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2024 Report from the European Commission on CO_2 Emissions from Maritime Transport

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2024 Report from the European Commission on CO_2 Emissions from Maritime Transport

EUROPEAN COMMISSION

Directorate-General for Climate Action
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Table of contents

Executive Summary

Since 2018, the 'EU Maritime MRV Regulation'[1] , requires shipping companies to monitor and report their fuel consumption, greenhouse gas emissions [2] and other key parameters for their ships when sailing to/from and between ports of the European Economic Area (EEA).

Every year, the European Commission publishes the reported aggregated data and prepares an annual report to analyse changes over the years. This report is the sixth one. It analyses the data from the period 2018-2023, following the release of the data in 2024.

The monitored voyages for the 2023 reporting year emitted 126.7 million tonnes of CO_2 into the atmosphere. These emissions were 7.9% lower than those reported in 2022 and nearly the same (-0.1 million tonnes) as the ones reported for 2021, which was a year marked by the long-lasting effects of the COVID-19 crisis. When compared to the reporting years preceding the COVID-19 pandemic (i.e. 2018 and 2019), which included emissions related to the United Kingdom, the 2023 reported emissions are around 13% lower [3].

The emissions reported for 2023 originated from a fleet of almost 12 300 ships, the second highest number recorded so far (5.4% lower than in 2022 but 2.9% higher than in 2021).

In 2023, the vast majority of ship types (12 out of 15) reported lower emissions compared to 2022. reflecting the lower level of activity experienced by most of the subsectors of the maritime industry, in a year marked by the decrease in the volume of goods handled in EU ports (-3.9% compared to 2022), notably due to the restrictions on goods transport with Russia: The most significant absolute decrease in CO_2 emissions can be seen in bulk carriers (-23% compared to 2022). This is the result of different factors, including a considerable decrease in the number of bulk carriers calling at EEA ports in 2023 (-12%), less distance travelled per ship (-8%), or the effect of slower speed (-4%). Russia's war of aggression against Ukraine kept affecting energy imports. While CO_2 emissions from Liquified natural gas (LNG) carriers, recorded a decrease (-11%) on 2022, they remain at a level much higher than in previous years (+42% on 2021). Oil tankers CO_2 emissions experienced a slight decrease (-2%) compared to 2022. The CO_2 emissions from passengers ships increased by 6% on 2022, recording the highest level since 2018, thus confirming the full rebound of the sector after the COVID-19 years. Container ships recorded for the second consecutive year a decrease in emissions of 6%, which reflects the general decrease in the handling of containers in main EU ports (-3.8% in 2023 compared to 2022), the decrease in the average distance reported by containership (-3%) and a reduction in the average speed of active container ships (-5%).

Container ships, oil tankers, and bulk carriers were confirmed as the top emitters in 2023. They were responsible for around 52% of total reported emissions in 2023. Container ships alone were responsible for 28% of the total CO_2 emissions. Most ship types' relative contribution to total reported emissions remained stable overall in 2018-2023, but passengers ships, ro-pax ships, and LNG carriers confirmed the increase in the respective share of

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

[2] Following the entry into force of amendments to Regulation (EU) 2015/757 in June 2023, the Regulation is not limited to CO_2 emissions anymore but also covers greenhouse gas emissions. The monitoring and reporting requirements are extended to non-CO_2 gases only starting the reporting period 2024. The present report, which considers data reported over the period 2018-2022, therefore only covers CO_2 emissions as reported within the EU MRV scope.

[3] The level of granularity of the data reported under the EU MRV maritime Regulation does not allow recalibrating the MRV data so as to exclude the emissions resulting from the application of the EU Maritime MRV Regulation to the United Kingdom for the reporting years 2018, 2019 and 2020.

emissions visible since 2020, as a consequence of energy market dynamics and the rebound of passengers traffic after COVID-19.

The distribution of the fleet's total CO_2 emissions between the different types of voyages and at berth that was recorded in 2023 did not substantially change since 2021, after the withdrawal of the United Kingdom from the EU. Voyages starting or ending outside the EEA kept representing the bulk of the CO_2 emissions (around two thirds). This in line with the volume of inward and outward trade flows recorded by Eurostat data, even if these voyages' share slightly decreased in 2023, as a consequence of the decrease in the activity levels of the subsectors of the fleet which are most active on extra-EEA trade routes (bulk carriers and LNG carriers).

In terms of fuel consumption, the monitored ships consumed 41 million tonnes of fuel in 2023. Fuel consumption over the period 2018-2023 remains dominated by conventional fossil marine fuels (heavy fuel oil, light fuel oil, gas oil, diesel oil) which accounted for 91% of the total mass of fuels reported in 2023. The reported fuel data confirmed in 2023 trends visible in the reported fuel consumption since 2021, namely the decrease in the share of light fuel oil (accounting for 15.6% of total reported fuel in 2023) compensated by an increase in the use of heavy fuel oil (reaching 55.3% in 2023). 2023 saw the highest recorded level of LNG consumed by the fleet (around +11% higher than in 2022, accounting for more than 8% of total reported fuel in 2023), as LNG is being increasingly used by ships other than LNG carriers, with container ships, ro-pax, and passenger ships representing the lion share. The consumption of non-fossil bunker fuels remained negligible, as in all previous years.

According to Eurostat data[4], the total 2023 volume of inward trade flows decreased by 3.7%. Compared with 2022, the inflow from the United States (East Coast), Norway, Brazil, Egypt, Nigeria, Libya, and Algeria increased in 2023, while the inflows from the United Kingdom, Russia, Türkiye and China decreased. The total 2023 volume of outward trade flows decreased by 1.7%. Outflows to the four main partners (United Kingdom, United States, Türkiye and China) remained overall constant on the levels of 2022 and total outflows are still dominated, as in previous years, by the outward flow to the UK.

MRV data for 2018-2023 shows no indication of structural speed reduction for the MRV fleet during the period. 10 out of 15 ship types recorded higher average speed in 2023 compared to 2018, with some having considerably increased speed, as in the case of combination carriers (+32%), gas carriers (+20%), other ships (+19%), oil and chemical tankers (+14%), and passenger ships (+13%). Bulk carriers and container ships, the types which recorded the highest reduction in emissions in 2023, were amongst the few ones continuing decreasing speed compared to 2022, by 4% and 5% respectively.

The graphical analysis of key technical and operational efficiency indicators shows that no significant changes took place in 2018-2023. Container ships, Ro-Pax ships, and oil tankers show the highest increases in the average size of active ships over the period.

The completeness and correctness of the reported data, which improved over the period, is confirmed by increasing data correlation values between key technical and operational efficiency indicators[5] and the size of the ships reporting under the EU Maritime MRV Regulation.

[4] Inward and outward trade flows are considered for the 15 main extra EU-27 flows, in terms of gross weight handled in EU ports.

[5] The Energy Efficiency Design Index (EEDI) and the Estimated Index Value (EIV) are assessed for the technical efficiency of ships. The Energy Efficiency Operational Indicator (EEOI) and the Annual Efficiency Ratio (AER) are assessed for their operational efficiency.

In terms of implementation of the EU Maritime MRV Regulation, the results confirm the continuing improvement in the quality and completeness of submitted data. However, more data were submitted with a delay in 2023 compared to 2022, which could be explained by the workload on shipping companies and verifiers linked to the ETS extension to maritime transport and the application of the new monitoring and reporting rules.

1. Introduction

This report has been prepared using data from the implementation of the EU Regulation on the monitoring, reporting and verification of greenhouse gas emissions from maritime transport (Regulation (EU) 2015/757), hereafter called the “EU Maritime MRV Regulation”. All information was extracted on 19 September 2024[6]. Data provided or updated after this date is not reflected in this report.

1.1. The 2024 Annual Report: scope and objectives

This is the sixth report on CO_2 emissions from ships entering and leaving ports in the European Economic Area (EEA), collected under the EU Maritime MRV Regulation.

This regulation requires shipping companies to monitor and report on key indicators such as 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 analyses main trends in the form of an annual report[7].

The currently available set of MRV data is contributing to an enhanced understanding of the CO_2 emissions originating from the maritime transport sector. The published raw data[8] 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. This data is important to support policy discussions and to support the implementation and track the effectiveness of climate policies. In addition, it constitutes an important input for the sector in order to take more effective and efficient climate measures.

The main objective of this report is to examine trends in emissions and energy efficiency characteristics over the six available reporting cycles since the entry into force of the EU Maritime MRV Regulation despite different disruptive events affecting the sector over the period, such as the COVID-19 pandemic (from 2020 to 2022), the UK’s withdrawal from the Union (from 2021), and the Russia’s full-scale invasion of Ukraine (from 2022).

This report is based on data from the EU Maritime MRV Regulation over the period 2018-2023

The monitoring, reporting, and verification obligations apply to ships above 5 000 gross tonnage (GT) loading or unloading cargo or passengers at ports in the EEA. The Regulation covers CO_2 emissions produced when a ship travels to or from an EEA port, while transporting goods or passengers for commercial purposes. The Regulation is flag-neutral, which means that ships must monitor and report their emissions regardless of their flag.

The Regulation therefore covers the emissions of a ship travelling from Rotterdam to Shanghai (and vice versa). However, if a ship departs from Shanghai for Rotterdam and makes a stop at an intermediary port outside the EEA (e.g., port “A”) for cargo or passenger operations, only

[6] For the five previously published annual reports, related to the reporting periods from 2018 to 2022 the same principle, i.e. a cut-off date has been applied. For the purpose of this annual report, updated data as of 19 September 2024 has been used for these five previous periods (2018 to 2022). This means that the years 2018-2022 figures presented in this report might slightly differ from those published in the relevant annual reports.

[7] A detailed description of the monitoring, reporting and verification process (“The MRV system – Steps of the MRV process”) can be found in Annex 2 to the 2022 Annual Report from the European Commission on CO_2 Emissions from Maritime Transport, at https://climate.ec.europa.eu/system/files/2023-03/swd_2023_54_en.pdf.

[8] The relevant datasets are available for download as spreadsheet on the THETIS-MRV webpage at https://mrv.emsa.europa.eu/#public/emission-report.

the emissions related to the last leg of the voyage (in this case port A to Rotterdam) will be reported in the system. International voyages that take place within the EEA, such as a ship travelling from Le Havre to Rotterdam, are also covered, as well as domestic voyages, e.g., from Brest to Le Havre. Emissions produced by a ship in an EEA port are also covered, including when the ship is moored or anchored at a port whilst loading, unloading or hotelling.

Despite limiting monitoring requirements to large ships (above 5 000 GT), the Regulation covers around 90% of all CO2 emissions in the EU maritime transport sector, whilst only including around 55% of all ships calling into EEA ports. For reasons of proportionality and subsidiarity, military vessels, naval auxiliaries, fish-catching or fish-processing ships are excluded from the Regulation.

The Regulation underwent a major revision in the year 2023[9] to prepare for the EU ETS extension to maritime transport starting 2024. The revision, which includes an extension of the Regulation’s scope to additional greenhouse gases (i.e. nitrous oxide and methane) and ship types (i.e. offshore ships and general cargo ships below 5 000 GT but not below 400 GT) affects the monitoring and reporting system starting from the reporting period 2024. Since the present report only covers data from activities before 1 January 2024, it does not reflect the changes in the Maritime MRV system brought in by the 2023 revision of the Regulation. Further details on the functioning of the Maritime MRV system applicable starting reporting period 2024 are described in section 1.2.2 of this report[10].

1.2. Context

1.2.1. 2023: Persistent economic and geopolitical uncertainties drive down maritime transport activity levels in Europe

At global level, the year 2023 saw a rebound of maritime trade volumes, driven by the recovery in the world economy after the consequences of the COVID-19 pandemic and better-than-expected economic performance in large economies. Maritime trade recorded a 2.4% increase (in transported million tons) after the contraction registered in the previous year 2022 (UNCTAD, 2024). The increase in ton-miles (i.e. 4.2%) was higher than the increase in maritime trade (as traded tons), which can be explained by the changes in trade patterns following Russia’s war of aggression against Ukraine, the disruptions affecting the Red Sea (starting end 2023), and Panama Canal (reduced water levels).

At European level, 2023 saw a general decrease in goods handled in EU ports, which affected most maritime transport subsectors. Some (energy carriers and bulk carriers) were still highly impacted by the trade changes following Russia’s war of aggression against Ukraine, and few (Cruise sector and ferries) showed evident signs of a strong post-COVID19 rebound marking record activity levels.

In more details, the gross weight of goods handled in EU ports in 2023 decreased by 3.9% compared to 2022 and reached a level 2.3% lower than in 2021, with a decrease both for containerised trade (-3.8%) and bulk goods (-4%, dry and liquid combined)[11](Eurostat, 2024).

Trade in fossil energy imports (i.e. gas, oil, coal), remained affected by the impact of the Russia’s full-scale invasion of Ukraine. Since 2022, the replacement of gas imports by pipeline

[9] Through Regulation (EU) 2023/957, OJ L 130, 16.05.2023, p. 105–114, http://data.europa.eu/eli/reg/2023/957/oj.

[10] A detailed explanation of the functioning of the Maritime MRV system following the 2023 revision is available in the General Guidance Document for shipping companies (Guidance Document no.1), published under the section ‘Documentation’ at the following page: https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en#documentation.

[11] Port calls made by bulk carriers in EEA ports decreased by 7.2% compared to 2022 and were still 1.5% fewer than in 2021.

from Russia by seaborne transport from LNG carriers produced a spike of LNG carriers activity, which in 2023 remained well above 2021 levels. In 2022 high natural gas prices and reduced gas availability also led to fuel switching to coal in electricity generation in Europe (IEA, 2022) which produced an increase in seaborne imports of coal until the first half of 2023 (Eurostat, 2024).

On the other hand, tourism in Europe (both domestically and internationally) was marked by strengthened recovery from the negative consequences of the COVID-19 pandemic travel restrictions, with many countries exceeding pre-pandemic levels (OECD, 2024). This positively affected the maritime transport sector, with the cruise segment recording a 10% increase in the number of port calls at EEA ports compared to pre-COVID 2019, while the Ro-Pax sector recorded a 9.4% increase on the same year.

The last weeks of 2023 finally witnessed the first consequences of a major disruption in world maritime transport, due to the crisis in the Red Sea which made transit through the Suez Canal challenging and caused rerouting through the Cape of Good Hope for vessels heading to/coming from EEA ports. The impacts of the Red Sea crisis, notably in terms of an increase in distance sailed and speed, are expected to become visible on 2024 MRV data[12].

1.2.2. EU regulatory and policy progress in the decarbonisation of maritime transport

Stemming from the 2021 ‘Fit for 55’ package of proposals to deliver the EU’s 2030 climate targets, the decarbonisation of shipping is now firmly embedded in the EU’s regulatory framework as most of the elements of the ‘basket of EU measures’ to decarbonise the sector have been adopted through 2023 and have entered into implementation in the year 2024.

With the extension of the EU Emissions Trading System (ETS)[13] to maritime transport, the EU becomes the first jurisdiction to include shipping emissions into a cap-and-trade system, resulting in a price signal on shipping emissions. Starting 1 January 2024, the EU ETS covers CO_2 emissions[14] from all large ships (of 5 000 gross tonnage and above) entering EEA ports, regardless of the flag they fly. The system covers the entirety (i.e. 100%) of emissions that occur between two EEA ports and when ships are within EEA ports, but only half (i.e. 50%) of emissions from voyages starting or ending outside of the EEA, thus allowing third countries to decide on appropriate action for the remaining share of emissions.

Starting from the reporting period 2024, shipping companies will have to purchase and surrender EU ETS emission allowances for each tonne of reported CO_2 (or CO_2 equivalent) emissions in the scope of the EU ETS system following a phase-in approach. The amount of due allowances is determined on the basis of the monitoring and reporting system established by the EU Maritime MRV Regulation, which, to that end, underwent a significant revision in the year 2023. Starting 1 January 2024, the MRV system will include methane (CH_4) and nitrous oxide (N_2O) emissions and, starting 1 January 2025, offshore and general cargo ships below 5 000 GT but not below 400 GT.

In addition to the EU ETS extension to shipping, the year 2023 also saw the adoption of the FuelEU Maritime Regulation[15] for implementation starting 1 January 2025. The Regulation will ensure that the greenhouse gas intensity of energy used on-board ships gradually decreases

[12] UNCTAD estimates that by June 2024 the number of ship transits through the Suez Canal was down by half compared to May 2023 (UNCTAD, 2024). Rerouting vessels around Africa extends travel times and, if ships speed up as operators try to stick to schedules, emissions are also likely to increase.

