton is fuel consumed at berth.

MARPOL Annex VI Regulation 14 sets limits to the sulphur content of bunker fuel oils. As mentioned in the Introduction (Section 1.2.1.), some of the requirements have became stricter at the beginning of 2020: outside Emission Control Areas, the maximum allowed sulphur content of the fuel has been reduced from 3.5% to 0.5% m/m. To comply with this sulphur limit, ships can either use energy carriers with a lower sulphur content (Very low sulphur fuel oil (VLSFO), low sulphur marine gas oil, LNG, LPG, methanol or ethanol) or can keep on using heavy fuel oil in combination with an exhaust gas cleaning system.

In Figure 11: 2018 to 2020 total fuel consumption of EU MRV fleet and shares per fuel type, the effects of the stricter sulphur regulation cleary shows: compared to 2019, the consumption of heavy fuel oil has decreased significantly (-44%) while the use of light fuel oil has increased significantly (+197%); the consumption of diesel oil has also increased compared to 2019 (+10%). Note in this context, that VLSFO can, depending on the grade, fall into different fuel categories distinguished under the EU Maritime MRV Regulation.

For most ship types, except LNG carriers and passenger ships, Heavy fuel oil (HFO) is the fuel type with the highest share in the total 2020 fuel consumption of these ship types. For passenger ships, the share of gas oil (44%) is slightly higher than that of HFO (42%). LNG carriers' fuel consumption is highly dominated by LNG (72%) – these ships transport LNG and can also use LNG for propulsion purposes.

Total LNG consumption has increased between 2020 and 2019 (+12%) but with around 6% of the total fuel consumption the share remains relatively low.

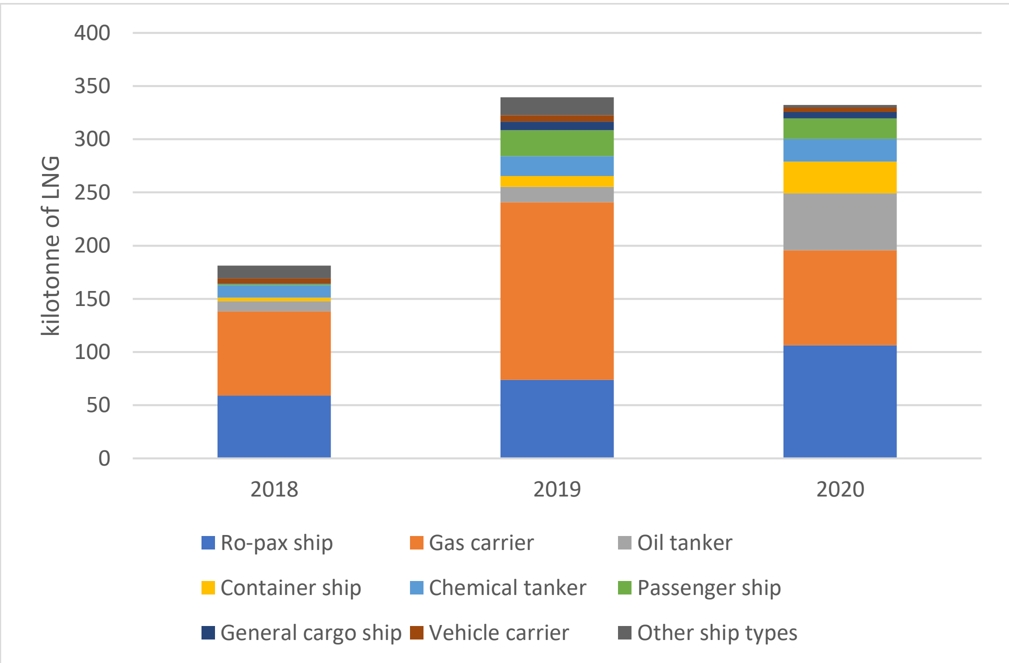

Figure 12: LNG consumed by ship types other than LNG carriers

Generaly LNG is mainly consumed by LNG carriers (86% of 2020 LNG consumption), but Figure 12: LNG consumed by ship types other than LNG carriers also shows that in 2020, compared to 2019, more LNG was consumed by RoPax vessels, oil tankers and containers ships but less by Gas carrier. This is an indication for an increased variety of ship types that, next to LNG carriers, also consume LNG.

The total share of LPG, ethanol, methanol and ‘Other fuel types’ in the fleet’s overall fuel consumption is neglible.

3. The monitored voyages at a glance: shipping routes, speed and time spent at sea

Main findings

Main shipping routes

- There is a high demand of waterborne transport services between the EU and countries such as Russia, USA, Canada, Brazil, China and neighbouring non-EU countries such as the UK, Norway and Turkey.
- Except for Brazil, all inward and outward flows (by gross weight of freigth handled in main ports) increased in 2019 compared to 2018. In contrary, due to COVID-19, all inward and outward flows decreased in 2020 compared to 2019, with the exception of the outward flow to China which actually increased.

Fleet speed

- Speed variation between 2018, 2019 and 2020 per ship type is negligible. This means that the ships have not slowed down structurally per ship type.
- Time at sea varies per ship type since every ship type has a different operational profile. However, for all ship types, with the exception of refrigerated cargo carriers, the average time at sea was significantly shorter in 2020 than in 2018 and 2019. This is due to a temporary reduction of the transport work because of COVID-19. Passenger ships suchs as cruise ships have been hit the hardest.

3.1. Main shipping routes

Similar to what was reported in the previous two annual emission reports, MRV voyages analysis continues to largely corroborate the data provided by Eurostat in terms of EU trade flows by gross weight of freight handled in main ports (see Figure 13: Main extra EU flows) It shows a high demand of waterborne transport services between the EU and countries such as Russia, USA, Canada, Brazil, China. It also reflects the main routes for the large international deep-sea ships such as large containerships, tankers and bulk carriers. In addition, this figure also highlights the number of voyages between the EU and the neighbouring non-EU countries such as the United Kingdom, Norway and Turkey.

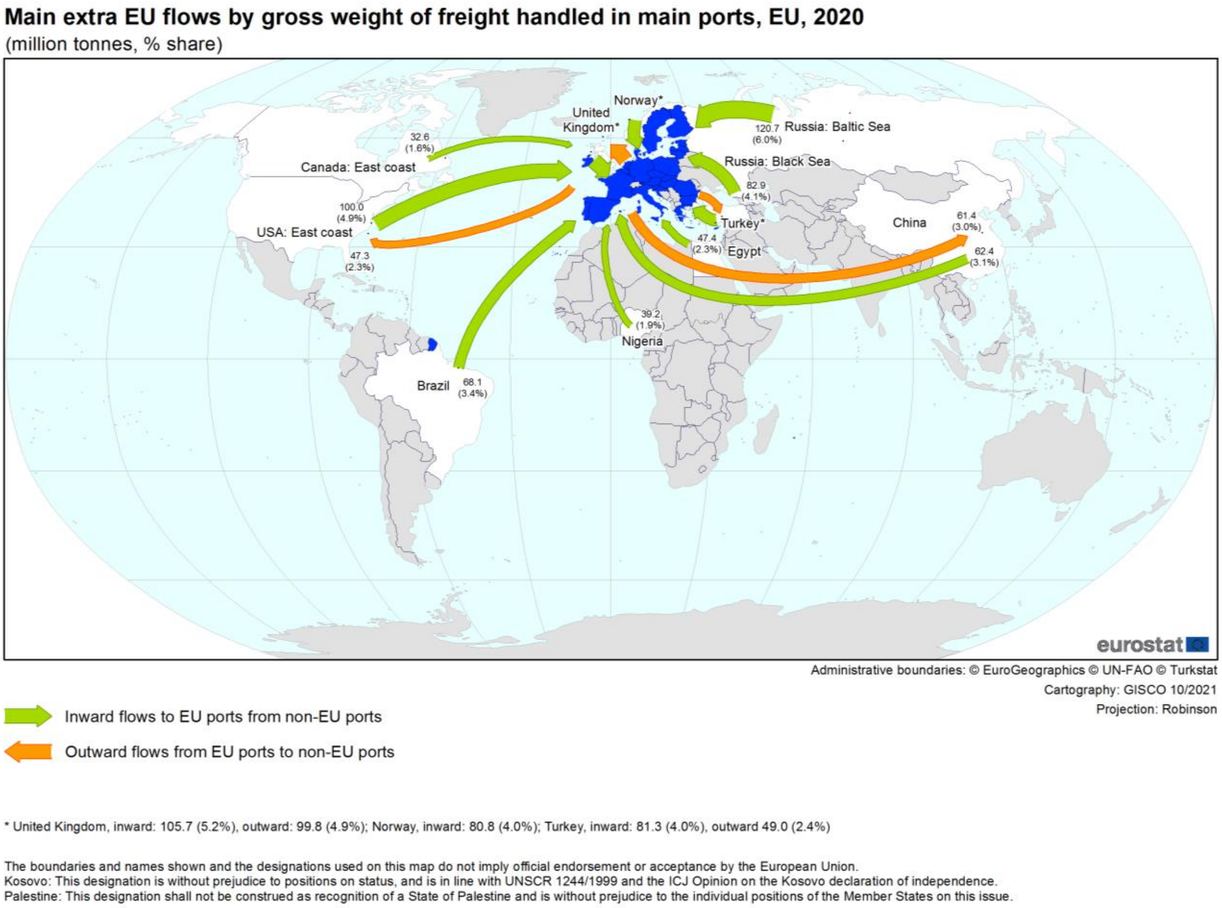

Figure 13: Main extra EU flows

Source: Eurostat, (2022)

Table 4 in the Annex provides the main extra EU-27 flows by gross weight handled in main ports in the years 2018, 2019 and 2020 in million tonnes. Except for Brazil, all inward and outward flows increased in 2019 compared to 2018. On the contrary, due to COVID-19, all inward and outward flows decreased in 2020 compared to 2019, with the exception of the outward flow to China which actually increased.

3.2. Fleet speed

3.2.1. Average speed by ship type

Speed has a direct effect on fuel consumption and on CO_2 emissions. Reduction of speed results in a reduction of fuel consumption and thereby a reduction of CO_2 emissions. Fuel costs are a big part of the operational costs of ships. By reducing speed, the operational costs will be reduced, which is likely to increase profits as well. The positive effect is thereby a reduction of the CO_2 emissions (IMO, 2020).

Speed is a parameter which is difficult to compare between different ship types since their different ship designs and business models play an important role. However, speed variation over time is a relevant indicator to explain the evolution of the operational energy efficiency of ships.

In this context, the average speed by ship type has been calculated based on the monitored fleet reported figures (time spent at sea and distance travelled). Figure 14: Average speed by ship type.

Considering the values obtained, it can be concluded that the THETIS-MRV speed variation between 2018, 2019 and 2020 per ship type is negligible, which means that the average speed per ship type has not structurally decreased. Exceptions to this are the cases of vehicule carriers and refregirated cargo carriers, for which a clear reduction trend in the average speed was recorded. Moreover, a significant drop in the average speed in the last year is evident for passenger ships, since these have executed almost no commercial voyages in 2020 compared to 2019, and even in the few voyages they did, speed had been reduced.