[13] Through Directive (EU) 2023/959, OJ L 130, 16.5.2023, p. 134, http://data.europa.eu/eli/dir/2023/959/oj.

[14] Further extended to methane and nitrous oxide emissions starting 1 January 2026.

[15] Regulation (EU) 2023/1805, OJ L 234, 22.9.2023, p. 48, http://data.europa.eu/eli/reg/2023/1805/oj.

over time, along with an obligation for passenger and container ships to use on-shore power supply while moored at the quayside in major EU ports as of 2030.

Further elements of the 'Fit for 55' package to decarbonise maritime transport adopted in 2023 include the Alternative Fuels Infrastructure Regulation (AFIR), which requires certain (larger) TEN-T ports to have OPS and LNG refuelling infrastructure available and mandates Member States to develop national policy frameworks for alternative fuels to be finalised by the end of 2025, and the revision of Renewable Energy Directive (RED), introducing more ambitious sector-specific targets in transport, including sub-targets for advanced biofuels and renewable fuels of non-biological origin.[16]

In addition to legislative measures, the EU is further supporting the successful implementation of shipping decarbonisation through support to research, innovation and deployment of innovative solutions. Through the Innovation Fund, an estimated €40 billion will be reinvested in the period 2020-2030 to support the demonstration and deployment of innovative low-carbon technologies. The outcome of the Call IF23 published in October 2024 included 6 maritime projects and one marine fuel related project with a total support above EUR 200 million[17]. The projects selected in 2024 add to the existing Innovation Fund project portfolio which was already supporting projects related with the maritime sector, specifically, on the production and or commercialization of fuels such as Methanol, Ammonia, e-fuels, e-SAF, e-methane, bio-fuels and projects focusing on the use of renewable energy in ports or innovative propulsion systems (e.g. fuel cell and wind sail).

Moreover, the first H2 EU-wide auction (IF23 Auction) for the production of RFNBO (renewable fuel of non-biological origin) hydrogen granted support to 6 projects from which one to develop a world-leading green hydrogen and renewable ammonia project for production of maritime fuels. While the Innovation Fund focuses on higher Technology Readiness Level (TRL) and deployment, the EU also has invested in lower TRL projects for the maritime sector through Horizon Europe, in particular the Zero-Emission Waterborne Transport Partnership. Under this partnership, the EU will invest up to EUR 530 million until 2027, primarily in 5 areas related to shipping, including use of sustainable alternative fuels, electrification, energy efficiency, design & retrofitting, digital and green ports.

The EU is further supporting the decarbonisation of shipping at the global level, in particular within the International Maritime Organisation, as detailed in the next section.

1.2.3. Developments at the International Maritime Organization

Throughout 2024, the Commission maintained its support for ambitious progress at international level to reduce greenhouse gas emissions from shipping through effective global measures. Following the adoption in July 2023 of a revised IMO strategy on reduction of GHG emissions from ships, work has progressed towards developing a basket of mid-term GHG reduction measures involving:

1. a technical element, namely a goal-based marine fuel standard regulating the phased reduction of marine fuel's GHG intensity; and
2. an economic element, on the basis of a maritime GHG emissions pricing mechanism.

To this end, a draft legal framework for these regulations was established during the 81st session of the IMO Marine Environment Protection Committee (MEPC) in March 2024. Negotiations towards the development of these measures further advanced during the 82nd MEPC session from 30 September and 4 October 2024. As part of that development, policy

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[16] The revision of the Directive on energy taxation, Council Directive 2003/96/EC of 27 October 2003, is still ongoing at the time of writing.

[17] These included the projects GreenWave, CORMORANT, INDIGO, REACH-REACH REMOTE, H2hydroShuttle, EO2 Energy Observer 2, Swap2Zero: https://ec.europa.eu/commission/presscorner/detail/en/ip_24_5423.

proposals were analysed as part of a Comprehensive Impact Assessment (CIA), consisting of four studies: a literature review, an assessment on the impacts on the fleet, an assessment on the impacts on States as well as a complementary assessment by means of several case studies.

MEPC 82 also considered the review plan of IMO short-term GHG measures which, in force since 2023, are to undergo a first review by 1 January 2026. These measures, aiming at reducing the carbon intensity of international shipping in 2030 by at least 40%, compared to 2008 levels, include:

1. The Energy Efficiency Existing Ship Index (EEXI), requiring all 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.
2. The Carbon Intensity Indicator (CII) implementing since 2023, a carbon intensity rating system for ships, with the objective to improve the operational performance of ships, including through a performance follow-up within the Ship Energy Efficiency Management Plan (SEEMP).

The schedule of the IMO strategy on reduction of GHG emissions from ships foresees the final agreed mid-term GHG measures are to be approved by MEPC at its session in spring 2025 (MEPC 83), to be adopted by MEPC in autumn of 2025 for entry into force in 2027.

1.2.4 Impact of maritime transport on global warming

CO_2 is emitted from ships as the result of the combustion of fuels in the ship's combustion machinery (i.e., main engines, auxiliary engines, boilers, etc.) and is the largest part of the GHG emissions released from ships. However other GHGs may be emitted such as methane (CH_4) from ships using gas or dual fuel engines or from the cargo tanks in Liquified Natural Gas (LNG) carriers, while nitrous oxide (N_2O) can be released during the combustion of certain fuels such as ammonia. Refrigerants used for air conditioning and for cargo cooling processes and various gases can also be a source of greenhouse gases from ships. Meanwhile, air pollutants such as sulphur oxides (SO_x), nitrogen oxides (NO_x), fine and ultrafine particulate matters, as well as black carbon (BC) can also be released during the combustion of marine fuels and in some cases can be a driver of global warming.

According to the Fourth IMO GHG Study, in 2018 the CO_2 emissions from international shipping accounted for between 2.02% and 2.51% of the total global anthropogenic CO_2 emissions (IMO , 2020).

The last IMO inventory of shipping emissions published in 2020 (and covering the period 2012-2018), provided the following breakdown of CO_2-equivalent emissions by type for voyage-based[18] international shipping emissions (see Figure 1):

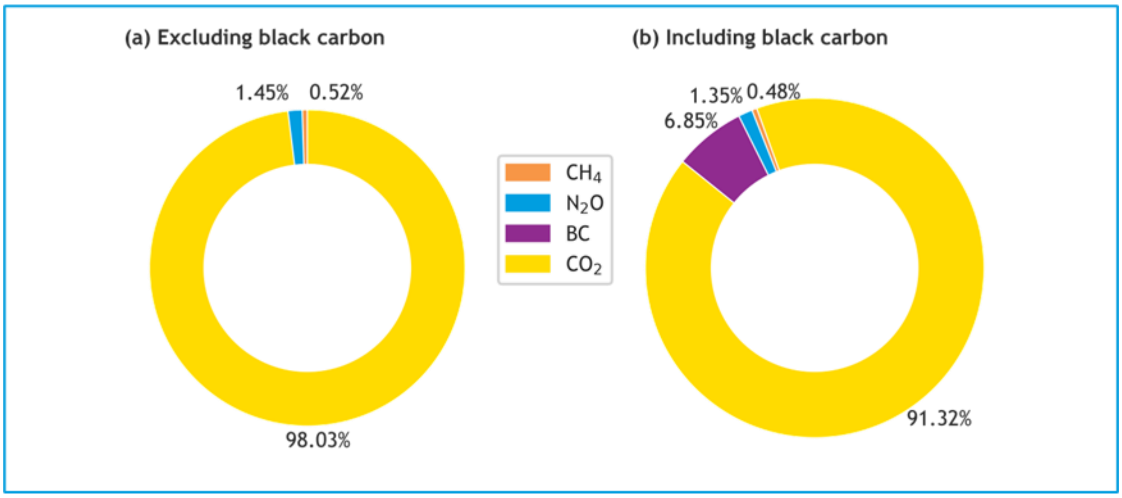

Figure 1 Contribution of different GHG emissions expressed in CO_2e to voyage-based international GHG emissions in 2018; Source: Fourth IMO GHG Study

The figure shows that the impact of CO_2 emissions on total emissions from maritime transport accounts for 91.32% of total GHG emissions when including black carbon emissions, which represent the second most significant contribution (6.85% of the total), before nitrous oxide (1.35% of the total) and methane emissions (0.48% of the total).

Black carbon, while not classified as a GHG, does represent a significant climate pollutant (IMO , 2020). Due to their dark colour, black carbon particles absorb a high proportion of incoming solar radiation, directly warming the atmosphere. The climate impact of black carbon may also be more pronounced at a regional level such as in the Arctic because when black carbon settles on snow or ice, their ability to reflect sunlight is reduced (EEA & EMSA, 2021). International maritime transport is thought to contribute to about 1-2% of global black carbon emissions (EEA & EMSA, 2021). Research indicates that the use of distillate fuels by ships may reduce black carbon by 33% compared to traditional Heavy Fuel Oil (HFO) while diesel particulate filters (DPFs) may reduce black carbon by more than 90% (ICCT, 2019). Fuel treatment, better engine maintenance, better fuel combustion, exhaust treatment systems, but also operational practices aiming at improving fuel efficiency (such as slow-steaming and de-rating) could further contribute to black carbon emissions reduction.

Over the period analysed under the Fourth IMO Study (2012-2018), total GHG emissions (as CO_2-equivalent) from shipping increased by 9.6% (from 977 million tonnes to 1 076 million tonnes). CO_2 emissions increased by 5.6% and were projected to increase from about 90% of 2008 emissions in 2018 to 90-130% of 2008 emissions by 2050 for a range of plausible long-term economic and energy scenarios. In the period 2012-2018, methane emissions were found to have increased by 150%, far greater than the use of LNG as a marine fuel. Black Carbon emissions, increased by 11.6% for total shipping (i.e. from 59 to 62 kilo tonnes). The deployment of dual fuel and LNG-powered ships and the growing use of new fuels such as ammonia are likely to further contribute to the increase in methane and nitrous oxide in the near future.

Latest studies on trends in international shipping for the period 2018 – 2022 have found that emissions have not decreased since the latest IMO inventory and remained in 2022 around 2008 levels (UMAS, UCL, 2024). Over the same period, also gains in carbon intensity of the world fleet were found to be rather limited, i.e. to 1.1% average annual reduction during 2018-2022, thus lower than higher attained improvements in the period 2008 - 2018. Data reported under the IMO Data Collection System (DCS) shows only a minor (-1%) reduction in fuel consumed by the world reporting fleet in 2023 compared to 2022. 2023 data further highlighted that the uptake of lower carbon alternative fuels in international shipping remains slow, with around 94% of all reported fuel being represented by Heavy Fuel Oil, Light Fuel Oil or Diesel/Gas Oil, and fossil LNG accounting for most of the rest (IMO, 2024).

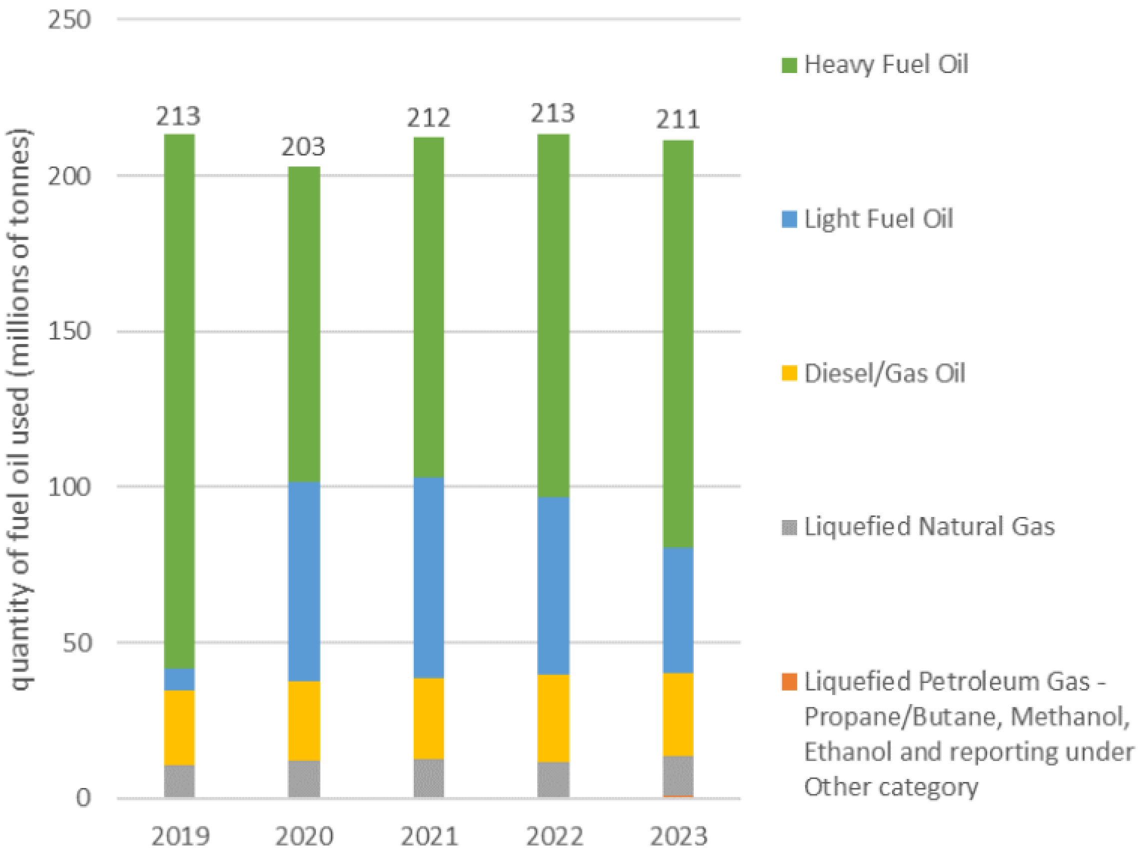

Figure 2 Aggregated annual amount of each fuel type reported by ships to to the IMO Data Collection System from 2019 to 2023 (Source: IMO, MEPC 82/6/38)

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

2.1. The Fleet: emissions and number of ships

In 2023, 12 344 ships submitted an emissions report for a total of 126.7 million tonnes of CO_2 emissions (see Figure 3).[19]

Emissions reported for the year 2023 are low compared to previous years. They are 7.9% lower than the ones reported for 2022 and when compared to the reporting years preceding the COVID-19 pandemic (i.e. 2018 and 2019), which included emissions related to the United Kingdom, they are around 13% lower. The 2023 emissions are comparable to the level of emissions reported in 2021, which was a year marked by the long-lasting effects of the COVID-19 crisis.

Since the entry into force of the MRV system, 2019 remains the year with the highest total CO_2 emissions on record. 2020 saw the highest year-on-year (-11.9%) drop in total reported emissions due to the economic effects of COVID-19. 2021 recorded a partial recovery from the pandemic's effect on the global economy but the comparison with 2019 proves challenging since 2021 was also the first year affected by the new geographical scope of the MRV system following the United Kingdom's withdrawal from the EU[20]. The following year, 2022, clearly showed a rebound in emissions levels linked to further recovery from the COVID-19 economic downturn, in a year marked by the economic and geopolitical consequences of the Russia's war of aggression against Ukraine.

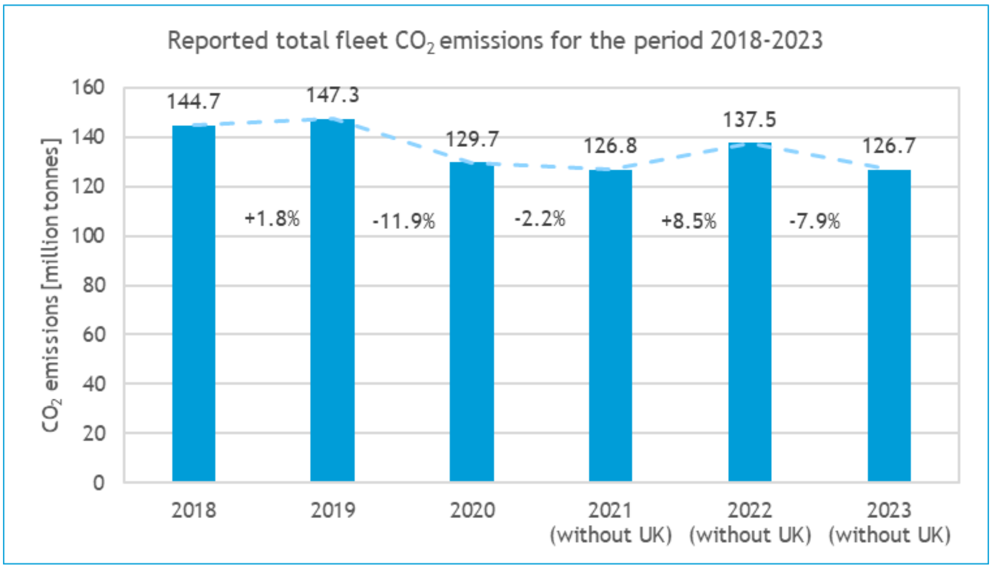

Figure 3 Total fleet CO_2 emissions, 2018-2023

[19] Emissions reports of ships declaring zero emissions and no fuel consumption under the MRV scope have been discarded from this Report. The relevant figures and analysis from previous reporting years have been adjusted accordingly. The number of ships reporting zero emissions is decreasing: 638 in 2018 down to 184 in 2023. Following the 2023 revision of the EU MRV Maritime Regulation, shipping companies are now required to submit partial emissions reports in the case of a change of shipping company during the reporting period: 113 partial emissions reports were submitted in the year 2023.

[20] As in the fourth and fifth MRV Annual Reports, it was not possible to recalculate historical data before 2021 so as to exclude the emissions resulting from the application of the EU Maritime MRV Regulation to the United Kingdom. This is because the legislation does not require shipping companies to report emissions at voyage level. Therefore, throughout this report, the figures presented for the reporting years after 2020 are based on the reported data, which excludes the Regulation's application to the United Kingdom (but only to EEA countries, including the EU-27). By contrast, the reported data for the reporting years 2018, 2019 and 2020 includes the Regulation's application to the United Kingdom, which is accounted for as part of the EEA (the EU-28).

The total number of ships submitting emission reports for the reporting year 2023 was the second highest on record and nearly 3% higher than the one recorded in the year 2021, despite total reported emissions being comparable. The first year of implementation of the EU MRV system (2018), remains the period with the lowest number of submitted emission reports.

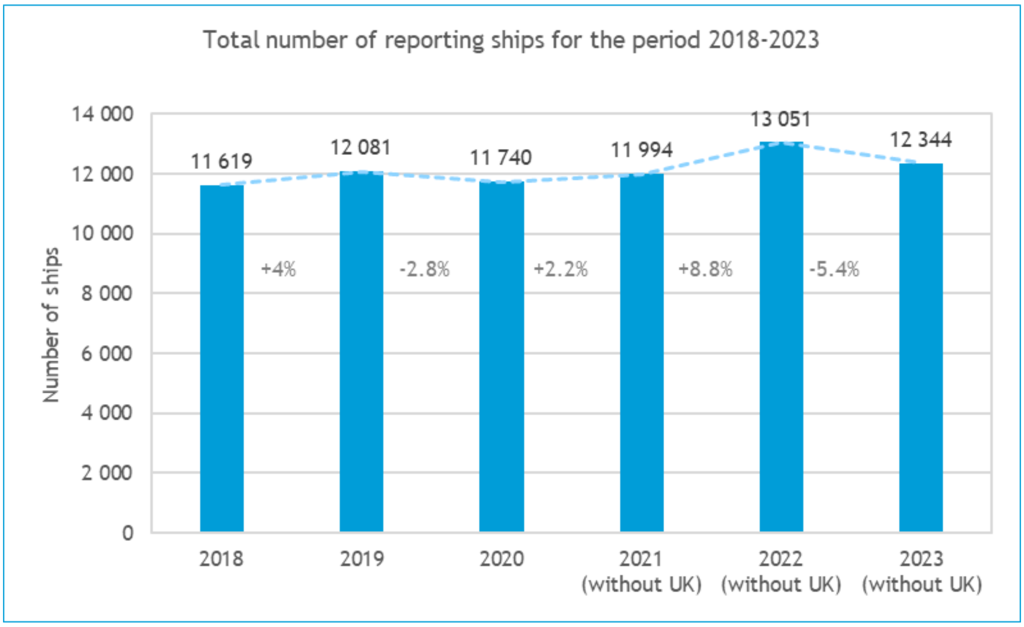

Figure 4: Total number of ships for which emissions report has been submitted; 2018-2023

The analysis of the composition of the fleet reporting under MRV over the period 2018-2023 reveals that in 2023, there was many more ships submitting an emissions report for the first time in the MRV system compared to previous years (9% of total reports in 2023 against an average of around 5% during the period). The share of ships having submitted a report in each of the six reporting periods so far represented 37% of total reporting ships in 2023.

The distribution of the fleet's total CO_2 emissions over the different types of voyages and at berth (see Figure 5) confirms the slight decrease in the share of extra-EEA voyages (incoming and outgoing) recorded in 2022: these reached the lowest level in the year 2023 since the withdrawal of the UK from the EU, down to 65.4% in 2023 from 67.6% in 2021, a decrease almost entirely matched by the increase in the share of intra-EEA voyages[21], while emissions at berth remained stable. In absolute terms, the emissions released during extra-EEA voyages decreased by around 10% in 2023 compared to 2022 against the overall decrease of 7.9%, while emissions from intra-EEA voyages decreased by only 2.2%. The decrease of the emissions from extra-EEA activities in 2023 is a consequence of the decrease in the activity levels of the subsectors of the MRV fleet which are most active on extra-EEA trade routes, such as bulk carriers and LNG carriers[22], in addition to the increase in activity for those which are most active in intra-EEA routes (such as passengers ships)[23].

[21] This is because, as a consequence of the UK withdrawal from the EU, voyages between the UK and an EEA country are no longer considered intra-EEA voyages but rather extra-EEA voyages.

[22] On average, extra-EEA emissions across the 2018-2023 period accounted for 86% of total reported emissions for bulk carriers and for 92% for LNG carriers.

[23] Figure 7 further details the distribution of emissions by geographical scope and by ship type.

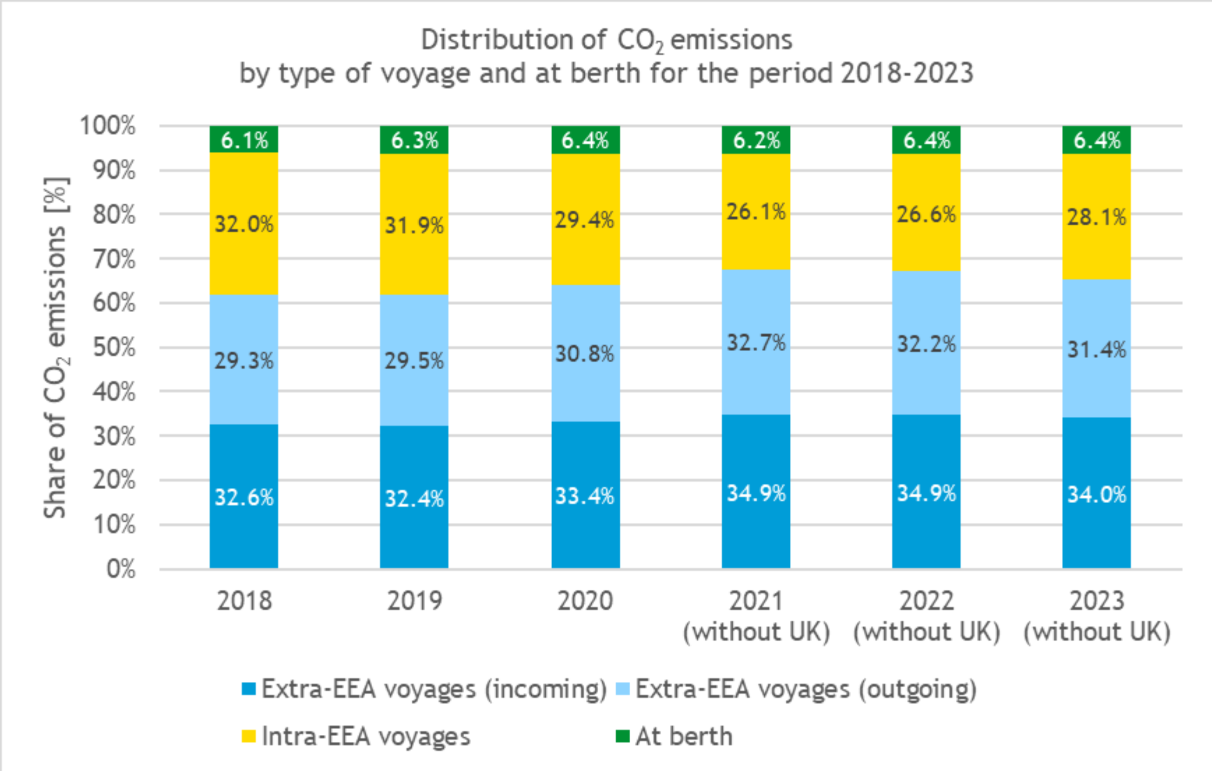

Figure 5: 2018 to 2023 share of fleet emissions per voyage type and at berth

2.2. Ship types: emissions and number of ships

For most of the ship types reporting under the EU Maritime MRV Regulation, the highest emission levels were recorded in the years preceding COVID-19 and the UK's withdrawal from the EU, i.e. before 2020. Four ship types recorded their highest reported levels after 2020: emissions for bulk carriers and LNG carriers peaked in 2022, as a consequence of the disruption to regional trade and energy markets caused by the Russian war of aggression on Ukraine. Emissions for passenger ships and the category 'other ship types' recorded the highest values in 2023.

In the year 2023, containerships remains the ship type releasing the most CO_2 emissions, followed by oil tankers and bulk carriers (see Figure 6). These ship types are also the most numerous in the MRV system (see Figure 11). In 2023 all ship types showed a decrease in emissions compared to 2022, except passenger ships[24] which increased by 7% and 'other ship types' which increased by over 40% (see Figure 7).

[24] All passenger ships reporting under MRV in the year 2023 were in fact cruise ships. Other passenger ships with cargo capacity reported as Ro-Pax ships.

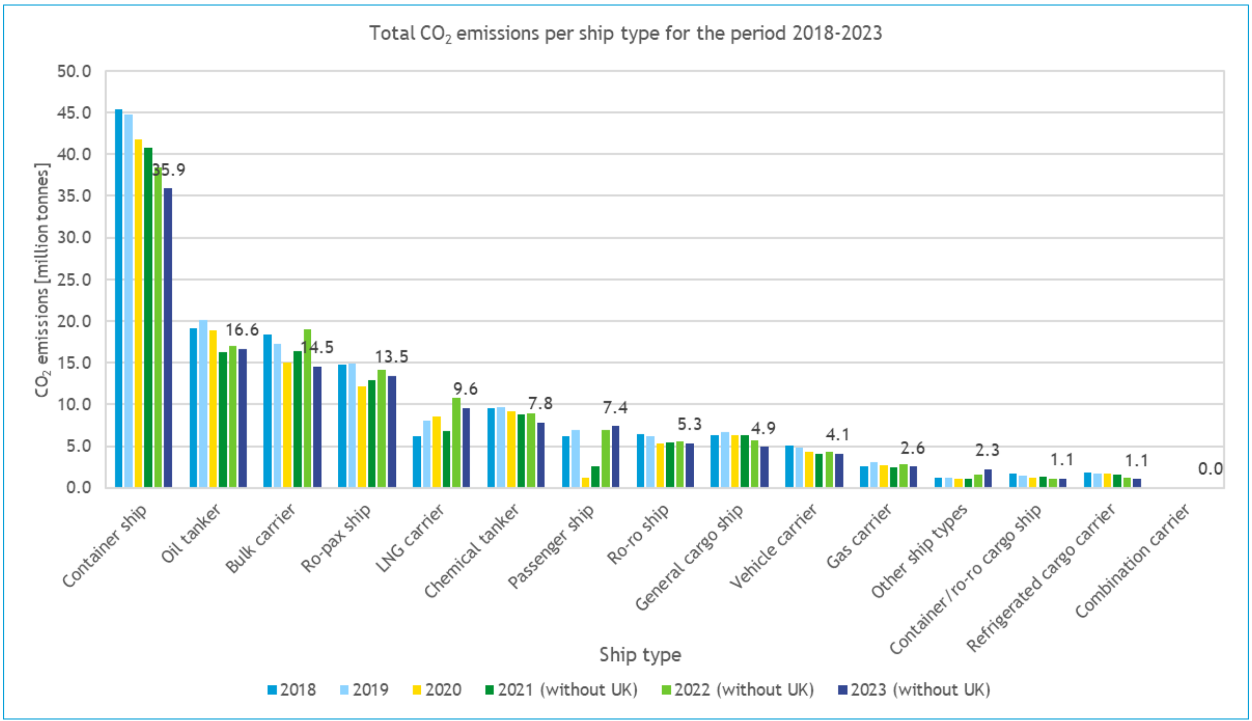

Figure 6: Total emissions per ship type; 2018 to 2023; descending 2022 order; levels given for 2023 (without UK)

The most significant absolute decrease in emissions can be seen in bulk carriers (by 4.5 million tons, i.e. -23%) which also recorded a considerable decrease in the levels of active ships in 2023 (-12%, see Figure 7 and Figure 11). General cargo ships, LNG carriers, combination carriers, refrigerated cargo carriers and chemical tankers recorded decreases in reported emissions of between 11% and 17%. The decrease in emissions from containerships of 6% is particularly significant given the high proportion of containerships in the EU MRV fleet and the increase in number of containerships that reported under MRV in 2023 (+54 ships).

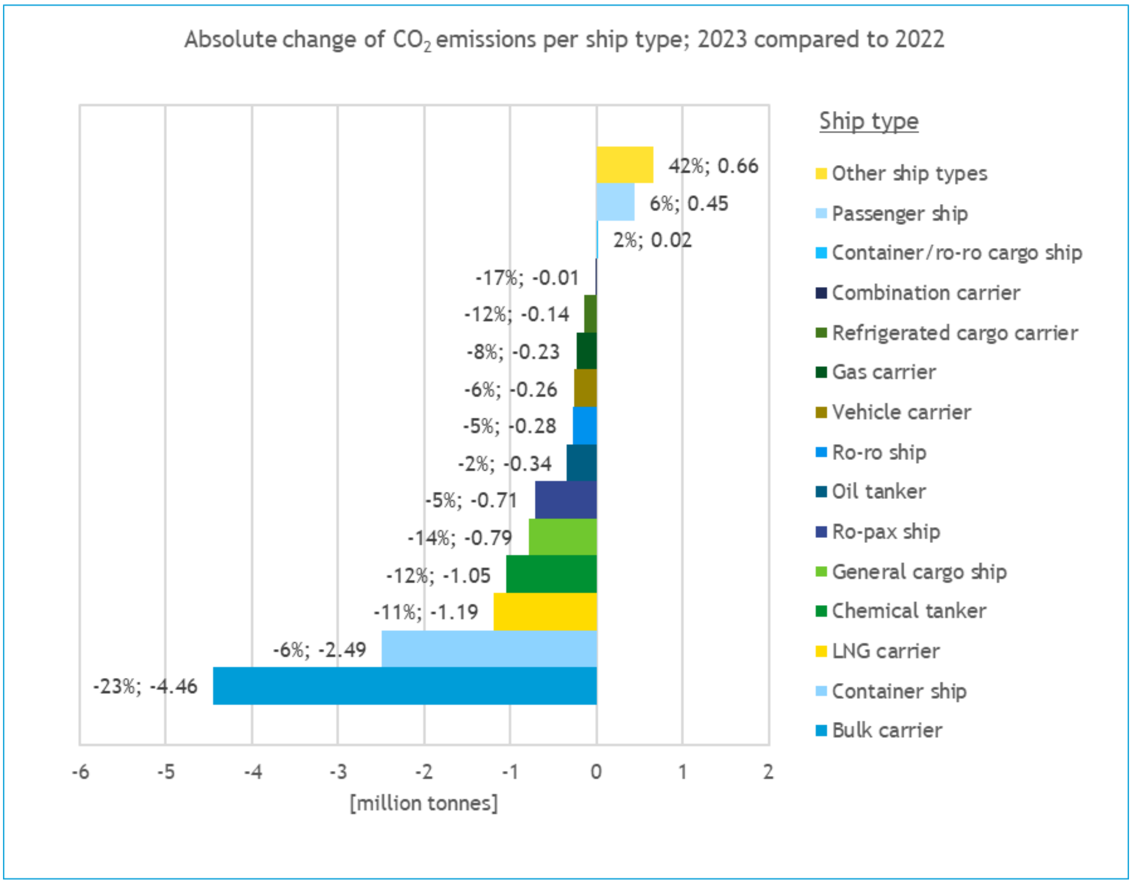

Figure 7: Change of emissions in 2023 compared to 2022 per ship type, in absolute and relative terms

Figure 8 allows to further analyse changes in total emissions reported, by ship and voyage type (including a differentiation between CO_2 emitted at sea and at berth), between 2022 and 2023.