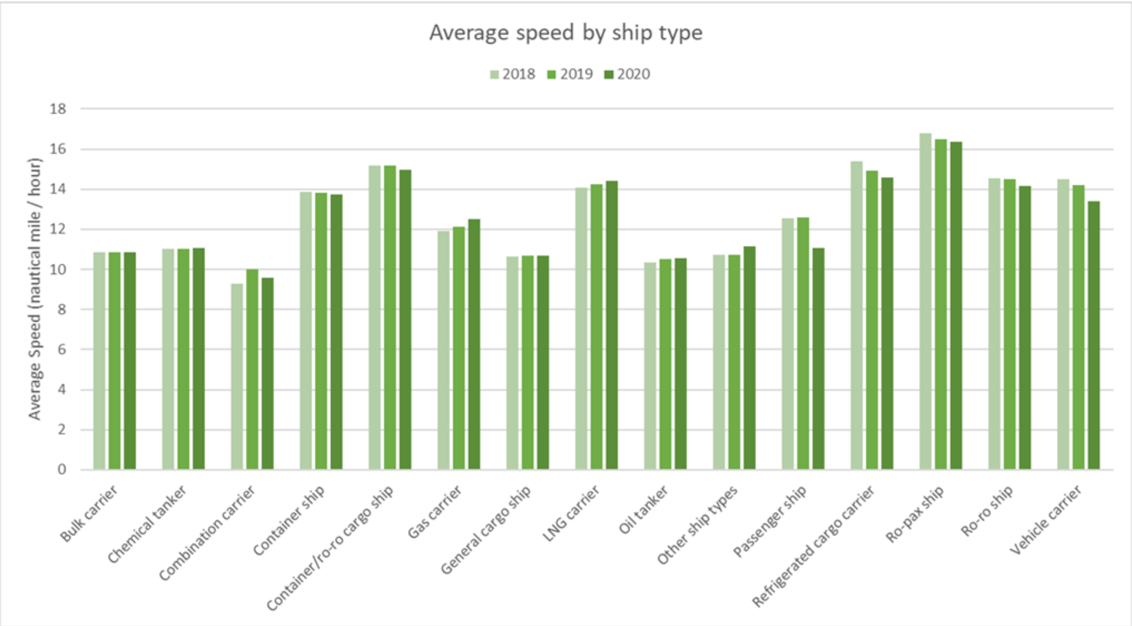

Figure 14: Average speed by ship type

3.3. Time spent at sea

3.3.1. Time at sea by ship type

Figure 15: Average time at sea by ship type shows how the the average time at sea varies per type since every ship type has a different operational profile. It is therefore difficult to compare time at sea for different ship types.

For all ship types, except for refrigerated cargo carriers, the average time at sea was significantly shorter in 2020 than in 2018 and 2019. This is due to a temporary reduction of the transport work because of COVID-19. Passenger ships, suchs as cruise ships, have been hit the hardest since it was not allowed to use these ships as holiday destination. Passenger ships/cruise ships stayed at anchor without passengers and only with a minimum amount of crew members during COVID-19. Time at anchorage is not part of the time at sea.

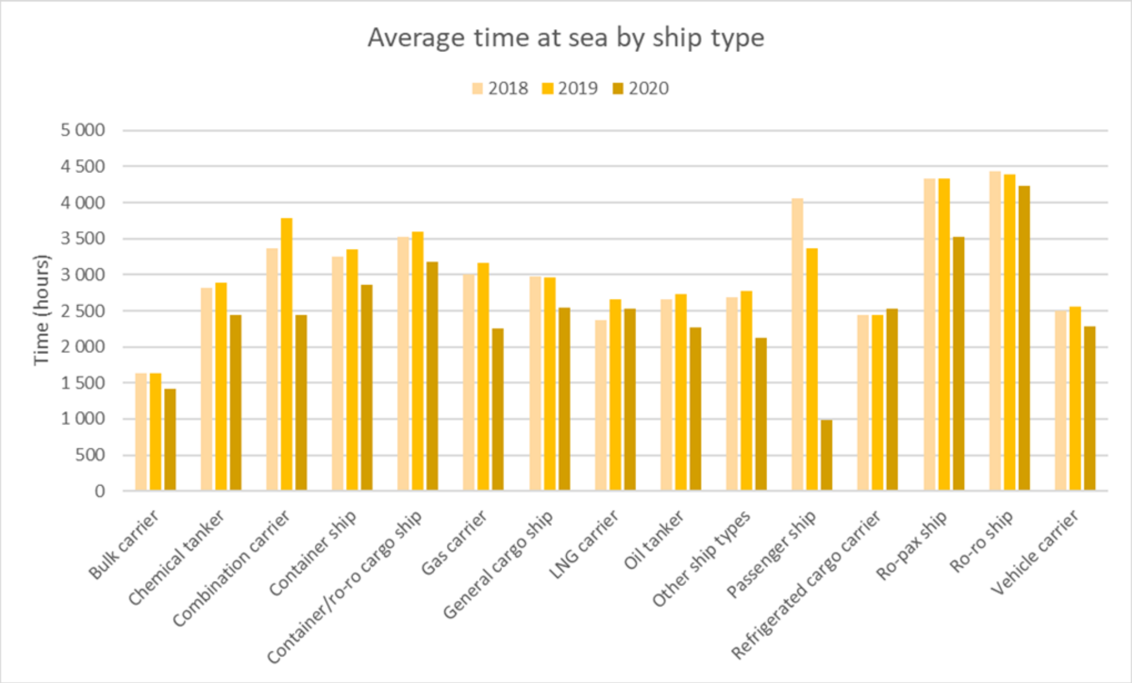

Figure 15: Average time at sea by ship type

4. Technical and operational efficiency of the monitored fleet

Main findings

Technical efficiency of the monitored fleet

In 2020, companies reported for 3 177 ships (27%) the Energy Efficiency Design Index (EEDI), and for 8 374 ships (72%) the Estimated Index Value (EIV).

As the EEDI is required for ships built as of 2013 or 2015, depending on the ship type, this gives a further indication on the age of the EU MRV fleet.

An analysis of the EEDI values reported in 2020 shows that a very high share of LNG carriers, general cargo ships and passenger ships, but a low share of vehicle carriers and bulk carriers, already meets the upcoming Phase 3 EEDI requirements that will hold for new ships from 2022 or 2025 on, depending on the ship type and size.

Operational efficiency of the monitored fleet

The fleet average operational efficiency of the ships that have been active both in 2020 and 2019 has not changed if measured in terms of CO_2 per distance, whereas, in terms of CO_2 per transport work (mass distance), calculated for the relevant subset of ships, it shows a slight improvement (-1.5%).

The energy/carbon efficiency of ships can be measured in terms of technical or operational efficiency and by means of various indicators. Technical efficiency indicators aim at measuring the energy consumption/the emissions of a ship, depending on its design, whereas operational efficiency indicators also account for how a ship is operated. Independent of the efficiency indicator, a lower indicator value means that the efficiency of a ship has improved.

4.1. Technical efficiency

4.1.1. Overview

According to the EU Maritime MRV Regulation, the technical efficiency of a ship has to be reported by using the Energy Efficiency Design Index (EEDI) or the Estimated Index Value (EIV) where applicable.

The EEDI is an energy efficiency measure implemented at the IMO level with the aim to improve the technical energy efficiency of newbuild ships. Newbuild ships of certain types and size segments need to meet EEDI requirements in terms of CO_2 per capacity nautical mile if they have been built after 1 January 2013 or 1 January 2015, depending on the ship type and size. The EEDI requirements become more stringent over time, also depending on ship type and size (see Table 5 in the Annex for an overview of the EEDI requirements).

The EIV is a simplified version of the EEDI, used to calculate the energy efficiency reference lines for ships pre-dating the application of the EEDI.

The specific EU MRV reporting requirements regarding the technical carbon efficiency of ships are as follows (European Commission, 2017):

- The attained EEDI has to be reported where required by and in accordance with MARPOL Annex VI, Regulations 19 and 20.'[9] (European Commission, 2017).
- Ships that do not fall under these MARPOL Annex VI Regulations (for example due to the year of build or the ship size), but that are ship types that in principle are covered by these MARPOL Annex VI Regulations, have to report the EIV. They are also encouraged to report the EEDI instead of the EIV on a voluntary basis.
- Ships of ship types not covered by the MARPOL Annex VI Regulations are not required to report their technical efficiency (European Commission, 2017), which explains why for some ships the 'not applicable' value was entered in the technical efficiency section.

The categories are mutually exclusive, i.e. ships either report their EEDI, their EIV or 'not applicable'.

In 2020, in total, 3 177 ships have reported their EEDI and 8 374 ships their EIV (with 138 'not applicable'). With a share of 72%, the majority of ships have therefore reported their EIV. This also holds for each of the ships types (see Table 6 in the Annex). With 30% and more, the share of ships that have reported the EEDI is relatively high for gas carriers (39%), chemical tankers (36%), oil tankers (35%), bulk carriers (31%) and container ships (30%). This reflects a relatively high number of young ships built in 2013[10] or later and also the fact that for these ship types, the EEDI requirements came into force at an earlier stage, i.e. 2013 instead of 2015. For other ship types that fall under the EEDI requirements (LNG carrier, Ro-ro ships, Ro-pax ships, vehicle carriers and cruise ships) no Phase 0 EEDI requirements applied for 2013 and 2014, independent of the ships' size (see Table 5 in the Annex).

4.1.2. The Energy Efficiency Design Index in 2020

The required EEDI value for each ship depends on the ship type, the deadweight (or gross tonnage) of the ship as well as the year of the building contract/keel laid/delivery of the ship. The requirements are also getting stricter over time. So far, Phase 0 (least strict) to Phase 3 (most strict) have been differentiated (see Table 5 in the Annex). Phase 4 will be subject todiscussion at the IMO level.[11]

Figure 16: Share of number of ships meeting Phase 2 and Phase 3 requirements in 2020, independent of their year of build gives the outcome of a comparison of the ships' attained EEDI values as reported in 2020 under the EU Maritime MRV Regulation and the corresponding ship types' Phase 2 and Phase 3 requirements, independent of the year of build of the ships.

[9] Regulation 19 (Application) and Regulation 20 (Attained EEDI) are part of Chapter 4 (Regulations on energy efficiency for ships) of Annex VI of the IMO MARPOL Convention.

[10] The first newbuild ships to which Phase 0 applied where ships with a building contract placed on or after 1 January 2013 / ships the delivery of which was on or after 1 July 2015

[11] Further details on the IMO EEDI framework can be found in the Technical study on the future of the ship energy efficiency design index at https://op.europa.eu/s/v6sB

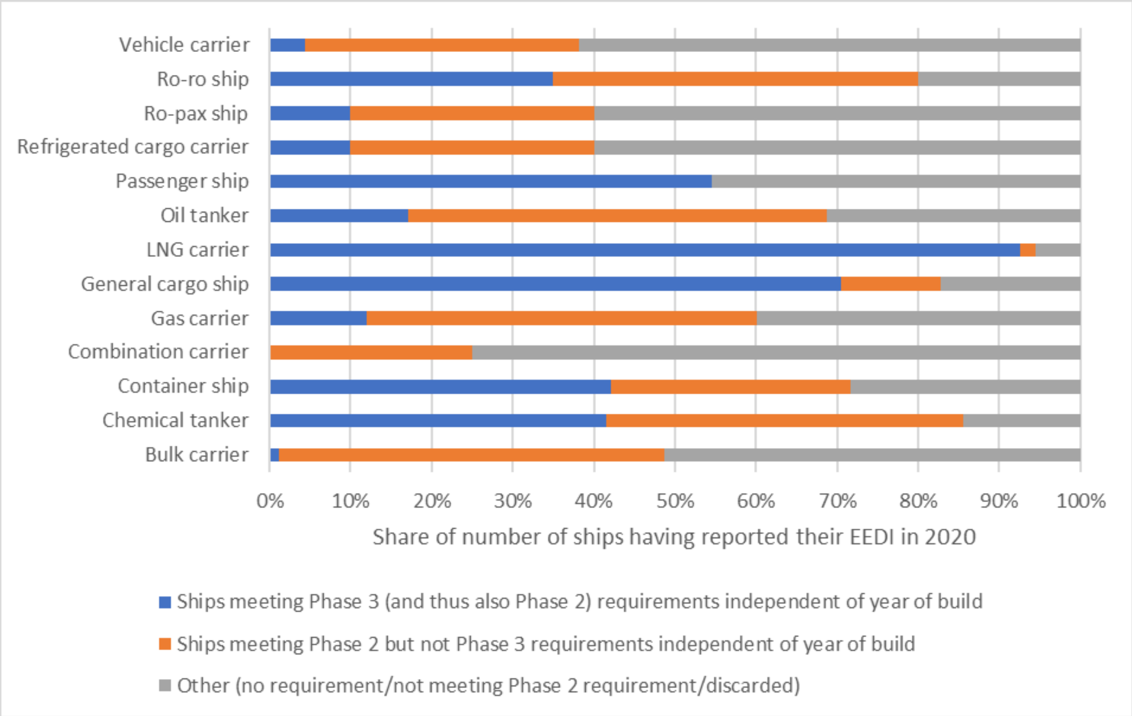

Figure 16: Share of number of ships meeting Phase 2 and Phase 3 requirements in 2020, independent of their year of build

Figure 16: Share of number of ships meeting Phase 2 and Phase 3 requirements in 2020, independent of their year of build illustrates that a very high share (more than 50%) of LNG carriers, chemical tankers, general cargo ships, oil tankers, Ro-ro ships, gas carriers and passenger ships meet the Phase 2 requirements and that a very high share of the LNG carriers, general cargo ships and passenger ships also already meet the upcoming Phase 3 requirements. The figure also shows that a low share of vehicle carriers and bulk carriers already meets the upcoming Phase 3 requirements.