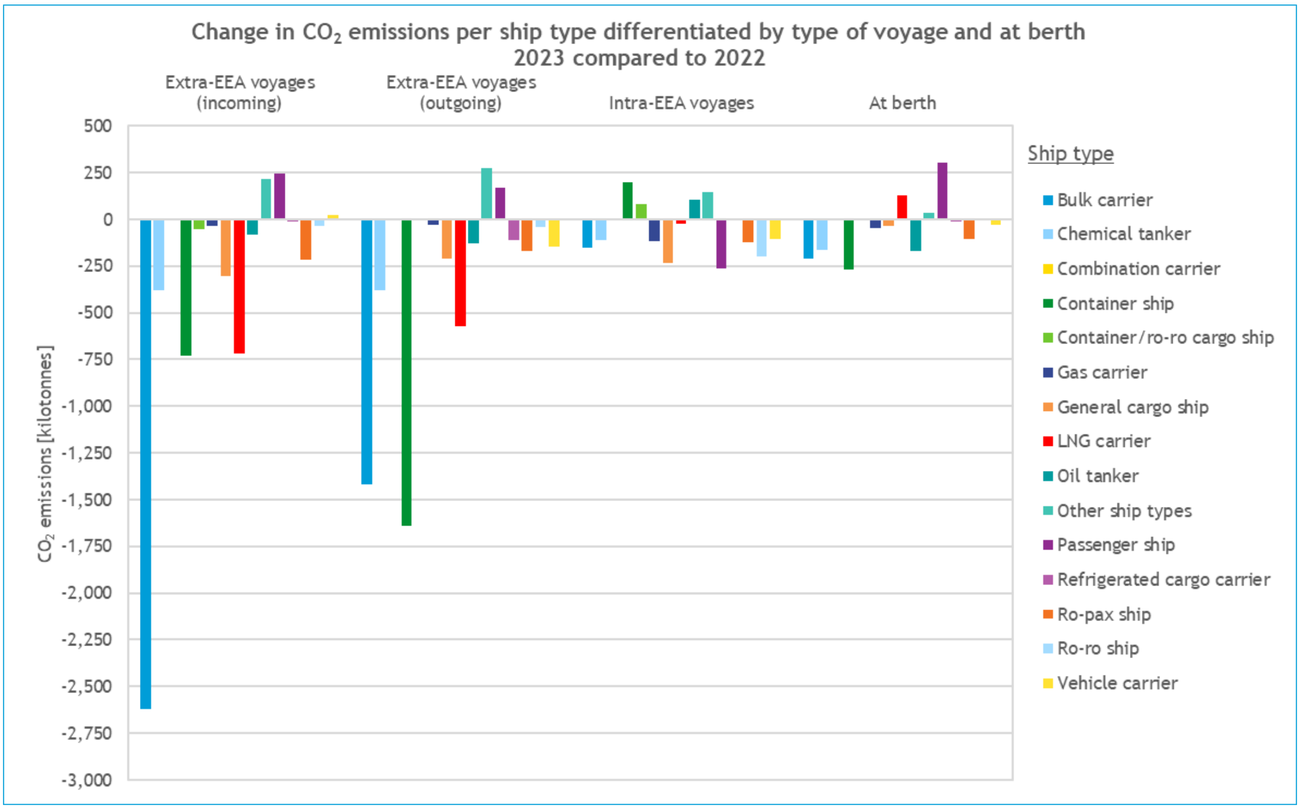

Figure 8: Change in emissions by ship type, differentiated by type of voyage; 2022 (without UK) on 2021 (without UK); ship types sorted by change of total emissions

The most significant changes in emissions by voyage type from 2022 to 2023 are the reductions in CO_2 emissions from bulk carriers on incoming and outgoing extra-EEA voyages. Other significant reductions can be observed from containerships on outgoing and (to a lesser extent) incoming extra-EEA voyages, while emissions from these ships on intra-EEA voyages increased. For both incoming and outgoing extra-EU voyages the emissions from LNG carriers are also significantly less than in the 2022 reporting period. On the other hand, emissions from passenger ships increased for extra-EEA voyages (slightly more on incoming voyages than outgoing) and, more substantially, at berth although they decreased on intra-EEA voyages.

As illustrated in Figure 9 containerships remain by far the top emitters in the MRV system. Taken together, the three main emitters by ship type (i.e. containerships, oil tankers and bulk carriers) still account for more than half of all reported emissions, at 52% of total MRV emissions (down from the 59% peak recorded in 2020).

In terms of type of activity, these three ship types are the biggest emitters on extra-EEA voyages (both incoming and outgoing) while emissions from intra-EEA voyages only represent a minor share of total emissions for bulk carriers and oil tankers. This reflects the differences in trading characteristics of these ship segments. While oil tankers and bulk carriers are usually deployed in extra-EU trade activities, i.e. they transport cargo from/to an extra-EEA port to/from one single port in the EEA, containerships, on their way to/from extra-EEA ports, are more likely to call multiple EEA ports as part of their scheduled service, thus reporting a higher share of intra-EEA and at berth emissions, in addition to extra-EEA voyages.

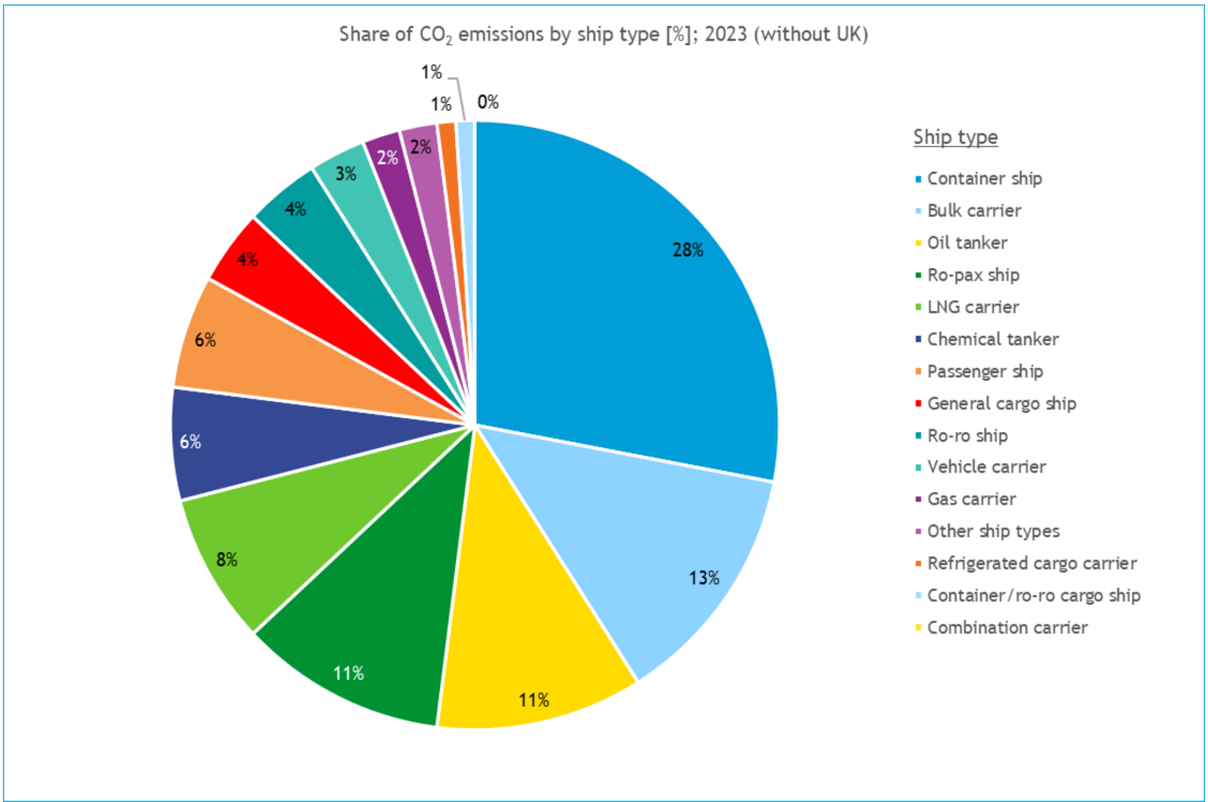

Figure 9: Share of overall fleet CO_2 emissions by ship type; 2023 (without UK), in %

As illustrated in Figure 10, the drop in emissions from bulk carriers impacted their share on total reported emissions, which reached the lowest level on record (down to a share of 11% from 14% in 2022). While the relative share of most ship types remained stable, 2023 emissions confirmed the increase in the share of LNG carriers and Passenger and Ro-Pax ships, as a consequence of energy market dynamics following the Russian full-scale invasion of Ukraine and the complete rebound over pre-COVID levels for passengers traffic.

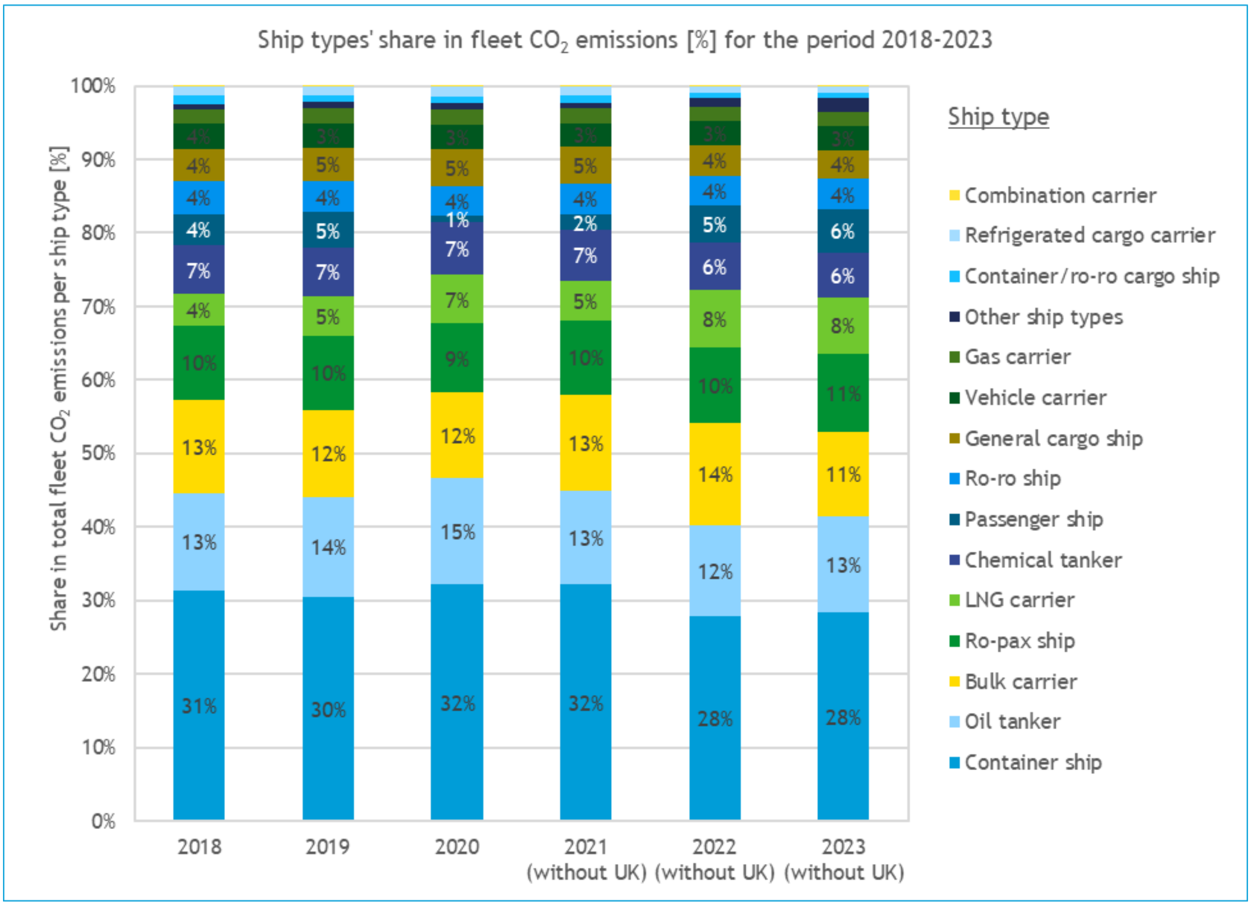

Figure 10: Ship types' share in fleet CO_2 emissions; 2018 - 2023

In terms of number of ships active in the EU MRV system, 5 ship types keep representing the lion's share: bulk carriers (29%), oil tankers (15%), container ships (15%), chemical tankers (11%) and general cargo ships (9%) account for 79% of emission reports submitted in 2023, a trend in line with the previous five years (see Figure 11). This confirms the overall stability in the composition of the active fleet per ship type under the EU MRV system.

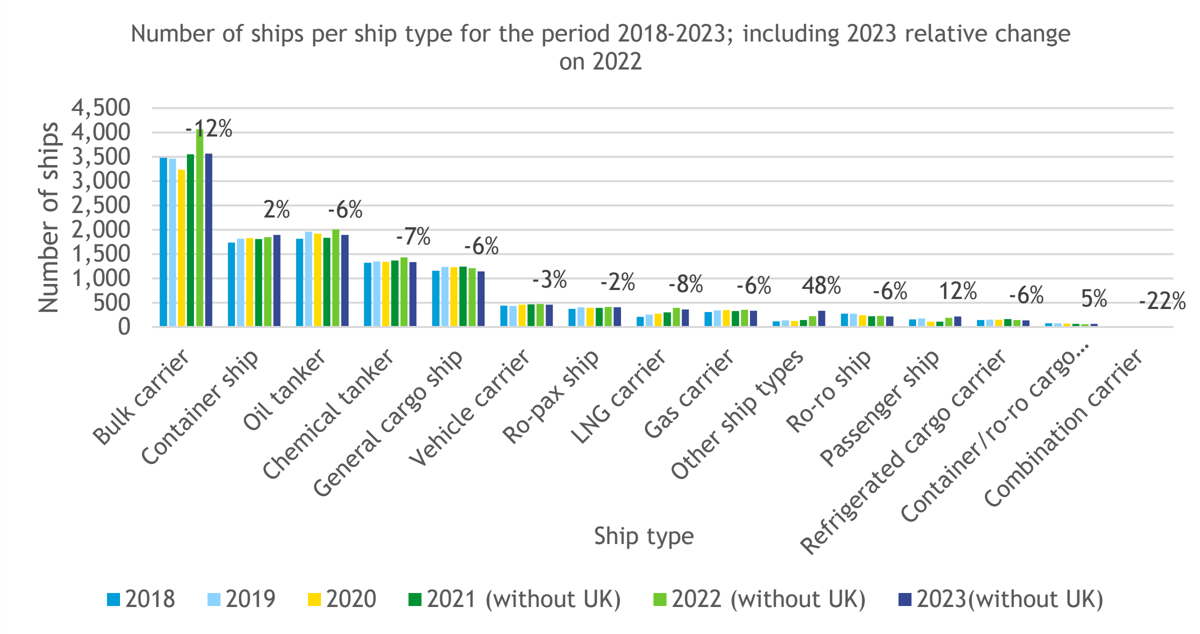

Figure 11: Number of ships per ship type; 2018 to 2023; descending 2023 order; percentage change in 2023 compared to 2022

The year 2022 remains to date the one recording the highest number of ships active under the MRV scope, which decreased by around 5% in the year 2023, with most ship types submitting less emissions reports than in the previous year. In absolute terms, the greatest reduction in the number of active ships between 2022 and 2023 was from bulk carriers (-12% or 503 ships), oil tankers (-4% or -114 ships) and LNG carriers (-8% or -30 ships). The decrease in active bulk carriers stands out and accounted for the large majority (i.e. 71%) of the total decrease in the MRV fleet for 2023 (707 fewer ships). Such a sharp decrease in the number of bulk carriers active in the scope is an indicator to a return to normal for activity levels after the disruptive year 2022 for the subsector, as the size of the active fleet in 2023 was roughly in line (+0.3%) with the one reporting in the year 2021.

Only four ship types recorded an increase in the number of reporting ships in 2023, namely ships categorised as ‘other ship types’ (107 ships or +48%), containerships (42 ships or +2%), passenger ships (23 ships or +12%), and container/ro-ro cargo ships (3 ships or +5%). With the exception of the latter one, these ship types confirmed the trend in the increase of active ships recorded starting 2021 and reached in 2023 the highest number of active ships since 2018. The large increase in the number of ships reporting under the category ‘Other ship types’ is at least partially explained by the fact that some ships decided to change their “ship type” category in 2023, as revealed by cross-checking the IMO numbers reported in previous reporting periods under MRV[25]. The increase in the containership and passenger ship fleet size under MRV is in line with developments for the global fleet[26].

[25] Of all ships reporting as ‘Other ship types’ in 2023 34% have reported as general cargo ships and 3% as bulk carriers in 2022.

[26] 350 new containerships were delivered globally in 2023 totalling an aggregate capacity of 2.2 million TEU, the highest on record (BIMCO, 2024). 14 new cruise ships from the members of the Cruise Line Industry Association alone were scheduled to enter service in 2023 (CLIA, 2023).

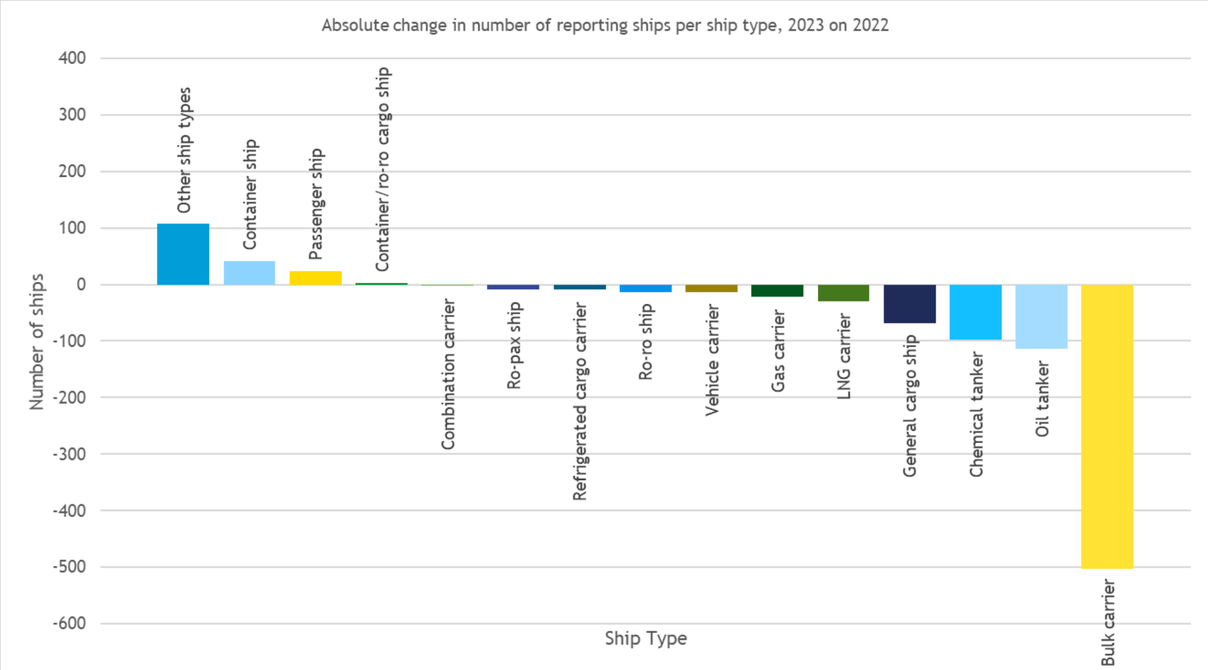

Figure 12: Change in number of ships per ship type; 2023 (without UK) on 2022 (without UK)

2.3. Further analysis of CO_2 emissions

In principle, the annual reported fleet CO_2 emissions can vary over time due to four main factors, the last three of which also have an impact on the average emissions per ship:

1. **More/fewer ships** active within the scope of the EU Maritime MRV Regulation (i.e. more/fewer ships submitting an emissions report during the year);
2. Active ships within the scope of the Regulation are **used to a different degree** (i.e. more or less distance is travelled during the year);
3. Active ships within the scope of the Regulation are **more/less energy efficient** (i.e. more/less emissions per distance travelled);
4. Active ships within the scope of the Regulation use **energy carriers** that are more/less carbon intensive (i.e. higher/lower CO_2 emissions per gram of combusted fuel).

Below, changes in CO_2 emissions are further analysed for specific ship types, first focussing on the latest developments (2023 compared to 2022), followed by an analysis of identified trends in the first six reporting periods (2018 to 2023).

2.3.1. 2023 compared to 2022

The analysis of key changes in emissions per ship type in reporting year 2023 compared to 2022 focuses on the three ship types (bulk carriers, oil tankers and containerships) responsible for the highest combined share (i.e. 52%) of total CO_2 emissions. The analysis further considers passenger ships, the type recording the highest increase in reported emissions on 2022 (+6%) after the category “other ship type”.

Table 1 Analysis of 2023 CO_2 emissions compared to 2022

The 3 largest CO_2 emitters in the 2023 EU MRV fleet as well as passenger ships (% change)

Ship type	Total CO_2 emissions	Number of reporting ships	Average change of CO_2 emissions per ship	Average change of nautical miles per ship	Average speed	Total travelled nautical miles
Bulk carriers	-23%	-12%	-13 %	- 8%	-4%	-19%
Oil tankers	-2%	-6%	+4%	+5%	+2%	-1%
Containerships	-6%	+2%	-9%	-3%	-5%	-0.4%
Passenger ships	+6%	+12%	-5%	-5%	+12%	+6%

Analysing the emissions trends for these 4 ship types, it can be concluded that:

1. The significant decrease (-23%) in emissions from bulk carriers is linked to the decrease in the overall activity of the subsector, which is shown in port activity data (decrease in bulk goods handled in port). MRV data shows that in the year 2023 less bulker carriers were active under scope than in 2022 and those which were active travelled shorter cumulated distances. In addition, as showed in Figure 22, bulk carriers sailed almost 4% slower than in 2022 which further contributed to reducing emissions.
2. The small decrease (-2%) in overall emissions from oil tankers between 2022 and 2023 resulted from the combined effect of the decrease in the number of active ships which however sailed longer cumulated distances at higher average speed (+2%, see Figure 22).
3. The containerships sector recorded for the second consecutive year an increase in the number of active ship, coupled with a decrease in the activity levels of ships, which not only sailed shorter cumulated distances but also at a slower speed. These factors resulted in a significant decrease in reported emissions (-6% compared to 2022 and around -12% compared to 2021). It is also worth noting that average emissions per containership have continuously decreased since 2018, which may be an indication of the improvement of the technical efficiency of the ships under MRV scope, driven by fleet renewal and deployment of bigger and more efficient containerships[27].
4. Passenger ships, which include cruise ships, experienced a full rebound from the decrease in activity triggered by the COVID-19 pandemic, and recorded in the year 2023 a considerable increase of emissions, driven not only by the fact that more passenger ships were active under scope, but also by the increase of total distance sailed and, more importantly, speed (+11% on average), which resulted in this ship

[27] The average size of containerships active within MRV scope (expressed in dwt) has increased by 18% since 2018.

type being the only one reporting an increase in emissions per nautical mile in 2023. 2023 marked thus the year with the highest emissions from this type since 2018.

2.3.2. Analysis over the period 2018-2023

2023 was the EU Maritime MRV system's sixth reporting period. An analysis of the data reported in the period 2018 to 2023 potentially allows to identify certain trends over time. An analysis of trends is, however, limited due to two orders of factors: first, the composition of the active fleet within the scope of the EU Maritime MRV system changes annually[28] and, second, different major disruptive events have marked the years after 2019[29].

An analysis of the average annual CO_2 emissions per ship type (see Figure 13) reveals a cluster of 9 ship types with similar average emissions of between 4 000 and 9 000 tonnes CO_2 per ship in 2023. The remaining 6 ship types feature much higher average annual CO_2 emissions, ranging from 17 190 tonnes CO_2 for container/ro-ro cargo ships to 34 650 tonnes for passenger ships in 2023. Of these 6 ship types, only container ships show a continuously decreasing trend of the average annual CO_2 emissions (decreasing by about a third in the period 2018-2023). Average annual CO_2 emissions of LNG carriers, Ro-Pax ships and especially of passenger ships show strong fluctuations over time, an indication that the relevant market segments have been affected by disruptive trends in the period (such as the COVID-19 economic downturn and the Russia's full-scale invasion of Ukraine)[30].

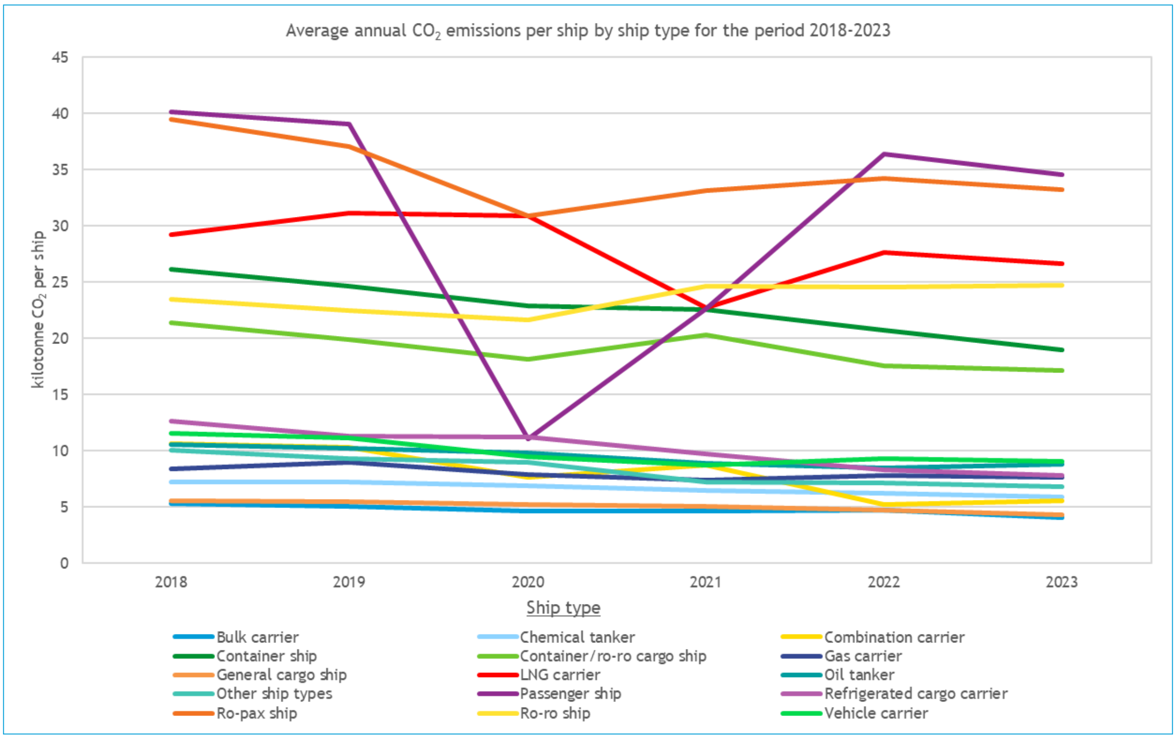

Figure 13: Average annual CO_2 emissions per ship per ship type

[28] To date, only 4 520 ships have reported in each of the six reporting periods which corresponds to between 35% and 39% of the total number of ships for which a report has been submitted in a year.

[29] This is the case of the economic consequences of COVID-19 (starting 2020), of the United Kingdom's withdrawal from the EU (since 2021) which impacted the geographical scope of the EU Maritime MRV Regulation, and of Russia's full-scale invasion of Ukraine (since 2022).

[30] The average CO2 emissions per ship within the scope of the EU Maritime MRV Regulation may vary over time for three, not mutually exclusive reasons: the activity of the ships (i.e. fuel consumption, which mainly depends on distance travelled), the energy efficiency of the ships, and the carbon intensity of the energy used onboard ships.

The analysis of the emissions per nautical mile of the MRV fleet (expressed as tonCO_2/nm) reveals a decrease in 2023 of 2.5% on 2022, well above the average annual reduction of 1% for the period 2018-2023. During the period 2018-2023 all ship types recorded an improvement in the reported emissions per nautical mile, with the only exception of passenger ships, which reported 2.6% more emissions per travelled nautical miles in 2023 compared to 2018.

The analysis of the average age per ship between 2018 and 2023 confirms trends valid for the world shipping fleet (UNCTAD, 2024), both in terms of differences between ship types and increasing average age[31]. All ship types under the MRV system recorded a higher average age in 2023 compared to what was reported in 2018. The average age has also been continuously increasing for all ship types except passenger ships for which the average age has fluctuated around 14 years[32]. LNG carriers, oil tankers, gas carriers, bulk carriers and chemical tankers are currently the types of ships with the lowest average age (ranging from 9 to 12 years) while refrigerated cargo ships, containerships, ro-pax and (container) ro-ro ships as well as passenger ships are generally much older (14 to 25 years).

[31] 2023, in line with 2022, saw a decrease in scrapping rates, with only 431 vessels sent to dismantling at the global level 11 less than in 2022, reaching the lowest levels in over a decade.

[32] In the case of passenger ships it is worth stressing that the fleet composition greatly changed in the years most affected by COVID-19 (2020 and 2021), when many ships reporting in previous years remained inactive.

2.4 Fuel consumption

In 2023, the EU MRV fleet consumed in total 41 million tonnes of fuel within the geographical scope of the Regulation, 7.6% less than in 2022 (Figure 14). It is worth noting that the change in the amount of consumed fuel is not always aligned with the change in total reported emissions. Such a difference can be explained by changes in the fuel mix of the reporting fleet, which experienced a slight decrease in the average applied emissions factor, due to the increase in the use of less carbon intensive fuels (mainly LNG, whose consumption peaked in 2023).

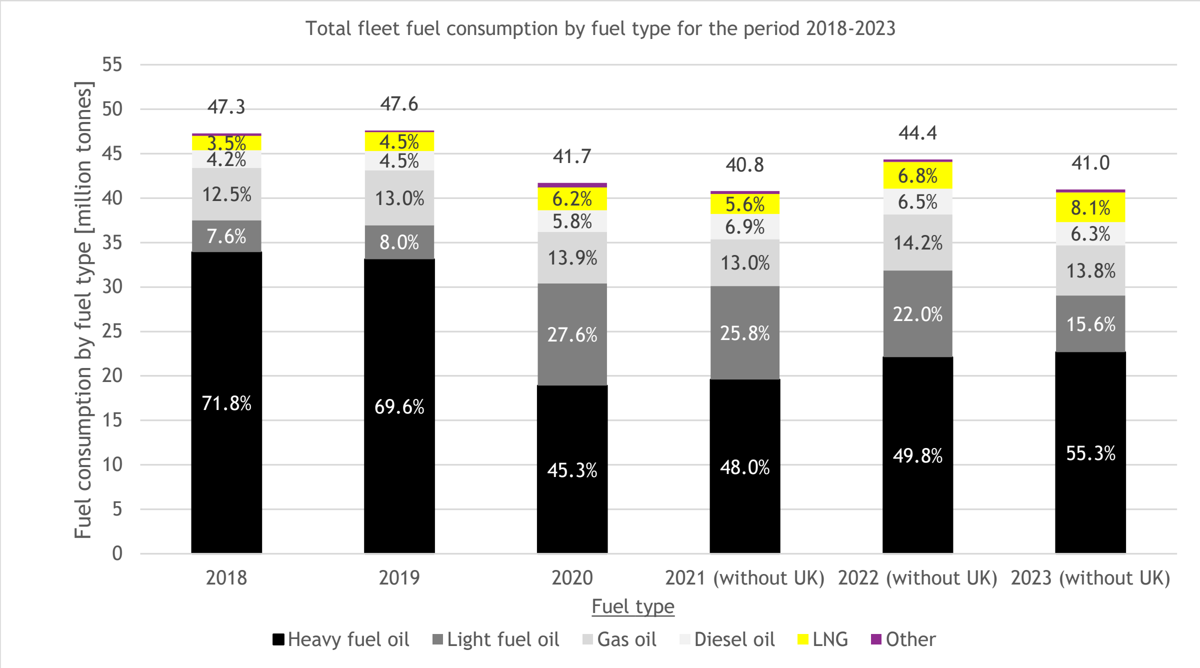

Figure 14: 2018 to 2023 total fuel consumption of EU MRV fleet and shares per fuel type

The analysis of the amount and type of fuel reported over the period 2018-2023 highlights the change in 2020 triggered by the application of MARPOL Annex VI Regulation 14, which set limits on the sulphur content of bunker fuel oils and in particular of some of its requirements becoming stricter at the beginning of 2020[33], leading to a large reduction in the use of Heavy Fuel Oil (HFO) and a significant increase in the use of Light Fuel Oil (LFO), which continued affecting in the following reporting periods. The year 2023, however, further amplified a trend recorded since 2021, namely a gradual increase in the consumption of HFO, almost entirely met by the decrease in the consumption of LFO. Different factors may be driving such a trend, including price changes for marine fossil fuels triggered by the 2022 energy crisis or the increasing uptake of exhaust gas cleaning systems in the fleet (which make possible the use of HFO within the latest IMO sulphur regulations).