For container ships, Phase 3 requirements are, in contrast to the other ship types, highly differentiated, depending on the ship size. Figure 17: Number of container ships meeting/not meeting Phase 3 in 2020, independent of their year of build illustrates that for most size categories it holds that the majority of container ships does not yet meet the upcoming Phase 3 requirements. The share of ships already meeting the upcoming Phase 3 is relatively high among the ships above 200 000 dwt. And the ships in the category of 120 000 dwt and above, but smaller than 200 000 dwt stand out: the vast majority of the ships in this category already meet the upcoming Phase 3 requirements.

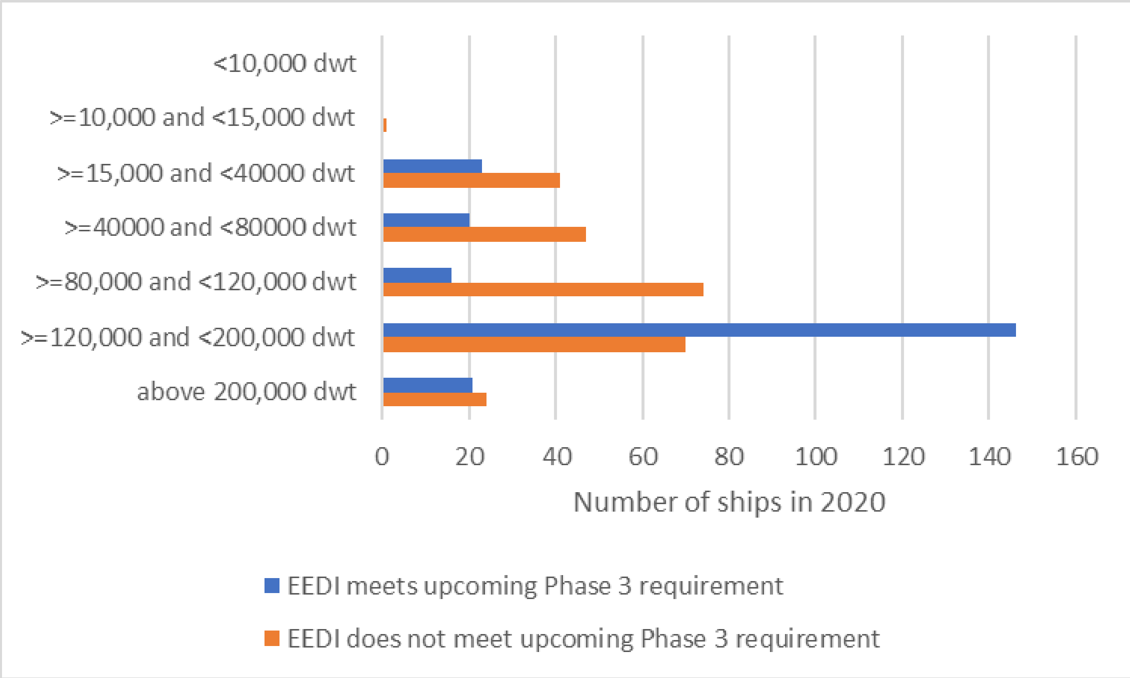

Figure 17: Number of container ships meeting/not meeting Phase 3 in 2020, independent of their year of build

4.1.3. Evolution of the Energy Efficiency Design Index

The fleet average 2020 EEDI has slightly improved (-1.6%) compared to 2019. This however does not necessarily mean that individual ships' technical efficiency has improved since the composition of the fleet differs between the two years.

If you compare the EEDI that the ships of a specific type have attained in 2018 to 2020, then the following conclusion can be drawn by means of a graphical analysis (see Figure 21: Plot of attained EEDI values of bulker ships in 2018, 2019 and 2020 and according trendlines and according trendlines in the Annex for an example): The EEDI trendlines for 2018 to 2020 for the following ship types overlap, which indicates that the technical efficiency of these subsegments of the fleet has not significantly changed in the last three years: bulk carriers, chemical tankers, container ships, gas carriers, and oil tankers. The graphical analysis shows an improvement of the EEDI for general cargo ships in 2020, while for the remaining ship types, either the sample was too small or no reliable trendlines could be established to draw relevant conclusions.

Around 63% of the 3 177 ships that have reported their attained EEDI in 2020 also reported an EEDI value in 2019 (see Table 7) and around 3.5% of the them an EIV value in 2019. If you compare the average EEDI of the ships that reported an EEDI in both years, then the technical efficiency seems to have slightly improved (-0.27%). 115 ships reported in 2020 an EEDI that deviates from the one reported in 2019.

4.2. Operational efficiency

4.2.1. Overview

According to the EU Maritime MRV Regulation (see Annex II, B. of the Regulation), ships have to monitor their average operational energy efficiency by using at least four indicators:

1. Fuel consumption per distance;
2. Fuel consumption per transport work;
3. CO_2 emissions per distance;
4. CO_2 emissions per transport work (also referred to as Energy Efficiency Operational Indicator (EEOI)).

which have to be calculated as follows:

- Fuel consumption per distance = total annual fuel consumption/total distance travelled;
- Fuel consumption per transport work = total annual fuel consumption/total transport work;
- CO_2 emissions per distance = total annual CO_2 emissions/total distance travelled;
- CO_2 emissions per transport work = total annual CO_2 emissions/total transport work.

The metric for the transport work can thereby differ, depending on the ship type (see Implementing Regulation 2016/1927), e.g. depending on whether cargo or passengers or both are transported. The majority of the ships (have to) apply a metric which uses the mass of the cargo transported, measuring their transport work in tonne nautical miles. (see Table 8 in the Annex for more details about the indicators reported per ship type).

The principal challenge with regards to the operational efficiency of ships lies in the fact that there are various factors that have an impact on the operational efficiency of a ship. Some of these factors, such as the speed of a ship, can be determined by the operator, while others, like voyage conditions (wind, waves etc.), cannot. Analysing the average operational efficiency of the ships on an annual basis allows to average out factors such as voyage conditions and for ships, like liner ships or ferries, which operate on the same/comparable routes in the different years, a change of the ships' operational efficiency between the years will likely be mainly linked to a change in the operation of the ship, like a speed reduction.

Based on the data reported by the companies, an additional operational efficiency indicator, the AER (Annual Efficiency Ratio) can be determined. This indicator works with a proxy for the ships' transport work, i.e. the deadweight tonnage, resulting in the following metric: g CO_2 / (dwt n miles). Comparing the different indicators, the AER features comparably less variation, since the proxy for the ships' transport work, i.e. the deadweight tonnage, is constant. This makes the AER metric more suitable when it comes to the determination of a ship-size dependent reference line and thus also easier to apply as a policy measure. At the IMO level, the Carbon Intensity Indicator (CII) applied the AER indicator to measure the ships' operational efficiency.

4.2.2. Evolution of the operational efficiency

The evolution of the operational efficiency of the fleet can be analysed by means of a graphical analysis. A graphical analysis of the EU MRV fleet's operational efficiency measured by means of the AER indicator shows that, for most ship types, the fleet operational efficiency seems not to have changed or to have only slightly changed in the period 2018 to 2020 (for more details, please see Section A.5.2 in the Annex).

In principle it holds that a comparison of the operational efficiency at fleet level does not necessarily allow to draw conclusions on the improvement/deterioration of the efficiency of the ships, since the composition of the fleet differs between years. An analysis of the evolution of the efficiency for that part of the fleet that has been active in 2020 as well as in 2019 is therefore more useful in this context. The operational efficiency indicators as reported by the companies have been used to this end (see Table 8 in the Annex for an overview of the indicators reported by the different ship types).

The fleet average operational efficiency of the ships that have been active both in 2020 and 2019 has not changed if measured in terms of CO_2 per distance, whereas, in terms of CO2 per transport work (mass distance), calculated for the relevant subset of ships, it shows a slight improvement (-1.5%). This however does not include Container/Ro-ro cargo ships, LNG carrier and Ro-pax ships which do not report this indicator under the EU Maritime MRV Regulation.

A comparison of the average efficiency per ship type is possible too and allows for a more detailed comparison (see Table 2 below).

Regarding the development of the operational efficiency of the ships that have been active both in 2019 and 2020, the following can be concluded, based on the **CO_2 per distance** indicator:

1. Two ship types (passenger ships (+70%) and Ro-pax ships (+2%)) feature in 2020 an average opertional efficiency that is worse than in 2019. Such trends reflect the specific market conditions encountered by passenger ships and Ro-pax ships due to COVID in 2020. For combination carrier (+15%) a similar trend can be observed, however, the sample is very small, with a single ship having a large impact on this outcome.
2. All other ship types feature no change or an improved operational efficiency in 2020 compared to 2019, especially chemical tankers (-6%) and Other ship types (-5%).

Based on the **Annual average CO_2 emissions per transport work (mass nm)**, the following conclusions can be drawn for the the development of the operational efficiency of the ships that have been active both in 2019 and 2020:

1. Four ship types (general cargo ships (+16%), Ro-ro ships (+8%), Bulk carriers (+2%) and vehicle carrier (+1%)) feature in 2020 an average operational efficiency that is worse than in 2019.
2. For all other ship types that have reported this indicator in 2019 and 2020 (thus not container/Ro-ro cargo ship, LNG carrier, passenger ship and Ro-pax ships), they feature no change or an improved operational efficiency in 2020 compared to 2019, especially refrigerated cargo carriers (-17%) and other ship types (-10%). For combination carrier (-25%) this also seems to be the case, however, the sample is very small, with a single ship having a large impact on this outcome.

The two ship types (Container/Ro-ro cargo ship, LNG carrier) that reported their operational efficiency in terms of **Annual average CO_2 emissions per transport work (volume nm)**, feature an improved efficiency in 2020.

Table 2 Average operational efficiency of ships that reported in 2019 as well as in 2020

Arithmetic mean per ship type; all ship sizes

	Annual average CO_2 emissions per distance [kg CO_2 / n mile]		Annual average CO_2 emissions per transport work (mass distance) [g CO_2 / (m tonnes · n miles)]		Annual average CO_2 emissions per transport work (volume) [g CO_2 / (m^3 · n miles)]	
	2019	2020	2019	2020	2019	2020
Bulk carrier	290	284 (-2%)	11	12 (+2%)	N/a	N/a
Chemical tanker	285	273 (-5%)	25	23 (-7%)	N/a	N/a
Combination carrier	329	379 (+15%)	89	67 (-25%)	N/a	N/a
Container ship	585	580 (-1%)	27	27 (-0.0%)	N/a	N/a
Container/Ro-ro cargo ship	390	389 (-0.0%)	N/a	N/a	25	24 (-4%)
Gas carrier	303	303 (-0.0%)	76	74 (-2%)	N/a	N/a
General cargo ship	191	189 (-1%)	41	48 (+16%)	N/a	N/a
LNG carrier	908	890 (-2%)	N/a	N/a	16	14 (-12%)
Oil tanker	449	438 (-2%)	17	16 (-8%)	N/a	N/a
Other ship types	301	284 (-6%)	412	373 (-10%)	N/a	N/a
Passenger ship	904	1 546 (+70%)[12]	N/a	N/a	N/a	N/a
Refrigerated cargo carrier	275	266 (-3%)	105	89 (-17%)	N/a	N/a
Ro-pax ship	514	523 (+2%)	N/a	N/a	N/a	N/a

[12] Please note that in 2020, due to the economic effects of COVID-19, passenger ships produced a significant share of their total emissions while at berth.

Ro-ro ship	346	344 (-0.0%)	160	172 (+8%)	N/a	N/a
Vehicle carrier	329	323 (-2%)	75	76 (+1%)	N/a	N/a

Please note that a comparison between the three efficiency indicators presented is limited due to the fact that the samples considered per ship type do not match perfectly. This is for two reasons: first, some ships have been discarded for one indicator, but not for the other, as the reported efficiency is considered as not realistic. The number of ships in question is however low. Second, and more importantly, all general cargo ships and other ship types have reported the CO_2 emissions per distance, but only a subset of them have reported the annual average CO_2 emissions per transport work (mass distance). The other ships of these types have reported the CO_2 emissions per transport work (dwt carried) instead.

5. Assessing the implementation of the EU Maritime MRV Regulation

Main findings

- The main advantage of the EU Maritime MRV Regulation is the insights gained in the environmental performance of the largest vessels entering or leaving EEA ports. This enables shipping companies, but also other stakeholders, like Member State authorities, to identify trends in the overall performance of individual vessels and/or the entire fleet. It also enables them to use this information to develop further policies options.
- Many start-up issues that stakeholders encountered at the beginning of the implementation of the EU Maritime MRV Regulation seem to be resolved - stakeholders seem to have familiarised themselves with the system, resulting in smoother internal procedures and better quality of the submitted data.

5.1. Key indicators on the MRV process in 2020

5.1.1. Punctuality

According to the EU Maritime MRV Regulation, by 30 April in the year after the reporting period, shipping companies have to submit the verified emissions report to the Commission and the flag State. The share of all emissions reports that have been submitted to the European Commission (including resubmitted reports that required a revision) until May has been relatively stable for the reporting year 2018 and 2019: with 55%, it has been relatively low. With a share of 66%, the reporting period 2020 shows some improvement.

A timely submission of the verified emissions report to the Commission highly depends on a timely submission of the emissions report by the company to the verifier. The share of the emissions reports that have been submitted to the verifier (including those that had to be revised and thus had to be submitted twice) by 30 April is clearly higher for the reporting period 2020 compared to the reporting period 2019 (77% versus 71%), but there is certainly still room for improvement.

5.1.2. Non-compliant emission reports and revisions

The number of initially non-compliant emission reports, as a transitory status at the moment of transmission, is continuously decreasing over time, down from 149 in 2018 to 10 in 2019, with only 4 cases in the reporting year 2020.

The share of the emissions reports that have been verified as satisfactory without any additional revision has increased from 38% for the 2018 reporting period to almost 70% for the 2020 reporting period.

5.2. Quality and completeness of EU MRV data

5.2.1. Outlier

There are some cases of misstatements in verified emissions reports. Some of the verified emissions reports indeed include outliers, i.e. relatively easily identifiable, obvious mistakes. The number of emissions reports with outliers has decreased over the years, with around 190 reports related to the 2018 reporting period to around 85 reports related to the 2020 reporting period. The impact of these misstatements on the total fleet CO_2 emissions is relatively low (below 1% for the 2020 reporting period), but further actions together with verifiers, National Accreditation Bodies and shipping companies are necessary to continue reducing the number of outliers.

5.2.2. Verifiers

For the majority of the verifiers (13 out of 17), the number of emissions reports that contain outliers is lower for the 2020 reporting period in comparison to the 2019 reporting period.

In terms of absolute numbers, the number of emissions reports that contain outliers is not evenly distributed over the different verifiers. Regarding the 2020 reporting period, three verifiers stand out with between around 10 and 30 emissions reports that include outliers.

In line with this, the total number of misstatements in emissions reports of the 2020 reporting period is also significantly higher for these three verifiers.

With the aim of continuous improvement in the implementation of the EU maritime MRV Regulation, the Commission holds periodic meetings over the year with the relevant stakeholders, namely verifiers and National Accreditation Bodies, in which these issues are addressed.

6. EU funding programmes supporting maritime transport decarbonisation

Main findings

- The European Commission has a set of funding programmes which support, in combination with legislation, the decarbonisation of the maritime transport sector.
- Renewable and low carbon fuels are required for the decarbonisation of the sector. The EU funding programs focus therefore mainly on the application of alternative fuels and required energy technologies. Examples of alternative fuels in the maritime sector are biofuels, methyl alcohol (i.e. methanol), hydrogen and ammonia. Examples of energy technologies are fuel cells and batteries and, for innovative propulsion, wind assisted propulsion systems.
- Horizon Europe, the Innovation Fund, the Modernisation Fund, Connection Europe Facility and InvestEU are EU funds which support the decarbonisation of the maritime sector, whereby each fund focuses on a different technology and commercial readiness level.

For the decarbonisation of the maritime shipping sector, renewable and low carbon fuels are required. Currently, renewable low carbon fuels are either not available yet, or not available at a commercial scale and thus are hardly used in the sector. In addition, renewable bunker fuels (liquid or gaseous e-fuels or biofuels) are more expensive than conventional fossil bunker fuels, and there is no regulation in place yet that could support diminishing this cost differential. This is hampering the development and availability of these fuels and onboard systems. At this stage, different types of renewable fuels (e.g. methanol, hydrogen or ammonia) are considered and there seems to be no silver bullet. For the decarbonisation of maritime shipping, different energy sources will likely be used in the future.

To facilitate the use of alternative fuels and energy technologies on board ships, several stakeholders have to be involved: the alternative fuels have to be produced, the fuel supply infrastructure must be available, ships must have the appropriate technologies installed on board to convert the fuel/energy carrier into power, and regulations are also required to actually facilitate the use of the fuel in the maritime sector. All stakeholders involved somehow have to innovate in parallel to actually achieve a sustainable decarbonised maritime sector.

Together with the legislation supporting the decarbonisation of maritime transport, the Commission has a set of funding programmes supporting this objective. Through financing projects in energy efficient and zero emission vessels, alternative fuel-related port infrastructure or efficient waterborne operations, the European Union is supporting decarbonisation in view of achieving the commitments contained in the Climate Law.

These programmes mainly focus on the application of alternative fuels and energy technologies in the maritime sector. Examples of alternative fuels are biofuels, methyl alcohol (i.e. methanol), hydrogen and ammonia. Examples of new propulsion and energy technologies are fuel cells, wind assistance and batteries. These programmes cover a large span from the support to research and innovation, to enabling the deployment of emerging technologies, thus directly supporting the implementation of our legislation. An overview of the EU funding programs and the relationship with the technology and commercial readiness levels of the projects subsidised by them is shown in Figure 18: EU funding programs in support of maritime decarbonisation

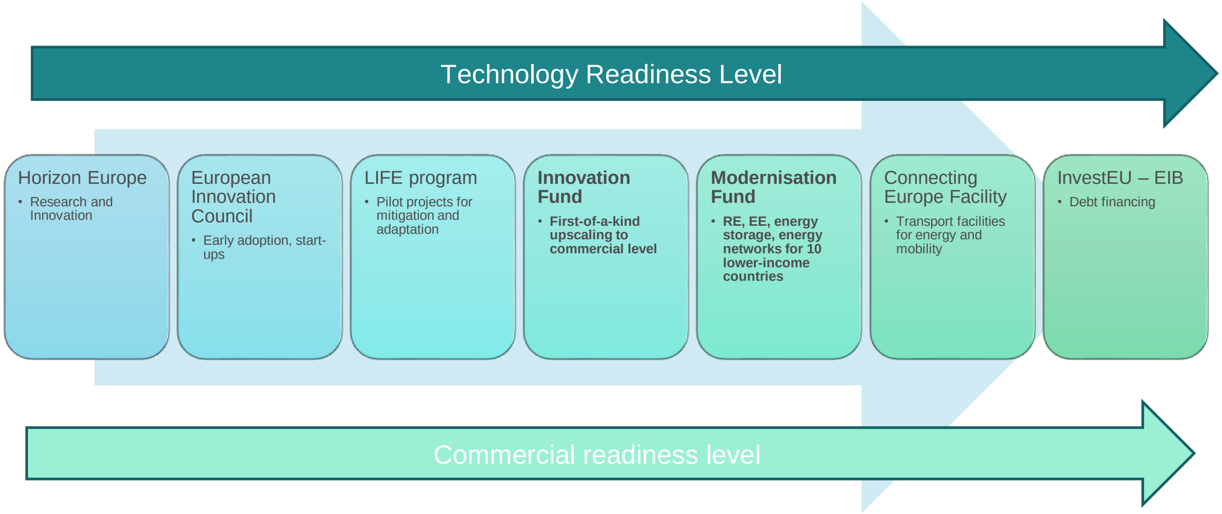

Figure 18: EU funding programs in support of maritime decarbonisation

Through the Horizon 2020 programme (H2020), now replaced by Horizon Europe, the Commission had financed waterborne transport projects, including those directly aiming to maritime transport decarbonisation with a total contribution of more than EUR 465 million. **HyMethShip** and **Hercules 2** are examples of projects supported by H2020, of which more information is given in below text boxes.

The **HyMethShip** system innovatively combines a membrane reactor, a CO_2 capture system, a storage system for CO_2 and methanol as well as a hydrogen-fueled combustion engine into one system. The proposed solution reforms methanol to hydrogen, which is then burned in a conventional reciprocating engine that has been upgraded to burn multiple fuel types and specially optimized for hydrogen use. This system had been developed and demonstrated on shore with a typical engine for marine applications in the range of 2 MW, achieving a reduction in CO_2 of more than 97% and will practically eliminate SOx and PM emissions, with NOx emissions down by more than 80%.

The HyMethShip consortium includes a globally operating shipping company, a major shipyard, a ship classification society, research institutes and universities, and equipment manufacturers. The total cost for this project is EUR 9.3 million, of which EUR 8.4 million is funded by the H2020 program. The project started in July 2018 and was completed in December 2021 (European Commission, 2022b).

HERCULES-2 is the follow up of the HERCULES project which has developed new technologies for marine engines. The follow up is achieved by building several full-scale prototypes and shipyard demonstrators of a marine engine that are expected to quickly mature into commercially available projects. The focus of this project is on improving fuel flexibility, developing adaptive control methodologies to retain the performance over the propulsion plant lifetime and achieving near-zero emissions. The consortium of this project consist of 32 partners from the industry (30%) and research (70%) and is coordinated by the National Technical University of Athens (NTUA) in Greece.

The total cost for this project is EUR 25.1 million, of which EUR 16.8 million is funded by the H2020 program of the EU. The project started in May 2015 and is completed in October 2018 (European Commission, 2022c).

Within **Horizon Europe**, successor of H2020, 600 million Euro have been earmarked for waterborne transport research and development focusses on enabling decarbonised shipping for the period 2021 to 2027. A new "Zero Emission Waterborne Transport" (ZEWT) co-programmed research and innovation partnership has become the leading initiative, focussed on the goal to achieve clean decarbonised shipping. This partnership will leverage the EU's investment with over 100 private members and an estimated €3.1 Bn of additional industrially supported activities.

Using revenues obtained through the auctioning of the Emission Trading System, the ETS-funded **Innovation Fund** focuses on highly innovative technologies and big flagship projects that can bring on significant emission reductions. The Innovation Fund is already supporting commercial deployment of breakthrough technologies in waterborne transport, such as the use of wind propulsion technology in large sailing cruise ships (**WAVE**) or the production of bio-LNG that substitutes carbon intensive marine fuel (**FirstBio2Shipping**). More information about these projects is given in below textboxes.

WAVE has been submitted and selected within the first call for large-scale projects for Project Development Assistance support by the EU Innovation Fund. The focus of this project is on a large cruise ships featuring an innovating wind propulsion technology. The project will be executed in France (European Commission, 2021b).

FirstBio2Shipping will develop the first industrial plant which convert biogas into renewable, low-carbon bio-liquefied natural gas (also called bio-LNG) in a scalable and standardised way with minimum energy usage. The will be built in the Netherlands and the bio-LNG will be delivered to the maritime sector.