In 2023, 91% of the total mass of fuels reported were conventional marine fuels (HFO, LFO, MGO or MDO), the rest being alternative fuels, namely LNG (8.1%), 'other' fuels (0.7%), LPG (0.1%) and methanol (0.02%). For all ship types, except LNG carriers[34], Heavy Fuel Oil (HFO)

[33] 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.

[34] For LNG carriers, LNG accounts for 76% of total reported fuel consumption, followed by HFO (12%), and LFO (6%).

is the fuel type with the highest share of total 2023 fuel consumption. Despite this, the year 2023 clearly shows the acceleration in the uptake of LNG consumption in the MRV fleet, which is likely to continue in the coming years as more of LNG-capable ships currently on the orderbook[35] across different segments enter into operation.

The share of LNG in the fuel consumption of the entire fleet increased every year over the period 2018-2023, with the exception of 2021, because of the reduction of LNG consumed by LNG carriers, in line with the decrease of seaborne LNG imports to Europe. As a result, the amount of LNG consumed by the fleet over the period 2018-2023 more than doubled (i.e.+104%) and its relative share of the total went from 3.5% (2018) to 8.1% (2023).

In 2023 the fuel consumption of LNG carriers, which usually use for propulsion part of the LNG transported as cargo, remained highly dominated by LNG (76% of total fuel consumption in tonnes for the type, the highest share on record). Despite this, the amount of LNG consumed by LNG carriers slightly decreased in absolute terms compared to 2022, as LNG seaborne imports to Europe slightly decreased on the previous year (IGU, 2024). This, combined with the significant increase in the LNG consumption by other ship types, drove the share of LNG carriers in total LNG consumption to the lowest relative value on record, 78% of total reported LNG, as in Figure 15.

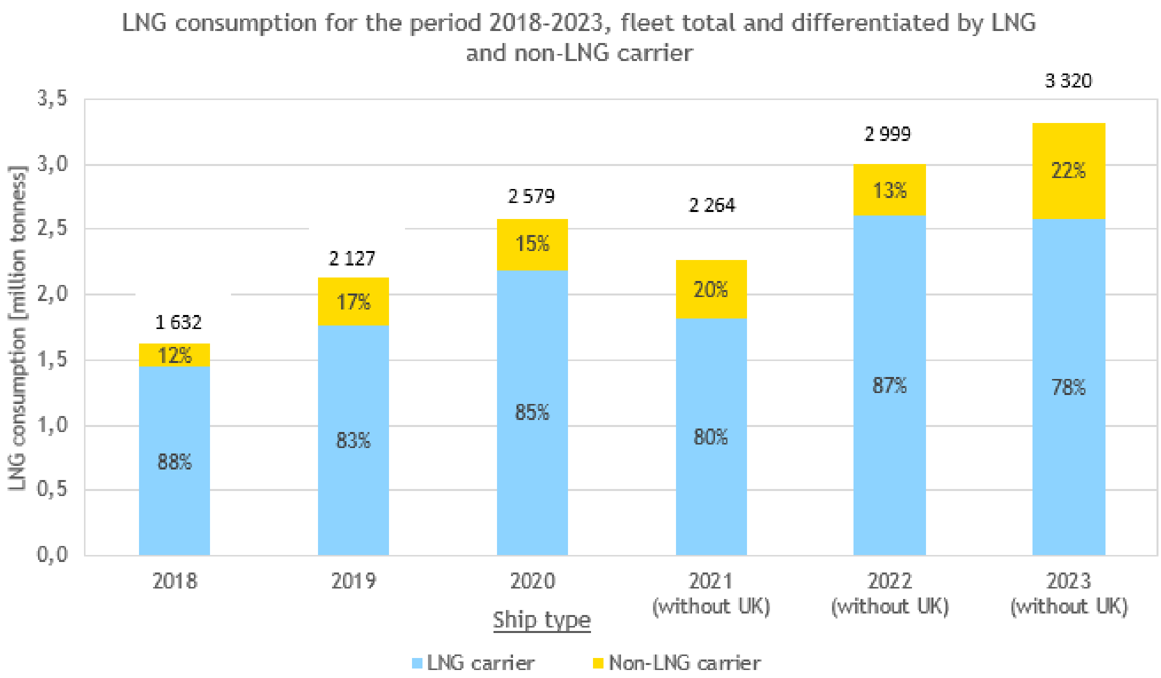

Figure 15: Total LNG consumption and distribution of the consumption over LNG and non-LNG carriers

As shown in Figure 16, beyond LNG carriers all remaining ship types, with the only exception of bulk carriers, reported some LNG consumption in 2023. The increase in LNG consumption compared to 2022 was most prominent for passenger ships (which consumed 6 times more LNG than in 2022), vehicle carriers (which consumed nearly 3 times more), and Ro-Pax ships (which consumed about twice as much LNG than in 2022). Different factors can explained the increased use of LNG in 2023, one being the lower LNG price in 2023 after the market tension experienced in 2022, and another one being the increased use of dual fuel engines that allow

[35] As of June 2024, there were 832 ships on order with the ability to use LNG as propulsion fuel, of which 339 LNG carriers, 171 containerships, 157 vehicle carriers, 93 tankers, 22 cruise ships, and 16 bulk carriers. Measured in gross tonnage, 49.5% of ships on order are designed to be able to operate on alternative fuels (i.e. fuels different from HFO, LFO, MGO or MDO), compared to 7.4% of ships currently in operation. In addition to LNG-capable ships, alternative fuel-capable ships on order include: 10 hydrogen-capable ships, 25 ammonia-capable ships, 96 LPG-capable ships, more than 200 methanol-capable ships, and 433 battery/hybrids ships (DNV, 2024).

ships to be operated on either LNG or conventional liquid marine fuels. In terms of LNG share in the fuel mix by type, LNG plays the larger role for gas carriers (12%), followed by passenger ships (7%), Ro-pax ships (4%), Containerships (2%) and Vehicle carriers (2%). For all other ship types the share of LNG in total fuel consumption reported was 1% or less.

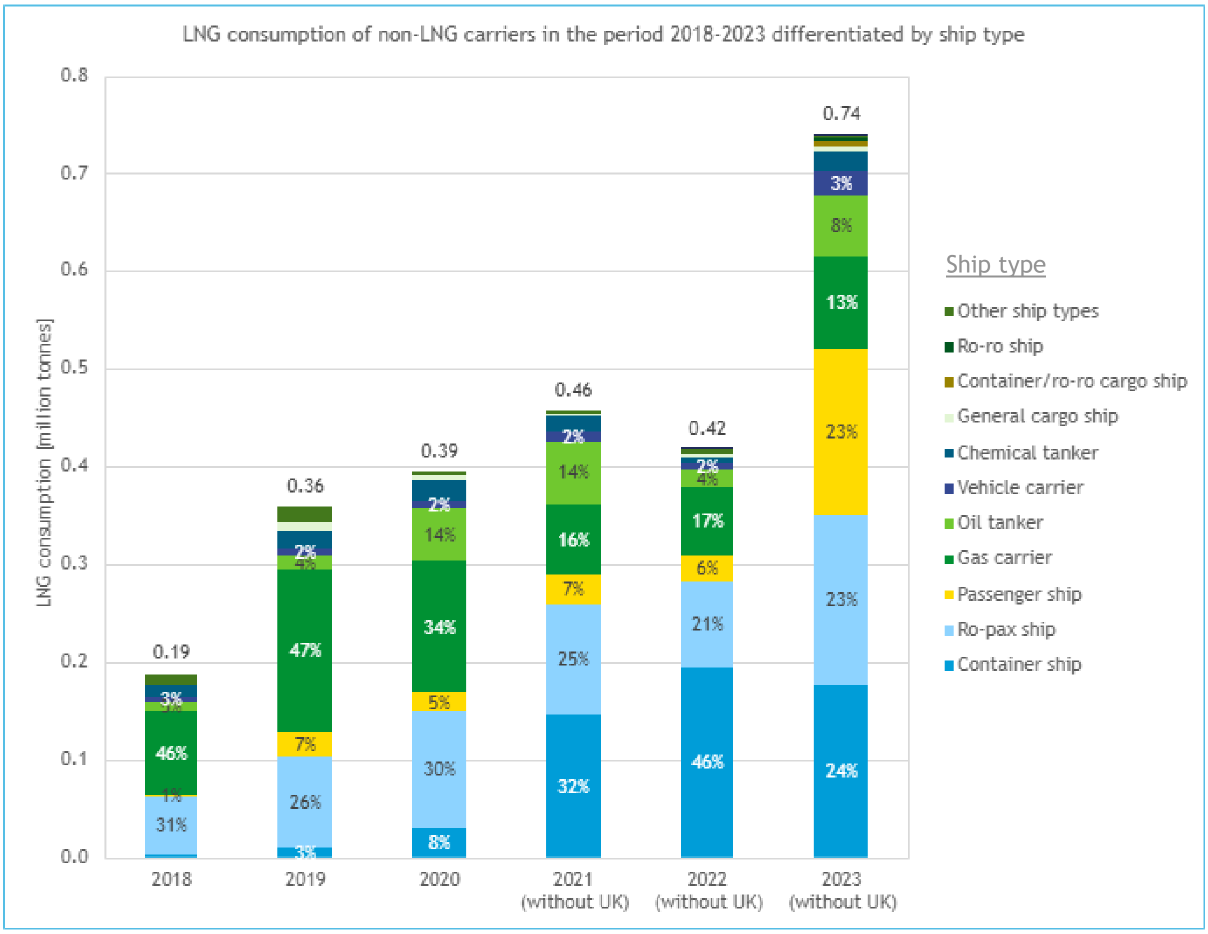

Figure 16: LNG consumed by ship types other than LNG carriers

Consumption of Liquefied petroleum gas (LPG), either as butane or propane, has increased by a third on the previous year and is continuously on the rise since 2020. In relative terms on the overall fuel mix of the MRV, its role remains however very limited, representing around 0.1% of all fuel consumed in 2023 (24 000 tonnes).

The amount of methanol consumption peaked in 2023 at 7 356 tonnes, which represents an increase by around 8% compared to 2022, still accounting only for 0.02% of total fuel consumption in the MRV system. The fleet reporting methanol consumption remains extremely limited, being composed by only 11 ships, out of which eight are chemical carriers (accounting for 90% of total reported methanol). As methanol-capable ships of different types are currently on order, this is expected to change in the coming years, in particular for the containership, bulk carriers, and vehicle carriers segments[36].

No ethanol consumption was reported in 2023, the only year having recorded ethanol consumption being 2020, with only 560 tonnes.

[36] As of June 2024, there were 173 methanol-capable containerships on order as well as 24 bulk carriers and 20 vehicle carriers (DNV, 2024)

Beyond the standard fuel types applied to the MRV reporting for the year 2023[37], ships can report under the category 'Other fuel types' any alternative fuel which do not match the other standard categories. 2020 remains to date the year in which most fuel was reported under this category (0.48 million tonnes), and 2023 recorded levels comparable to the two previous years, with 0.30 million tonnes, i.e. around 0.7% of total reported fuel in the year.

[37] The 2023 revision of the MRV Regulation introduced a different fuel categorization, based on 23 standard fuel types as detailed in Annex I to Regulation (EU) 2015/757. Since Annex I will start being applied to the reporting period 2024, fuel reporting for the year 2023, as analysed in the current report, is not affected by the revision.

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

3.1. Main shipping routes

Similar to what was reported in the previous five annual emission reports, EU MRV data continues to largely corroborate the data provided by Eurostat in terms of EU trade flows by gross weight of freight handled in main ports. The Eurostat data show a high demand for waterborne transport services between the EU and countries such as the United States and neighbouring non-EU countries such as the United Kingdom, Norway and Türkiye.

Table 6 in Annex 3 provides the 15 main extra EU-27 flows by gross weight handled (in millions of tonnes) in main ports in the years 2018 to 2023. Eleven of the flows are inward flows, while four are outward flows.

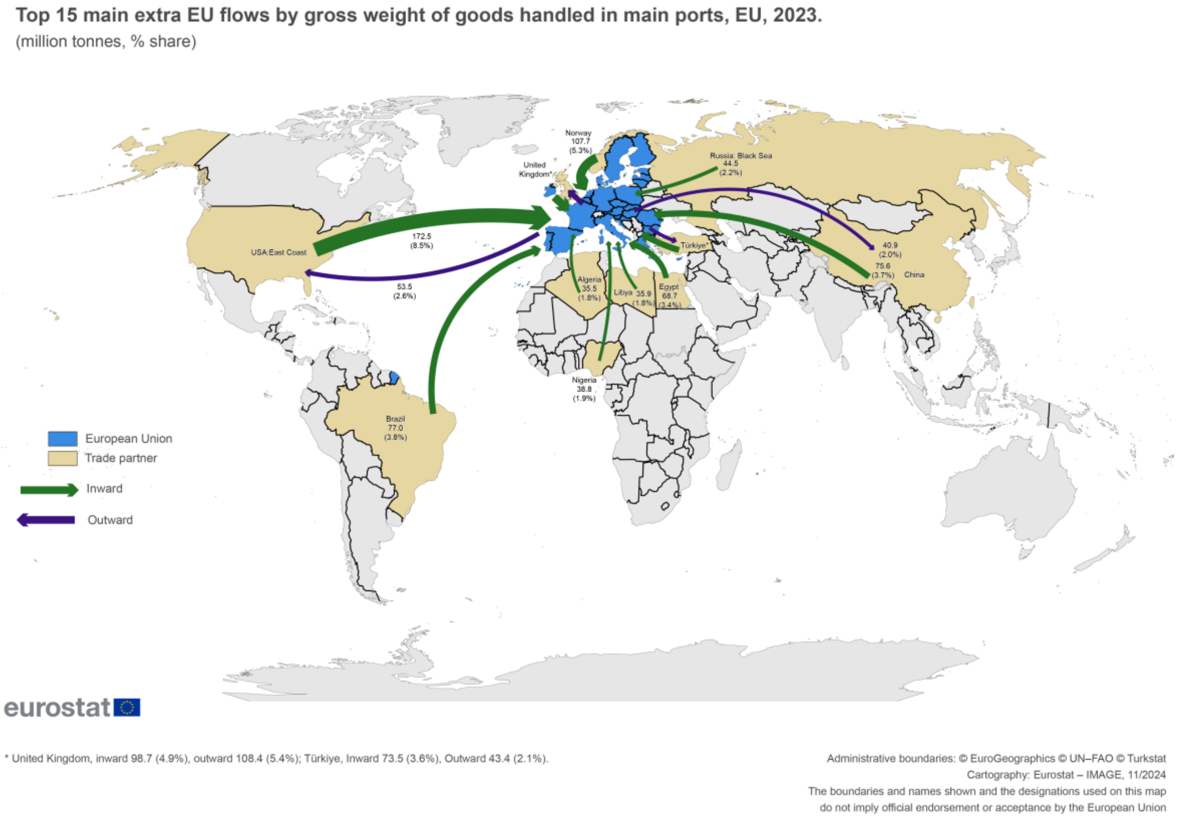

Figure 17: Main extra EU flows; Source: (Eurostat, 2024)

The 15 countries related to these flows remained fairly stable over the last six years however for the first time in this period inwards flows from Algeria exceeded those from Canada, pushing Canada outside the top 15 in 2023. The position of other countries within the top 15 in terms of annual volume of the flow also varies over time. Compared to 2022, inflows from the United States (East Coast), Norway, Brazil, Egypt, Nigeria, Libya, and Algeria increased in 2023. On the other hand, inward flows from the United Kingdom, Türkiye and China decreased in 2023 compared to 2022. Inward flows from Russia (Black Sea) more than halved. Concerning outwards flows, the volumes of goods handled in EEA ports towards the 4 largest flows (United Kingdom, United States, Türkiye and China) is very consistent between 2022 and 2023. Total EU outflows are still dominated by the outward flow to the UK.