The total cost for this project is EUR 7.2 million, of which EUR 4.3 million is funded by the EU Innovation Fund. The project is started in December 2021 and is planned to enter into operation in Q4 2023 (European Commission, 2021a).

The **Connecting Europe Facility (CEF)** for Transport is a funding instrument to realise the European transport infrastructure policy (TEN-T), supporting the deployment of innovation in the transport system in order to improve the use of infrastructure, reduce the environmental impact, enhance energy efficiency and increase safety. CEF supports projects like **Bio2Bunker**, of which more information is given in below textbox.

Bio2Bunker aims to develop and expand a bio-LNG supply chain by introducing three bio-LNG bunker barges: two 'Flexfueler' bunker barges in the ports of Zeebrugge (Belgium) and Lübeck (Germany) and the 'Hyperion' bunker barge in Rotterdam (The Netherlands). In this way the project will contribute to a reduction of the environmental impact of the maritime transport and ports operations through the decrease of emissions of emissions of pollutants and greenhouse gases from the vessels.

The total eligible cost for this project is EUR 55 million, of which maximum EUR 11 million is funded by CEF Transport. The project is started in October 2020 and is planned to complete in May 2024 (European Commission, ongoing).

The **InvestEU Fund** is a market-based and demand-driven instrument from the EU and has a strong emphasis on the EU policy priorities. The Fund supports the following four policy windows, whereby the focus lies on investments where the EU can add the most value: sustainable infrastructure; research, innovation and digitalisation; small- and medium-sized companies & social investment and skills (European Union, 2022).

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Annex 1 Abbreviations and definitions

Table 3 Abbreviations and definitions

Abbreviation	Meaning
AER	Annual Efficiency Ratio
AFIR	Regulation on Alternative Fuels Infrastructure
BDN	Bunker Delivery Note
CII	Carbon Intensity Indicator
DoC	Document of Compliance
dwt	Deadweight tonnage
EC	European Commission
EEA	European Economic Area (EU-27 + Norway, Iceland, Liechtenstein)
EEDI	Energy Efficiency Design Indicator
EEOI	Energy Efficiency Operational Indicator
EEXI	Energy Efficiency Existing Ship Index
EIV	Estimated Index Value
EMSA	European Maritime Safety Agency
ETD	Energy Taxation Directive
ER	Emissions report
EU	European Union
GHG	Greenhouse gas emissions
GT	Gross tonnage
HFO	Heavy Fuel Oil
IMO	International Maritime Organization
LNG	Liquefied Natural Gas

LPG	Liquefied Petroleum Gas
LRIT	Long Range Identification and Tracking
MARINFO	EMSA's internal database fed by information bought from commercial providers
MARPOL	International Convention for the Prevention of Pollution from Ships
MEPC	Marine Environmental Protection Committee
m/m	Mass per mass
MP	Monitoring plan
MRV	Monitoring, Reporting, Verification
MS	Member State
NAB	National Accreditation Body
n miles	Nautical miles
Pax	passenger
RED	Renewable Energy Directive
Ro-ro ship	Roll-on/roll -off ship
Ro-pax ship	Roll-on/roll-off passenger ship (vessel built for freight vehicle transport along with passenger accommodation)
TEN-T	Trans-European Transport Network
THETIS-MRV	EMSA web-based application established for the implementation of the EU Maritime MRV Regulation (e.g. to be used by companies to generate emissions reports).
VLSFO	Very Low Sulphur Fuel Oil

Annex 2 The EU MRV system: Steps of the process

Figure 19 illustrates the different steps of the EU MRV system.

Figure 19: Steps of the EU MRV process

Step 1: Producing a Monitoring Plan

The first step of the MRV process consists of the drafting of the so-called **monitoring plan**.

Ship owners are required to fill out a monitoring plan before engaging in monitoring and reporting. In this document, ship owners explain how they intend to monitor the relevant parameters required by the EU Maritime MRV Regulation. This monitoring plan must provide complete and transparent documentation of the monitoring method that will be applied for each ship. It must follow the pre-defined template provided in the implementing legislation.

Companies can choose between four methods for monitoring CO_2 emissions:

1. Bunker Fuel Delivery Note (BDN) and periodic stocktakes of fuel tanks;
2. bunker fuel tank monitoring on board;
3. flow meters for applicable combustion processes;
4. direct CO2 emissions measurements.

For each method, companies have to indicate the corresponding level of uncertainty.

All monitoring plans need to be assessed by an accredited verifier. If the verifier identifies any non-conformities, the company must revise its monitoring plan and submit the revised plan for a final assessment. Monitoring plans can be created and assessed in THETIS-MRV on a voluntary basis.

Step 2: Monitoring and reporting

Once the monitoring plan has been assessed by an accredited verifier, ship owners can proceed to the second step of the MRV process, which consists of the monitoring and reporting of the relevant parameters. The data produced by this ongoing monitoring activity is reported on an annual basis. The monitoring requirements in the Regulation are based on information already available on-board ships. This maximises the effectiveness of the Regulation, and minimises the administrative burden placed on companies.

Monitoring and reporting of CO_2 emissions and other mandatory information has to occur while the ship is at sea as well as at berth.

In addition, companies can report voluntary information to ease the interpretation of their CO_2 emissions and energy efficiency indicators. For instance, companies can voluntarily distinguish ballast voyages (without cargo) from laden voyages (with cargo), and, for relevant ship types, single out fuel consumption and CO_2 emissions related to cargo heating, and dynamic positioning.

Shipping companies are ultimately responsible for the accuracy and completeness of the monitored and reported data. Accordingly, they must record, compile, analyse and document monitoring data, including assumptions, references, emission factors and activity data. This must be done in a transparent manner that allows for reproduction of the determination of CO_2 emissions by the verifier.

Step 3: Monitoring and reporting

In the third step of the MRV process, companies must prepare an **emission report** in THETIS-MRV based on their monitoring activities.

Step 4: Verification of Emission Report

In the fourth step of the MRV process, independent accredited verifiers have to corroborate the emission reports submitted by companies. The design of this verification mechanism is in part modelled on other emission monitoring systems.

Verifiers should assess the reliability, credibility, and accuracy of the reported data and information in line with the procedures defined in the legislation. If an emission report is without omissions and errors – and if it fulfils the requirements under the legislation – verifiers issue a **verification report** classifying the emission report as satisfactory.

Starting in 2019, companies must have their emission report verified as satisfactory in THETIS-MRV by 30 April of each year, and submit it to the Commission and to their flag State.

Step 5: Issuing a Document of Compliance

When an emission report has been satisfactorily verified, the verifier drafts the verification report, issues a **document of compliance**, and informs the Commission and the flag State.

This document confirms a ship's compliance with the requirements of the Regulation for a specific reporting period. It has to be carried on board no later than 30 June. The document of compliance is generated using THETIS-MRV, and is valid for a period of 18 months.

Step 6: Publication of information and Annual Report

According to the legislation, the Commission has to make information on CO_2 emissions and other relevant information publicly available by 30 June each year. The information is available at individual ship level, aggregated on an annual basis.

This data is accessible on the public section of the THETIS-MRV website in the form of a searchable database or a downloadable data sheet. Making the information publicly available and easily accessible ensures a high level of transparency. Such transparency is key to addressing market barriers related to the lack of information, and stimulates the uptake of energy efficient behaviours and technologies.

Under specific circumstances, companies can make a request to the Commission to disclose less details of information unrelated to CO_2 emissions. Such requests can only be justified in exceptional cases, where disclosure would undermine the protection of commercial interests, thereby overriding the public interest in granular information.

The Regulation also requires the Commission to publish an annual report in order to inform the public and allow for an assessment of CO_2 emissions and the energy efficiency of maritime transport.

Continuous enforcement activities throughout the EU MRV process

Member States implement and enforce the EU MRV process by inspecting ships that enter ports under their jurisdiction and by taking all the necessary measures to ensure that ships flying their flag are compliant with the regulation.

Non-compliance should result in the application of penalties fixed by Member States. Those penalties should be effective, proportionate, and dissuasive. Expulsion is a last resort measure when a ship is non-compliant for two or more consecutive reporting periods

Annex 3 Outcomes of the third compliance cycle

A.3.1 Fuel/emissions monitoring methods

As explained in Annex 2, the companies can choose between four different fuel/emission monitoring methods: Bunker Fuel Delivery Note (BDN) and period stock takes of fuel tanks (Method A), bunker fuel tank monitoring on-board (Method B), flow meters for applicable combustion processes (Method C) and direct CO_2 emissions measuring (Method D).

In the 2020 reporting period, Method D has, just like in the previous reporting periods, been hardly applied: only one ship has applied Method D. This ship applied this method to monitor the main engine's CO_2 emissions.

Regarding the other three methods, it can be observed that, for the monitoring of the main and auxiliary engines' and of the boilers' fuel consumption, Method A is applied most, followed by Method C and then Method B. For the monitoring of the fuel consumption of inert gas generators, however, Method B is applied most, followed by Method A and then Method C. This is in line with the 2019 reporting period.

A.3.2 Shipping companies

1 566 companies have submitted emission reports for the reporting period 2020; around 5% less companies than for the reporting period 2019 and around 1% less companies than for the reporting period 2018.

As the following figure illustrates, in the reporting period 2020, around 57% of these companies are registered in an EU country, around 41% in a non-EEA country and around 2% in an EEA-non-EU country. And these shares are comparable to the shares in the previous two years.

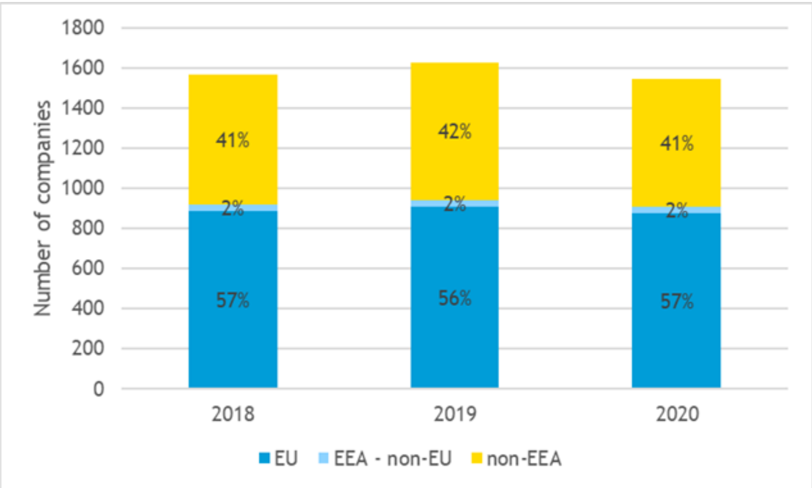

Figure 20: Number of companies and distribution over region of registration; 2018 to 2020

A.3.3 Verifiers and National Accreditation Bodies

In the reporting period 2020, 19 different accredited verifiers have been called in for verification activities required for the shipping companies' compliance with the EU Maritime MRV Regulation. The five largest of the verifiers have covered around 70% of the ships for which an emission report has been submitted in 2020. Four of the 19 verifiers are not located in an EEA country.

Ten different national accreditation bodies (NABs) have accredited the 19 verifiers active in the 2020 reporting period. Only three of these NABs have accredited more than one verifier.

Annex 4 Main extra-EU flows

Table 4 provide the main extra EU-27 flows by gross weight handled in main ports in the years 2018, 2019 and 2020 in million tonnes. Except Brazil, all inward and outward flows increased in 2019 compared to 2018. Due to COVID-19 all inward and outward flows decreased in 2020 compared to 2019, with the exception of the outward flow to China which actually increased.

Table 4 Main extra EU-27 flows by gross weight handled in main ports

Inward and outward flows from/to EU-27 ports (million tonnes)

	2018	2019	2020
Inward flows to EU-27 ports from non-EU ports			
Canada (East Coast)	34.5	34.8	32.6
U.S.A. (East Coast)	91.1	106.5	100.0
Turkey	73.2	82.1	81.3
Brazil	86.5	76.2	68.1
Nigeria	35.0	46.2	39.2
China	61.6	65.9	62.4
Egypt	50.0	54.2	47.4
Russia (Black Sea)	78.6	81.0	82.9
Russia (Baltic Sea)	129.0	131.5	120.7
Outward flows from EU-27 ports to non-EU ports			
U.S.A. (East Coast)	52.6	53.3	47.3
China	42.0	51.2	61.4

Source: Eurostat, 2018, 2019, 2020, 2022

Annex 5 Technical and operational efficiency of the monitored fleet

A.5.1 Technical efficiency (related to Section 4.1.1.)

Table 5 gives an overview of the EEDI requirements (=percentage reduction factor to be applied to reference value) that hold for the different ship types as specified in the first column, differentiated by ship size and Phase. To give an example: In 2013 and 2014 (i.e. in Phase 0) new bulk carriers of 20 000 dwt and above had to attain an EEDI value that was equal to the reference value (i.e. a reduction factor of zero applied), while in 2015 to 2019 (i.e. in Phase 1) new bulk carriers of 20 000 dwt and above had to attain an EEDI value that was 10% below the reference value (i.e. a reduction factor of ten applied).

Table 5 EEDI requirements depending on ship type and size and phase as published in Resolution MEPC.324(75)

"

Ship Type	Size	Phase 0 1 Jan 2013 – 31 Dec 2014	Phase 1 1 Jan 2015 – 31 Dec 2019	Phase 2 1 Jan 2020 – 31 Mar 2022	Phase 2 1 Jan 2020 – 31 Dec 2024	Phase 3 1 Apr 2022 and onwards	Phase 3 1 Jan 2025 and onwards
Bulk carrier	20,000 DWT and above	0	10		20		30
	10,000 and above but less than 20,000 DWT	n/a	0-10*		0-20*		0-30*
Gas carrier	15,000 DWT and above	0	10	20		30	
	10,000 and above but less than 15,000 DWT	0	10		20		30
	2,000 and above but less than 10,000 DWT	n/a	0-10*		0-20*		0-30*
Tanker	20,000 DWT and above	0	10		20		30
	4,000 and above but less than 20,000 DWT	n/a	0-10*		0-20*		0-30*
Containership	200,000 DWT and above	0	10	20		50	
	120,000 and above but less than 200,000 DWT	0	10	20		45	
	80,000 and above but less than 120,000 DWT	0	10	20		40	
	40,000 and above but less than 80,000 DWT	0	10	20		35	
	15,000 and above but less than 40,000 DWT	0	10	20		30	

Ship Type	Size	Phase 0 1 Jan 2013 – 31 Dec 2014	Phase 1 1 Jan 2015 – 31 Dec 2019	Phase 2 1 Jan 2020 – 31 Mar 2022	Phase 2 1 Jan 2020 – 31 Dec 2024	Phase 3 1 Apr 2022 and onwards	Phase 3 1 Jan 2025 and onwards
	10,000 and above but less than 15,000 DWT	n/a	0-10*	0-20*		15-30*	
General Cargo ships	15,000 DWT and above	0	10	15		30	
	3,000 and above but less than 15,000 DWT	n/a	0-10*	0-15*		0-30*	
Refrigerated cargo carrier	5,000 DWT and above	0	10		15		30
	3,000 and above but less than 5,000 DWT	n/a	0-10*		0-15*		0-30*
Combination carrier	20,000 DWT and above	0	10		20		30
	4,000 and above but less than 20,000 DWT	n/a	0-10*		0-20*		0-30*
LNG carrier***	10,000 DWT and above	n/a	10**	20		30	
Ro-ro cargo ship (vehicle carrier)***	10,000 DWT and above	n/a	5**		15		30
Ro-ro cargo ship***	2,000 DWT and above	n/a	5**		20		30
	1,000 and above but less than 2,000 DWT	n/a	0-5*,**		0-20*		0-30*
Ro-ro passenger ship***	1,000 DWT and above	n/a	5**		20		30
	250 and above but less than 1,000 DWT	n/a	0-5*,**		0-20*		0-30*
Cruise passenger ship*** having non-conventional propulsion	85,000 GT and above	n/a	5**	20		30	
	25,000 and above but less than 85,000 GT	n/a	0-5*,**	0-20*		0-30*	

* Reduction factor to be linearly interpolated between the two values dependent upon ship size. The lower value of the reduction factor is to be applied to the smaller ship size.

** Phase 1 commences for those ships on 1 September 2015.

*** Reduction factor applies to those ships delivered on or after 1 September 2019, as defined in paragraph 43 of regulation 2.

Note: n/a means that no required EEDI applies."

Table 6 gives an overview of the number of ships that, per ship type, have reported, the EEDI, the EIV or 'not applicable' as technical efficiency indicator.

Table 6 Number of ships which have reported their EEDI, EIV or 'not applicable' in 2020

Technical efficiency indicators reported per ship type

Ship type	# of ships which have reported their EEDI in 2020	# of ships which have reported their EIV in 2020	# of ships that have reported 'Not applicable'
Bulk carrier	1 042	2 281	24
Chemical tanker	477	849	5
Combination carrier	4	9	2
Container ship	536	1 281	14
Container/Ro-ro cargo ship	8	62	0
Gas carrier	133	202	1
General cargo ship	122	1 064	8
LNG carrier	54	210	2
Oil tanker	650	1 205	17
Other ship types	18	72	27
Passenger ship	22	68	21
Refrigerated cargo carrier	13	129	0
Ro-pax ship	10	341	17
Ro-ro ship	20	218	0
Vehicle carrier	69	383	0
Total	**3 177**	**8 374**	**138**

Evolution of the EEDI – graphical analysis

The figures below plot the EEDI values for bulk carriers, gas carriers, and general cargo ships in 2018, 2019 and 2020 against the size of the relevant ships measured in deadweight tonnage (see dots with a different colour per year).

Please be aware that the values and graphs presented this year do not allow for a direct comparison with the relevant graphs as presented in the previous Annual Reports – reporting years 2018 and 2019 – because a different methodology has been applied.[13]

Only graphs with robust R2-indicator (>0.6) have been included in this report.

The EEDI trendlines for 2018 to 2020 for bulk carriers and gas carriers overlap, which indicates that the technical efficiency of these subsegments of the fleet has not significantly changed. For general cargo ships the attained EEDI improved in 2020.

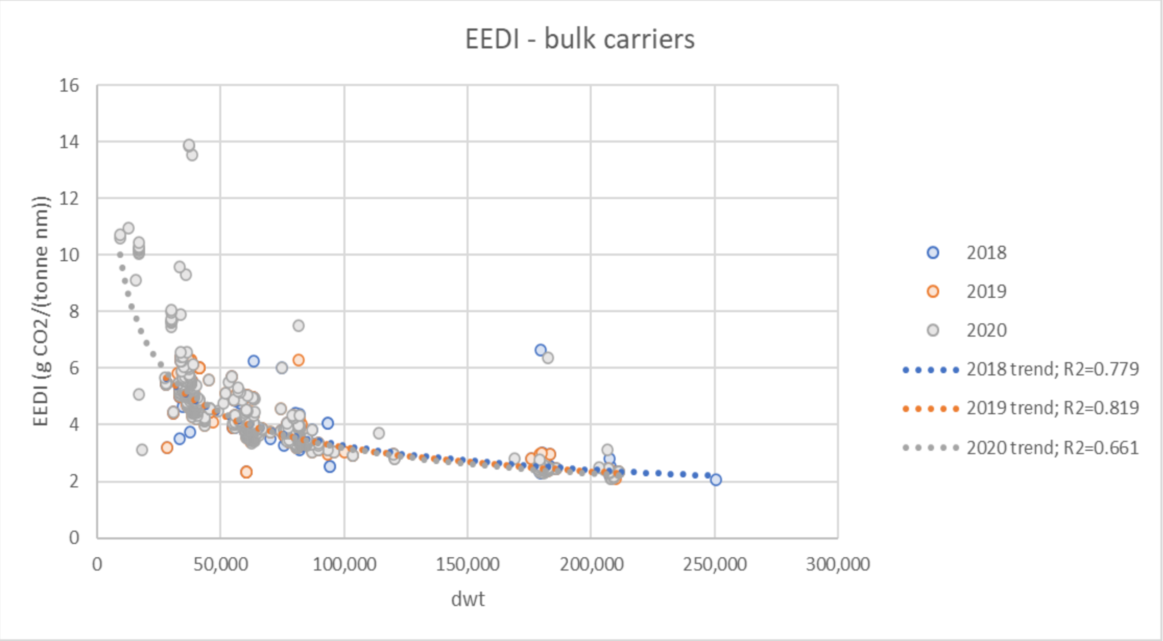

Figure 21: Plot of attained EEDI values of bulker ships in 2018, 2019 and 2020 and according trendlines

[13] The EEDI indicator in terms of g CO_2/(tonne*nautical mile) has been calculated for the individual ships, based on the data reported (total CO_2 emissions, distance sailed and deadweight tonnage). On a ship-type basis for each reporting year, obvious outliers have been discarded. For the remaining ships, a correction, in the form of a plus/minus two standard deviation has been applied.

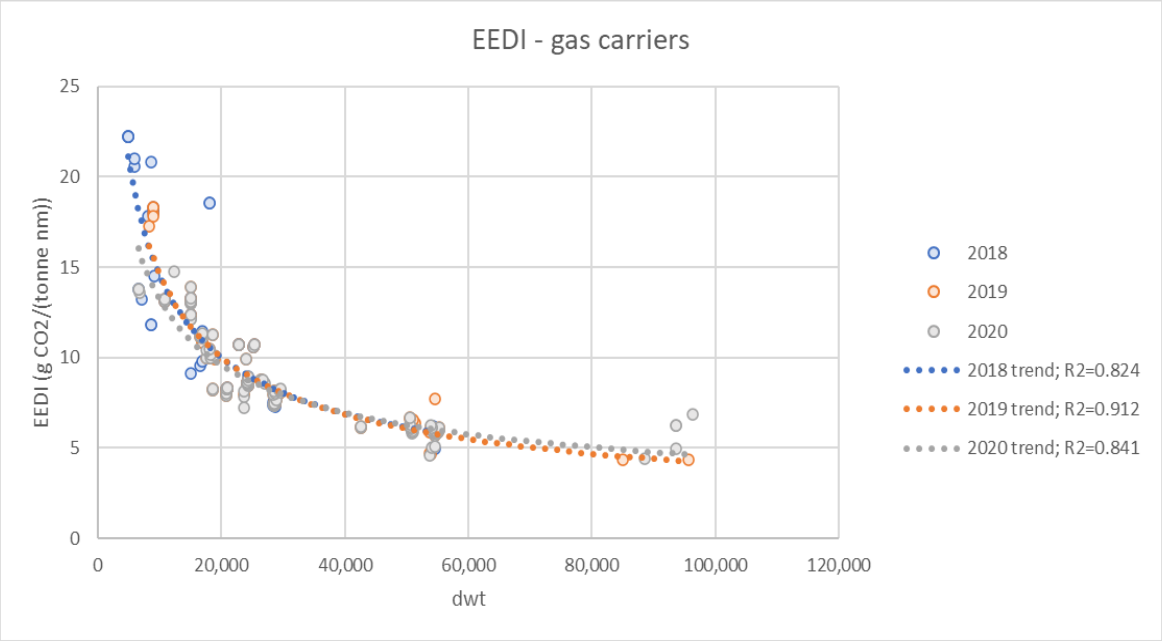

Figure 22 : Plot of attained EEDI values of gas carrier ships in 2018, 2019 and 2020 and according trendlines