3.2. Time spent at sea

The time that ships are active within the scope of the EU Maritime MRV Regulation during a reporting period can be expected to differ between ship types due to their different operational profiles. These differences in operating profiles are visible by comparing the average time at sea (see Figure 18): ship types that often sail according to a regular schedule (such as container ships, passenger ships, Ro-ro/Ro-Pax ships) show a higher average time at sea, while ships types which are most often engaged in tramp trade without a fixed schedule or route (such as bulk carriers and tankers) spend a lower average time at sea within the scope of the EU MRV.

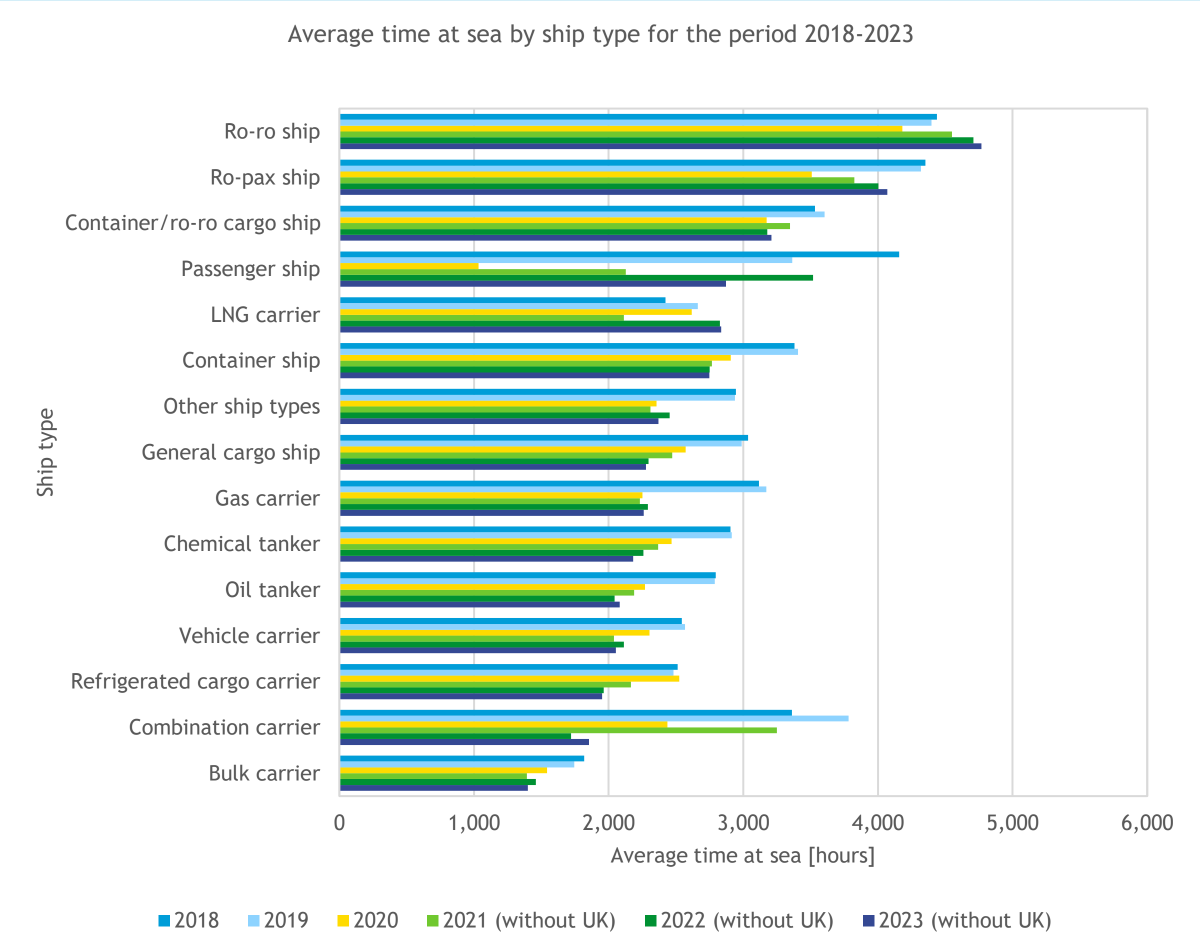

Figure 18: Average time at sea by ship type; 2018-2023; sorted by 2023 average time at sea

Goods shipped by dry bulk carriers are often traded on the spot market, leading to a high fluctuation in the number of individual bulk carriers that are used for trade to/from Europe as well as a high variety in the specific bulk carrier that actually performs the voyage. For instance, a specific bulk carrier may only be chartered for a few voyages to an EEA port in a given year and the rest of the time trade or wait for contracts in other regions of the world.

Lower average time at sea does not only depends on the frequency of port calls in EEA countries, but also on time spent in ports: the longer time a ship may wait in an EEA port in between voyages, the lower the time at sea reported under the MRV system.

In this respect, bulk carriers are most likely to spend days in port without transport activity, as they wait for the next assignment in between short-term contracts. In contrast, ships like Ro-ro, Ro-Pax, and, to a lesser extent, Passenger ships are more likely to consistently call the same (EEA) ports as part of a timetabled route, which does not foresee much idle time/days over the year.

As a result, individual bulk carriers have the lowest average time spent at sea in the EU MRV system[38] whereas Ro-ro ships have the highest average time spent at sea in all reporting years. On the other hand, because bulk carriers are one of the most numerous ship types in the MRV fleet and the long voyages associated with transporting bulk good from all areas of the world, the aggregate total time at sea of the entire bulk carrier fleet is still the highest of all ship types right after container ships.

Changes in the average time at sea for the different ship types across the reporting years can be related to different factors: the amount of idle time[39], shifts in trade patterns within the scope of the EU MRV (e.g. trade on shorter intra-EEA routes), and/or shifts in activity outside of the EU MRV (i.e. an increase in activities falling outside the EU MRV scope will negatively affect the average time at sea reported under the EU MRV scope). Such shifts can be linked to the UK's withdrawal from the EU and/or shifts in the economic activities between regions.

Between 2022 and 2023 the average time spent at sea within the scope of the EU MRV decreased slightly (less than 5%) for 9 out of the 15 ship types (see Figure 18). For passenger ships the decrease was more significant (-18% less average time at sea). This decrease in time spent at sea was met for passenger ships by an increase in at-berth emissions (as presented in Figure 8) as well as the increase in speed (as illustrated in Figure 22). For 4 vessel types, the average time spent at sea increased but only to a small degree (less than 2%), except for combination carriers for which the increase was 7%. The number of ships covered in this ship category is small, never exceeding 15 in the 2018-2023 period, which may explain why the average time spent at sea is among the most variable for this ship type.

3.3 Distance travelled

Figure 19 presents the average distance travelled per ship by type for the period 2018-2023. As for the average time spent at sea, differences are due to the different operational profile by ship type: ships that often sail according to a regular schedule show a higher average distance travelled, while ship types which are most often engaged in tramp trade without a fixed schedule show a lower average distance travelled. During the 2018-2023 period, Ro-Pax and Ro-ro ships consistently recorded the highest average distance per ship within the scope of the MRV Regulation (above 60 000 nautical miles). This is because these ships are likely sailing on a fixed service between EEA ports throughout the year, so all of the distance travelled in the year is reported under the MRV Regulation. In contrast, bulk carriers have had the lowest average distance travelled for all years (except 2020 when many passenger ships lay idle because of COVID-19) because the voyages of bulk carriers serving the tramp market are unpredictable and only the distances travelled on voyages to/from EEA ports is reported under the MRV Regulation.

[38] Except for 2020 when COVID-19 led many passenger ships to lie idle for long periods of time due to leisure travel restrictions.

[39] Time at anchorage is not part of the time at sea.

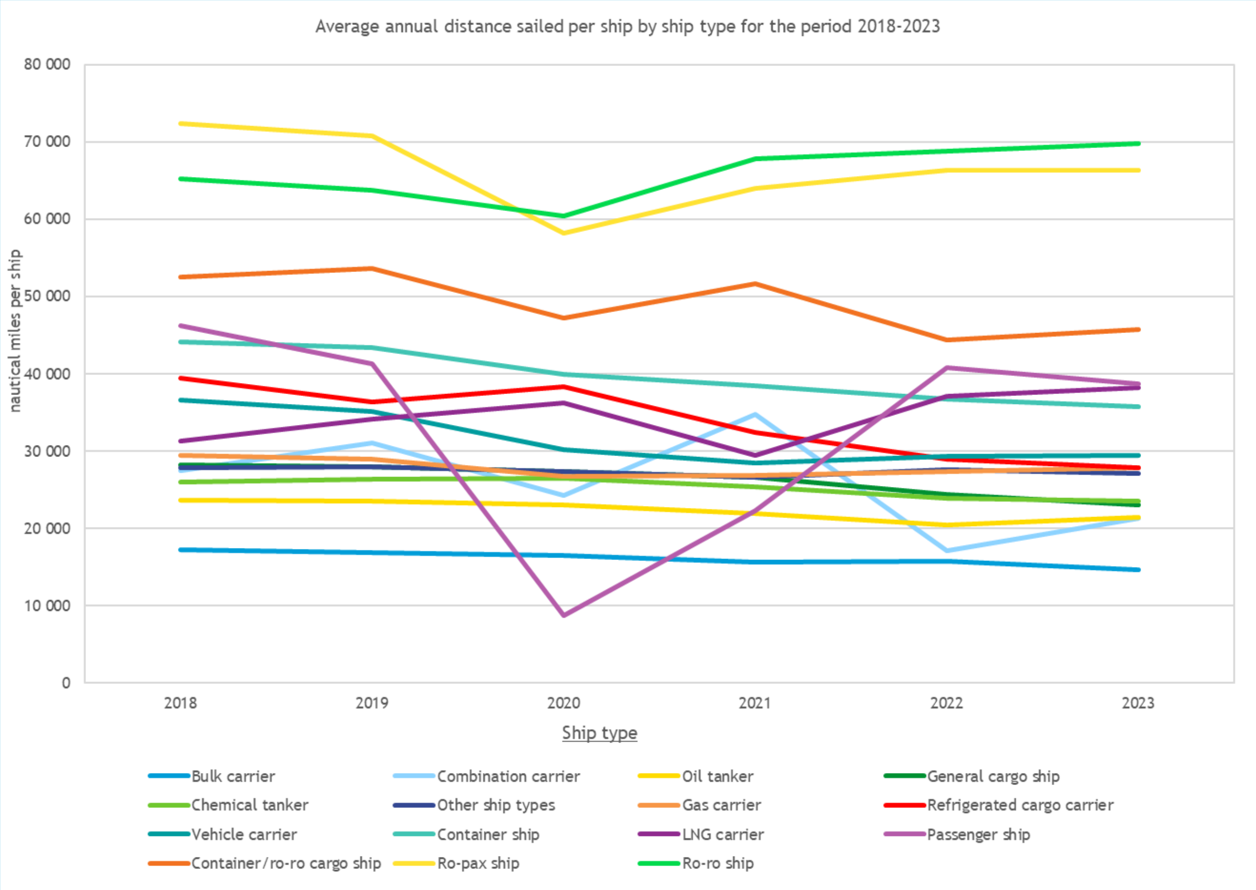

Figure 19: Average annual distance travelled per ship by type of ship for the period 2018-2023

In terms of total aggregated distance travelled by ship type, Figure 20 clearly shows that containerships, bulk carriers and oil tankers have consistently recorded the longest total distances travelled during the 2018-2023 period.

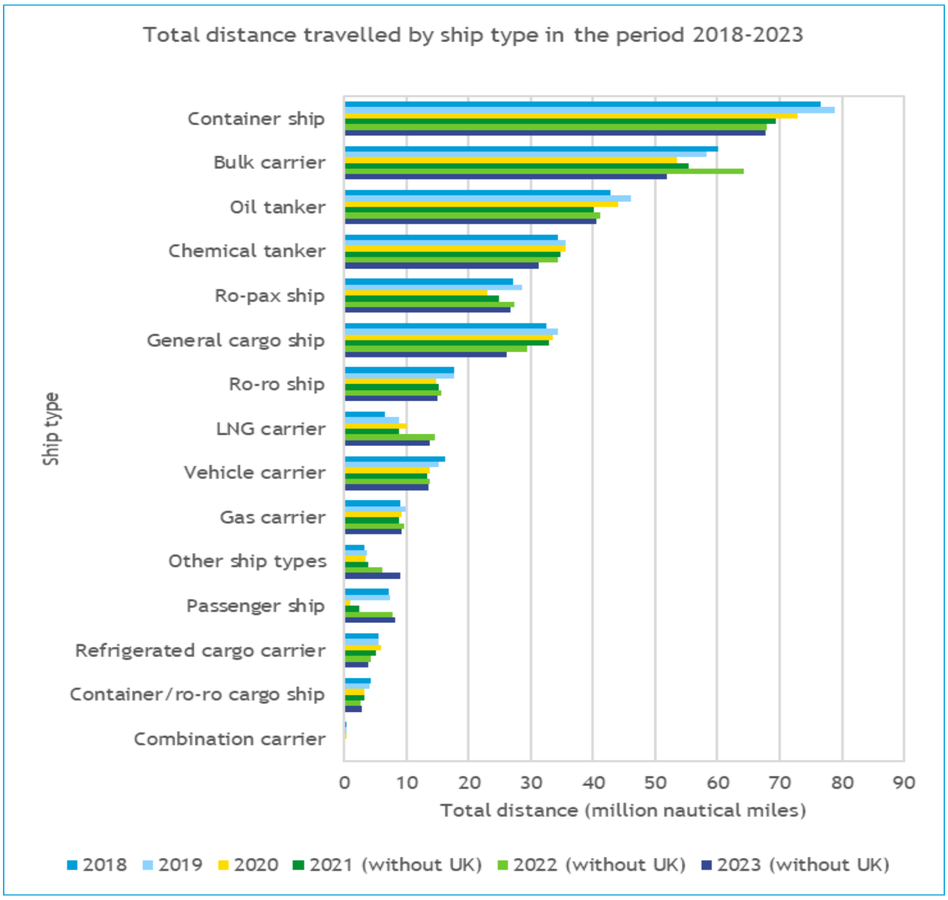

Figure 20: Total distance sailed per ship type 2018-2023

3.4. Fleet speed

The speed at which a ship sails is an important determinant of the ships' operational energy efficiency. By reducing their speed, ships can significantly reduce the fuel consumption of their main engines. Reduced power demand leads, in many cases, to a net reduction of the ships' fuel consumption, and therefore CO_2 emissions, even if the fuel consumption of the ships' auxiliary engines may increase due to longer transit times and/or extra ship capacity has to be used to carry out the same amount of transport work. The CO_2 reduction benefits of reduced speed are likely to be highly variable per ship type and individual ship design but in general, a reduction of the speed of ships can, per unit of time, reduce the energy consumption of the propulsion engines significantly – a 10% speed reduction can, for example, reduce the main engine energy consumption by approximately 27% per hour (CE Delft, 2022) [40].

Speed is a parameter which is difficult to compare between different ship types since ships have different designs and serve different markets[41]. Figure 21 shows the average speeds across ship types for the year 2023.