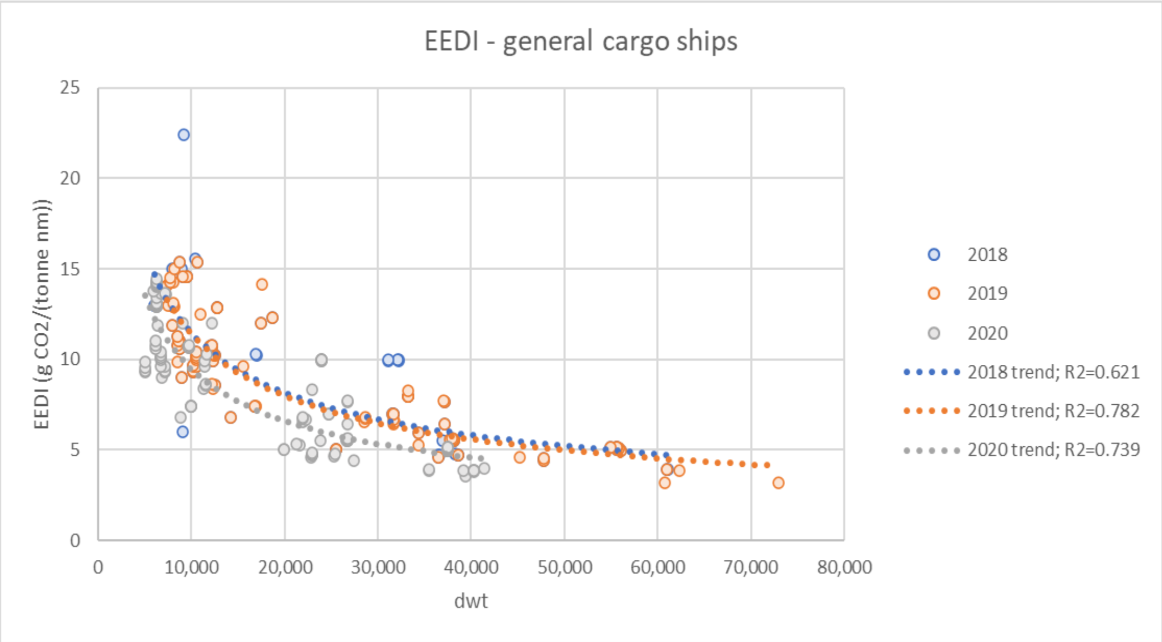

Figure 23 : Plot of attained EEDI values of general cargo ships in 2018, 2019 and 2020 and according trendlines

Table 7 gives an overview of the number of ships that, per ship type, has reported the attained EEDI in 2020, in 2019 and in both years.

Table 7 Number of ships that reported their attained EEDI

2019, 2020 and in both years differentiated by ship type

Ship type	# of ships which have reported their EEDI in 2019	# of ships which have reported their EEDI in 2020	# of ships which have reported their EEDI in both years
Bulk carrier	996	1 042	596
Chemical tanker	469	477	325
Combination carrier	1	4	1
Container ship	536	536	325
Container/Ro-ro cargo ship	8	8	8
Gas carrier	141	133	81
General cargo ship	138	122	77
LNG carrier	46	54	31
Oil tanker	619	650	450
Other ship types	17	18	13
Passenger ship	29	22	16
Refrigerated cargo carrier	29	13	11
Ro-pax ship	19	10	6
Ro-ro ship	25	20	14
Vehicle carrier	60	69	43
Total	**3 133**	**3 177**	**1 997 (63%)**

A.5.2 Operational efficiency (related to Section 4.2.)

Operational effiicency indicators

The majority of the ships (have to) apply a metric which uses the mass of the cargo transported, measuring their transport work in tonne nautical miles. In contrast, container/Ro-ro cargo ships and LNG carrier apply a metric which uses the volume of the cargo transported, measuring their transport work in cubic metre nautical miles. Passenger ships naturally determine their transport work in terms of passenger nautical miles. Ro-pax ships, which transport cargo and passengers, report two indicators, one in terms of passenger nautical miles and the other in terms of tonne nautical miles for the freight transported. Three categories of ship types (general cargo ships, vehicle carriers, other ship types) can, instead of mass of the cargo transported, alternatively determine their transport work by means of 'deadweight carried'[14].

Table 8 gives an overview of the different operational efficiency indicators and metrices thereof that have been reported in 2020. The table thereby only shows the CO_2 efficiency indicators. The corresponding energy efficiency indicators are not presented in the table, but the same according metrics hold (kg fuel/n miles instead of kg CO_2 / n mile etc.) and have been reported by the same ship types.

Table 8 Operational efficiency indicators

Indicators reported by ship type

Operational efficiency indicator	Metric of indicator	Indicator reported by…
Annual average CO_2 emissions per distance	[kg CO_2 / n mile]	All ship types
Annual average CO_2 emissions per transport work (mass distance)	[g CO_2 / (m tonnes · n miles)]	All ship types except • Container/Ro-ro cargo ship, • LNG carrier, • Passenger ships, • Ro-pax ships
Annual average CO_2 emissions per transport work (volume)	[g CO_2 / (m^3 · n miles)]	Container/Ro-ro cargo ship LNG carrier
Annual average CO_2 emissions per transport work (dwt carried)	[g CO_2 / (dwt carried · n miles)]	Mainly General cargo ships and Other ship types; very few ships of other types.
Annual average CO_2 emissions per transport work (pax)	[g CO_2 / (pax · n miles)]	Passenger ships Ro-pax ships
Annual average CO_2 emissions per transport work (freight)	[g CO_2 / (m tonnes · n miles)]	Ro-pax ships

[14] According to Implementing Regulation 2016/1928, deadweight carried (in metric tonnes) is the volume displacement multiplied with the water density, with the mass of fuel and lightweight subtracted.

Evolution of operational efficiency – a graphical analysis

Based on a graphical analysis of the EU MRV fleet's operational efficiency measured by means of the Annual Efficiency Ratio (AER) indicator (see graphs below), differentiated per ship type, we can conclude the following:

1. The fleet operational efficiency does not seem to have changed or to have only slightly changed in the period 2018 to 2020 for the following ship types (regression lines overlap/almost overlap):

    - Bulk carrier
    - Chemical tanker
    - Container ship
    - Container/Ro-ro cargo ship
    - Gas carriers
    - General cargo ship
    - Oil tanker
    - Ro-pax ships
    - Ro-ro ships
    - Vehicle carriers
    - Other ship types

2. For combination carriers, LNG carriers, and refrigerated cargo carriers, the sample is too small or the regression line not reliable enough to draw conclusions.

For passenger ships (cruise liners) no AER regression curve is presented since the COVID-19 pandemic resulted in higher and more fluctuant AER values for these types of vessels, limiting therefore the interest of applying a regression analysis.

Please be aware that the values and graphs presented this year do not allow for a direct comparison with the relevant graphs as presented in the previous Annual Reports – reporting years 2018 and 2019 – because a different methodology has been applied.[15]

Only graphs with robust R2-indicator (>0.6) have been included in this report.

[15] The AER indicator in terms of g CO_2/(tonne*nautical mile) has been calculated for the individual ships, based on the data reported (total CO_2 emissions, distance sailed and deadweight tonnage). On a ship-type basis for each reporting year, obvious outliers have been discarded. For the remaining ships, a correction, in the form of a plus/minus two standard deviation has been applied.

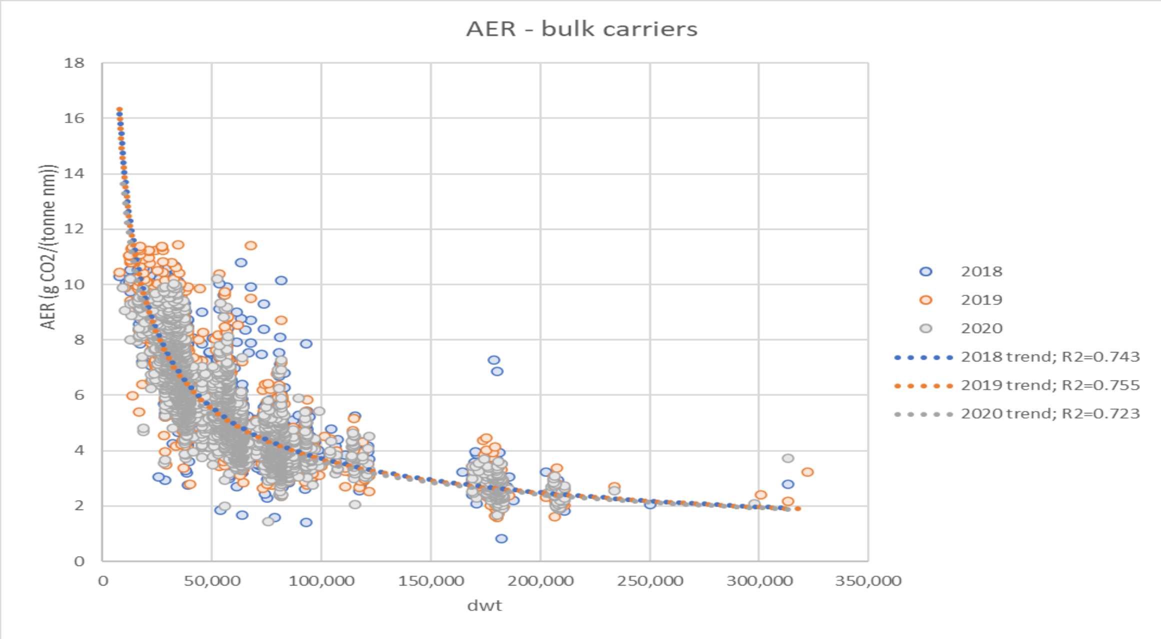

Figure 24 Plot of AER values calculated for individual bulk carriers and related annual regression lines ; 2018 to 2020

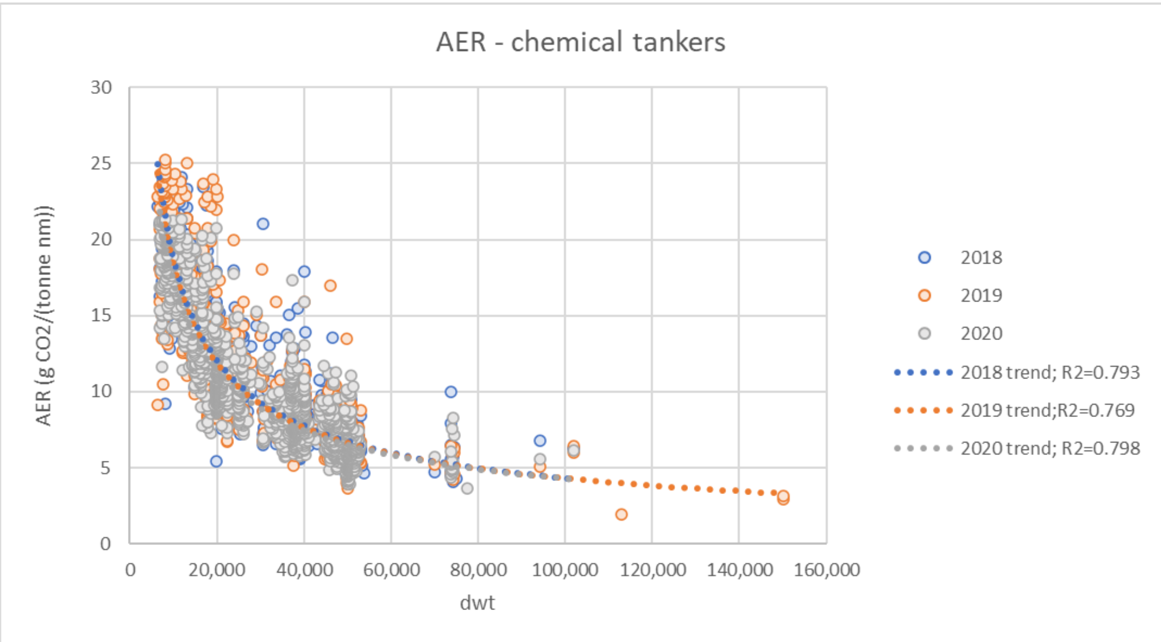

Figure 25 : Plot of AER values calculated for individual chemical tankers and related annual regression lines ; 2018 to 2020

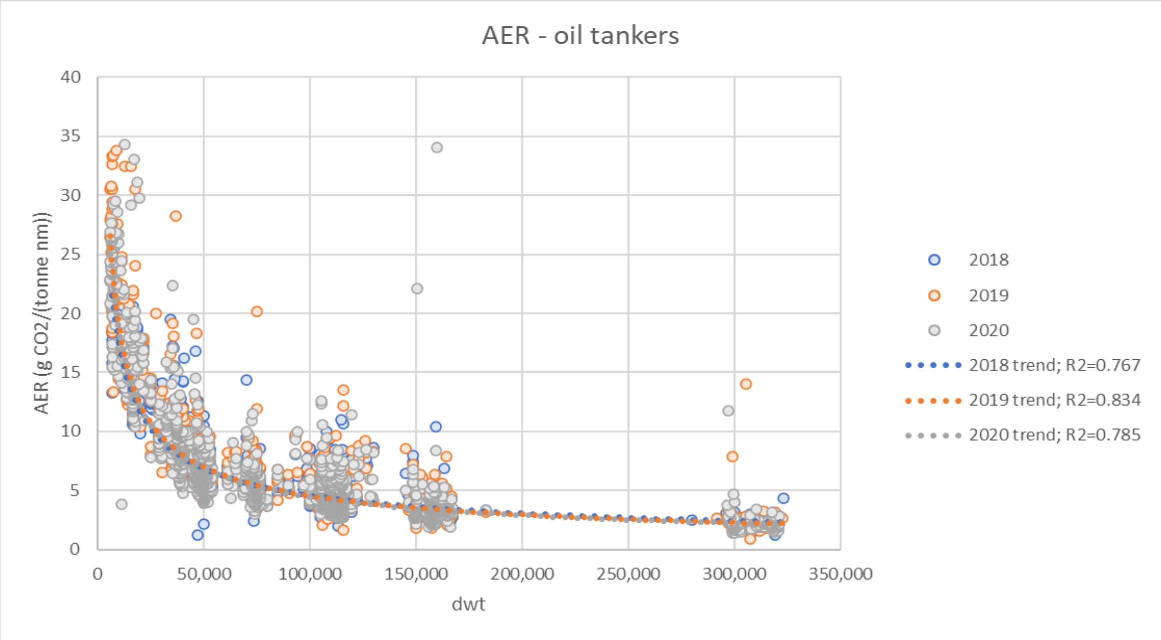

Figure 26 : Plot of AER values calculated for individual oil tankers ships and related annual regression lines; 2018 to 2020

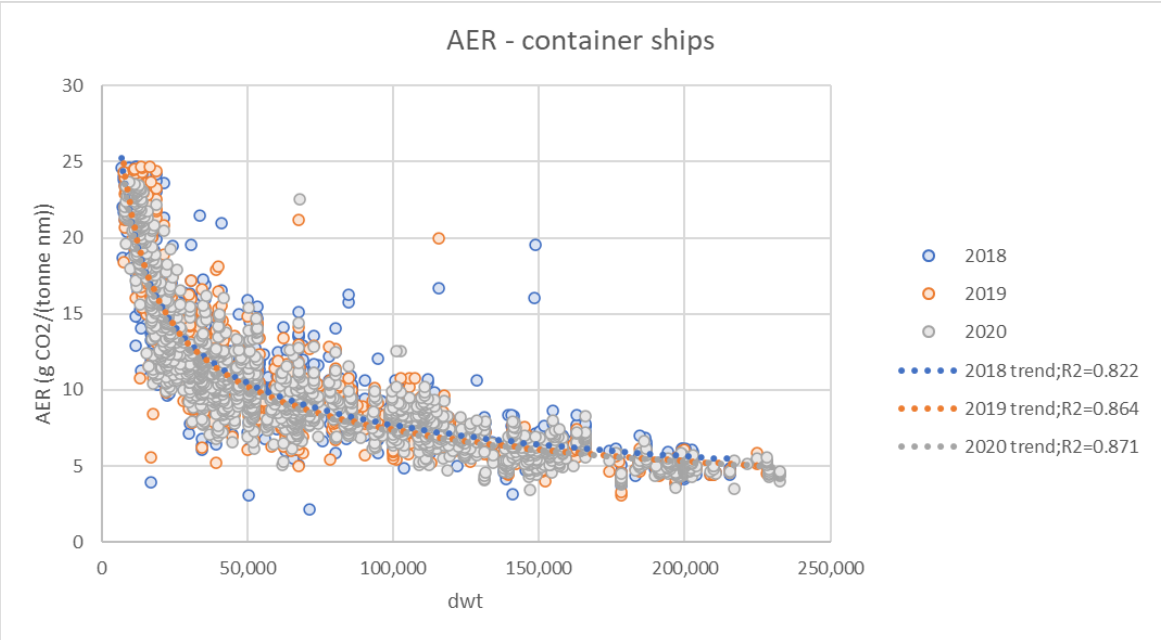

Figure 27 : Plot of AER values calculated for individual container ships and related annual regression lines; 2018 to 2020

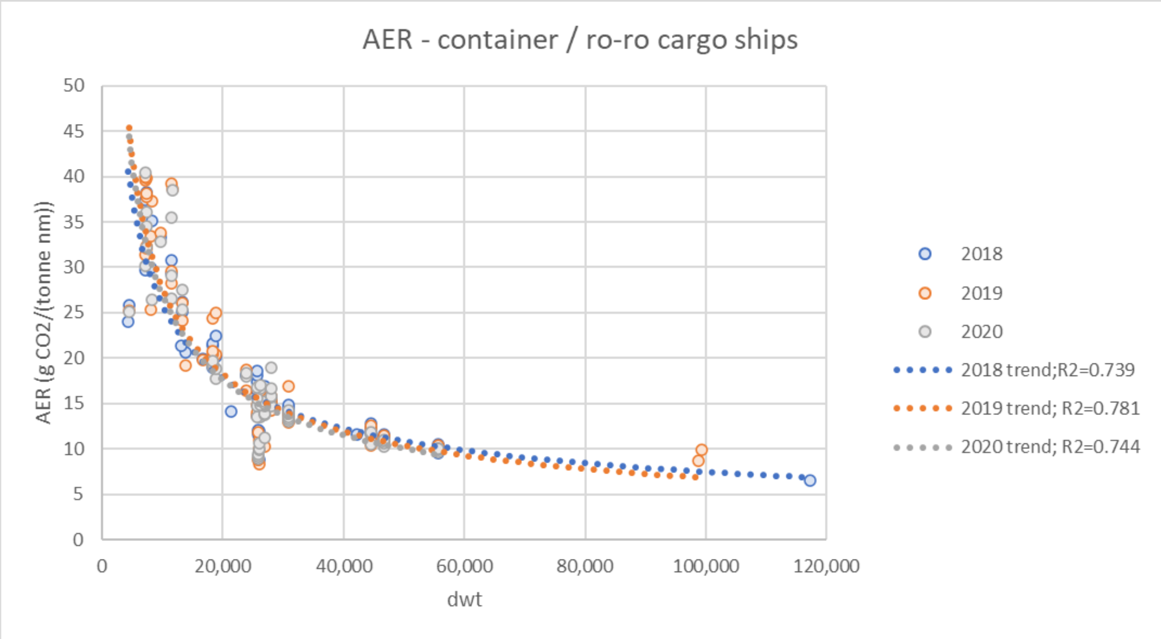

Figure 28: Plot of AER values calculated for individual container/ro-ro cargo ships and related annual regression lines; 2018 to 2020

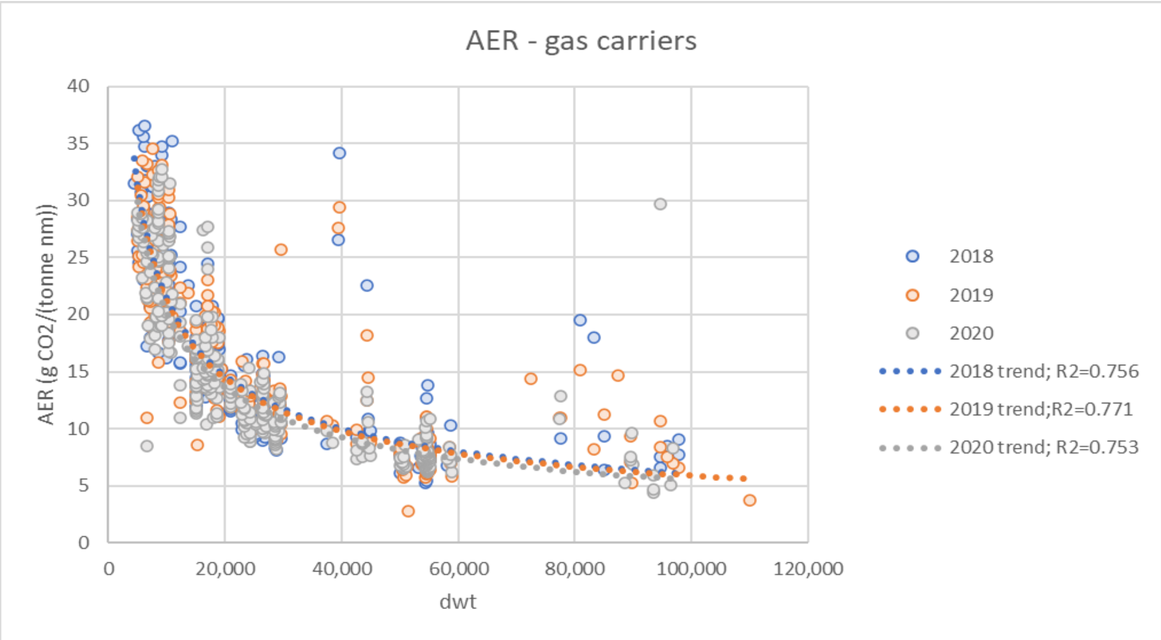

Figure 29 : Plot of AER values calculated for individual gas carrier ships and related annual regression lines; 2018 to 2020

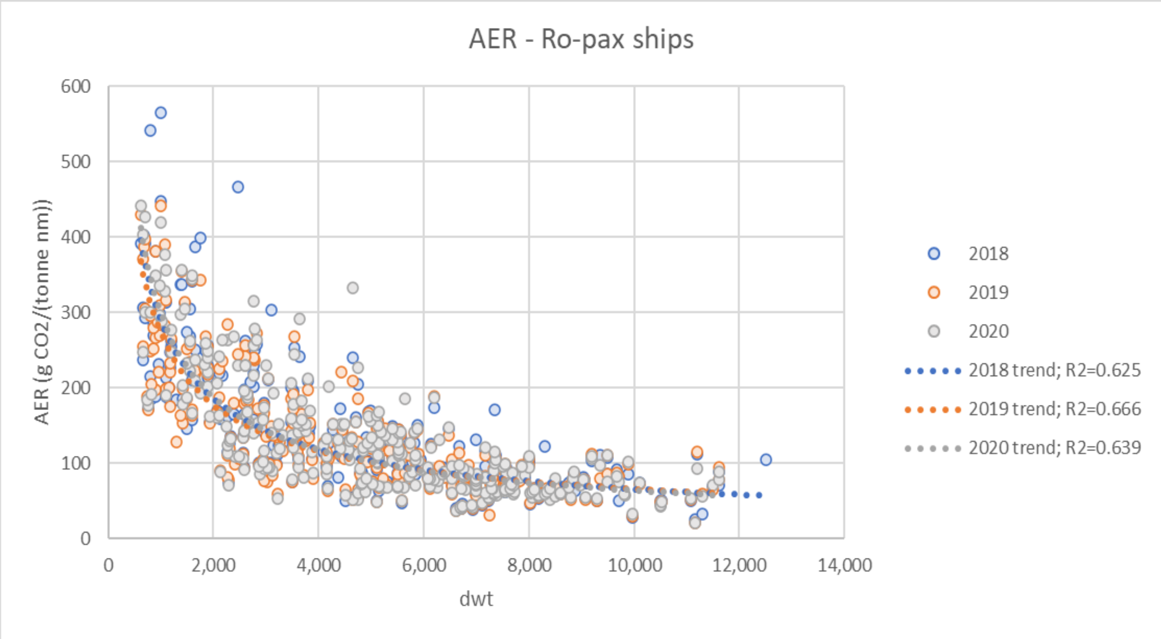

Figure 30: Plot of AER values calculated for individual ro-pax ships and related annual regression lines; 2018 to 2020