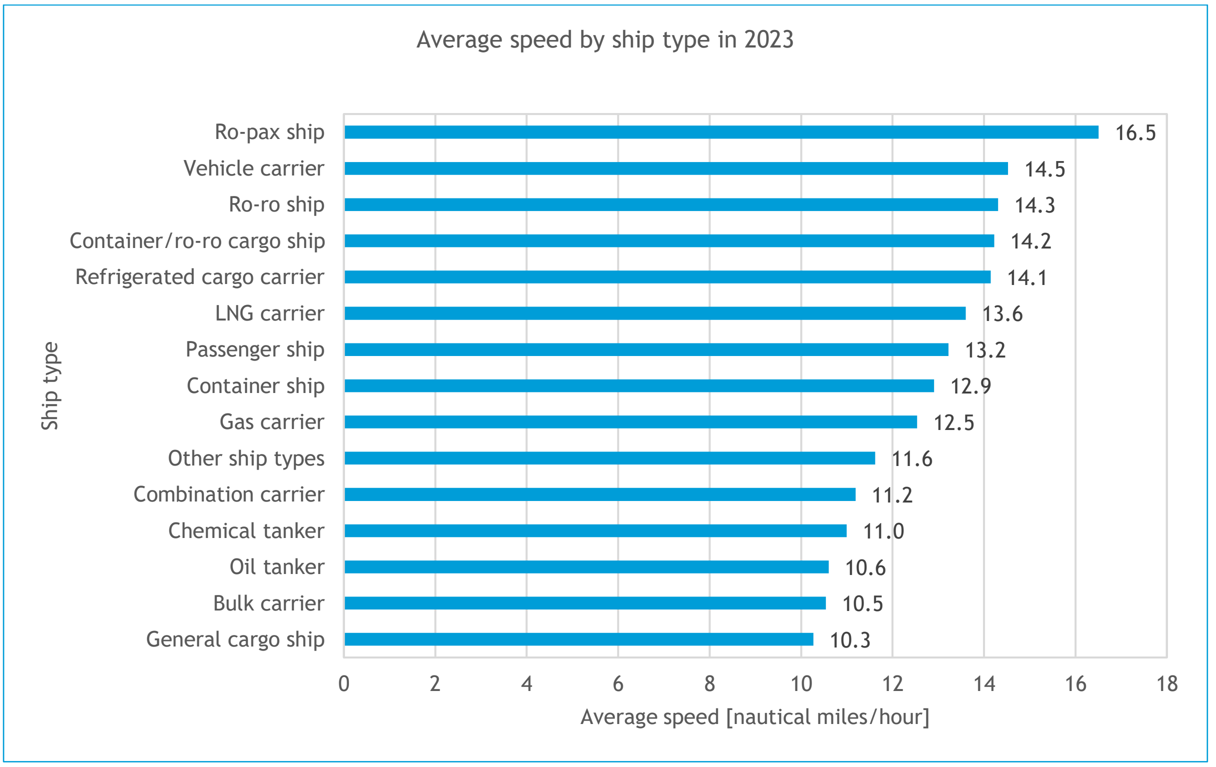

Figure 21: Average speed by ship type; 2023 (without UK); sorted by average speed

[40] It has to be considered, however, that due to the lower speed, ships need more time to cover a certain distance, reducing the main engine energy savings and increasing the energy consumption of the auxiliary engines per voyage. For an exemplary share of the auxiliary energy consumption of 5%/10%/20% in the overall energy consumption, a 10% speed reduction then translates into an overall energy saving of approximately 18%/16%/13%.

[41] Ro-Pax ships and refrigerated cargo ships are, for example, known to sail fast compared to oil tankers or bulk carriers as they serve very different needs.

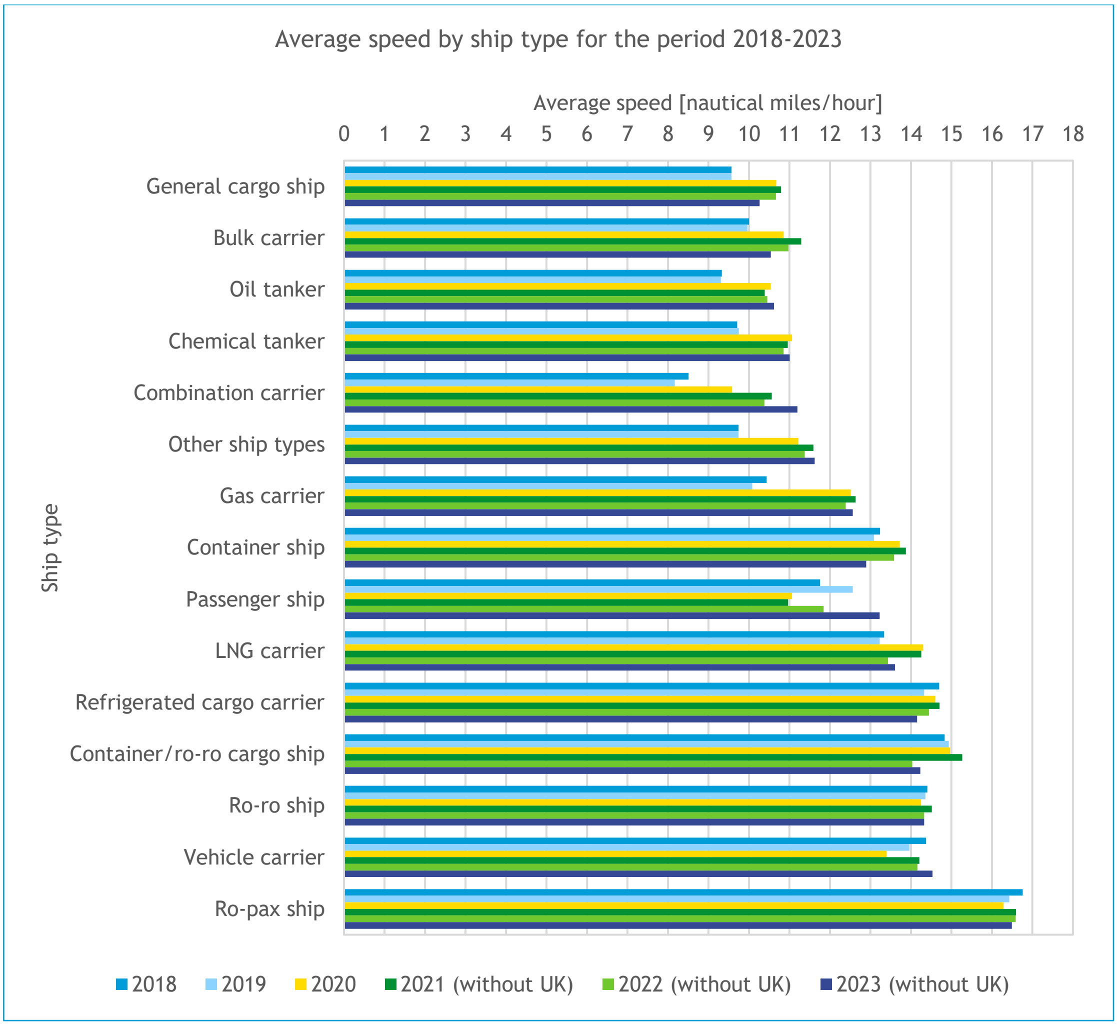

Figure 22: Average speed by ship type; 2018-2023; alphabetical order

Speed variation over time is a relevant indicator to understand the evolution of operational energy efficiency over the analysed period. In this context, the average speed by ship type was calculated based on figures reported by the monitored fleet (time spent at sea and distance travelled). The average speed by ship types over the period 2018-2023, as illustrated in Figure 22, shows that there is no indication of the MRV fleet structurally slowing down during the period. On the contrary, most ship types (10 out of 15 types) recorded higher average speed in 2023 compared to 2018, with some having considerably increased speed, as in the case of combination carriers (+32%), gas Carriers (+20%), other ships (+19%), oil and chemical tankers (+14%), and passenger ships (+13%). Over the six available reporting years, the largest difference between the highest and lowest average speeds was observed for gas carriers and combination carriers as these two ship types considerably increased speed after 2019 (by more than 2.5 knots), while the smallest different was recorded for ro-ro ships and refrigerated cargo carriers (less than 0.6 knots).

The comparison of the average speed recorded in 2023 on the year 2022 highlights a marginal increase in speed (in the range of 1-2%) for most ship types while passenger ships (+11%) and combination carriers (+7%) stood out for a considerable increase. The types with the highest decrease in speed in 2023 on the previous year were containerships (-5%), bulk carriers (-4%), and general cargo ships (-4%).

4. Technical and operational efficiency of the monitored fleet

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. For all the indicators in this section, the lower the value, the higher the efficiency of the ship.

The year 2023 represents the sixth reporting year of the EU MRV system. As such, a substantial amount of data on reporting ships has become available, allowing for an assessment of the evolution of both the technical and operational efficiency of the monitored fleet, and also the robustness of the reported data.

As in previous years, such an analysis was carried out by means of a graphical analysis, plotting the relevant indicators per ship type against the cargo carrying capacity. This year's analysis, the most representative results of which are shown in Annex 4, further corroborates two key findings which were highlighted in the fifth annual report: (1) The completeness and correctness of the reported data, which has been clearly improving over time, confirmed by the subsequent data correlation values' gradual increase, particularly when comparing the initial 2018 with 2023; (2) as in previous years, technical and operational efficiency trends did not significantly change, as shown by the different reporting periods' regression curves overlap (as shown in Annex 4).

Combining the above observations, it can be concluded that the sixth MRV reporting year confirms the consistency of reported data, and therefore the increasing robustness of the monitoring, reporting and verification framework for maritime transport.

4.1. Technical efficiency

4.1.1. Overview

The MRV Regulation requires ships to report their technical efficiency. This can be done through three indicators depending on the type and year of build of the ship: the Energy Efficiency Design Index (EEDI), the Energy Efficiency Existing Ship Index (EEXI) or the Estimated Index Value (EIV)[42].

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 built after 1 January 2013 or 1 January 2015 [43] need to meet the minimum EEDI requirements in terms of CO_2 per capacity nautical mile (CO_2/t*nm). The EEDI requirements become more stringent over time, also depending on ship type and size. From January 2023, the EEXI applies to all ships in international shipping of 400 GT and above. The EEXI is implemented at the IMO level and is similar to the EEDI in terms of the formula used to calculate the index, however, the EEXI applies to existing ships and not only newbuilds[44]. For ships that were previously subject to the EEDI from newbuilding, the attained EEDI value can be taken as the attained EEXI provided that it is equal or less than the required EEXI value for the ship type and size[45]. The EEDI

[42] A fourth, residual, possibility, i.e. report the entry 'not applicable', but only applies to a minority of ship types.

[43] Depending on the ship type and size.

[44] This is required for ships subject to the EEXI requirement on the basis of MARPOL, Annex VI, Chapter 4, Regulations 22.

[45] See Marpol Annex VI Regulation 23.3 (Attained EEXI)

required values can be less strict than the required EEXI values, depending on the date of construction and corresponding EEDI phase.

The EIV is a simplified version of the EEDI and EEXI to be reported for certain ship types which are out of scope of EEDI or EEXI.

Specific EU MRV reporting requirements regarding the technical carbon efficiency of ships are as follows (European Commission, 2024):

- The attained EEDI and EEXI has to be reported where required by and in accordance with MARPOL Annex VI, Regulations 22 and 23.[46]
- The EIV has to be reported for ships not covered by the EEDI or the EEXI (for example due to ship size) but which are ship types as listed in:
  - MEPC.231(65), paragraph 3: bulk carrier, gas carrier, tanker, containership, general cargo ship, refrigerated cargo carrier, combination carrier, ro-ro cargo ship, ro-ro cargo ship (vehicle), ro-ro passenger ship and LNG carrier.
  - MEPC.233(65), paragraph 5: cruise passenger ships having non-conventional propulsion, including diesel-electric propulsion, turbine propulsion, and hybrid propulsion systems.
- Ships of ship types not covered by the above MARPOL Annex VI Regulations or MEPC Resolutions are not required to report their technical efficiency which explains why for some ships the 'not applicable' value was entered in the technical efficiency section.

In 2023, a total of 2 459 ships reported their EEDI, 6 091 reported their EEXI and 2 924 reported their EIV (with an additional 279 'not applicable' reports). This is quite different to 2022 when a total of 4 232 ships reported their EEDI and 8 423 ships reported their EIV (with an additional 300 'not applicable' reports). The difference can be explained by the introduction of the EEXI measure which had to be reported for the first time in 2023. This lead many ships which previously reported their EIV (being a ship type covered by the EEDI but delivered before the IMO requirements started) to report their EEXI instead. The decrease in the number of ships reporting their EEDI can also be explained by ships instead reporting their EEXI.

4.1.2. Evolution of the Technical Efficiency of the monitored fleet

The technical efficiency of the monitored fleet was further analysed by means of a graphical analysis, by plotting EEDI and EIV values[47] against a ship's capacity (DWT or Gross Tonnage). Regression curves with R2-values have then been calculated. Similarly to previous years, **technical efficiency trends did not significantly change**, as shown by the different reporting periods' regression curves shown in Annex 4. These overlap for the most representative ship types in the monitored fleet, for which a high correlation between the technical efficiency index value and the carrying capacity was recorded. In addition, an improvement in correlation values is visible for the overall period 2018-2023, across different ship types.

As a representative example, the graph below shows the EIV's graphical analysis for bulk carriers. Robust R2 correlation values were calculated (above 0.6) for a total of nine ship types, representing 74% of total emissions reported in 2023. The graphs produced for this analysis, showing the most significant values, are presented in Annex 4.

[46] 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.

[47] EEXI values were not part of the graphical analysis since 2023 was the first year in which EEXI was reported.

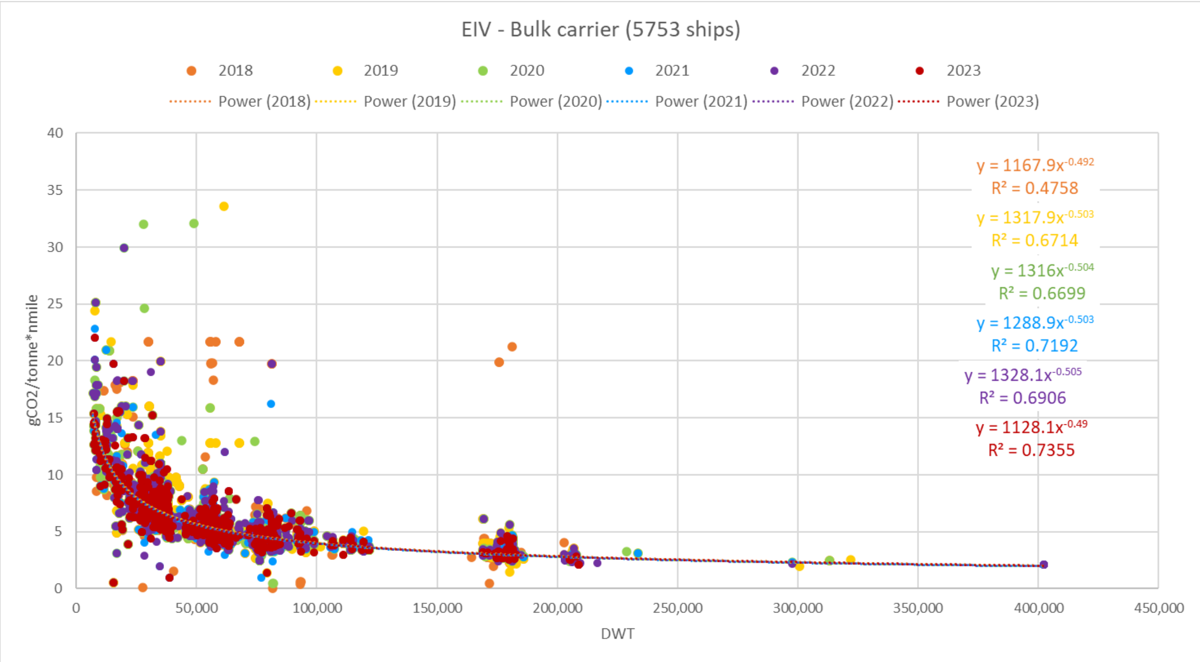

Figure 23: Plot of attained EIV values for bulk carriers over the reporting years and associated trendlines

4.2. Operational efficiency

4.2.1. Overview: EEOI and AER

According to the EU MRV Maritime 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 [48];
3. CO_2 emissions per distance;
4. CO_2 emissions per transport work (also referred to as Energy Efficiency Operational Indicator (EEOI)).

which are calculated as follows:

1. $$\text{Fuel consumption per distance} = \frac{\text{Total annual fuel consumption}}{\text{Total distance travelled}}$$

2. $$\text{Fuel consumption per transport work} = \frac{\text{Total annual fuel consumption}}{\text{Total transport work}}$$

[48] Transport work expresses the product of distance travelled per the amount of cargo carried over the period. For an overview of the metrics applied under the EU MRV to the different ship types, see Table 10 in Annex 4.

3. $$CO_2 \text{ emissions per distance} = \frac{\text{Total annual } CO_2 \text{ emissions}}{\text{Total distance travelled}}$$

4. $$CO_2 \text{ emissions per transport work} = \frac{\text{Total annual } CO_2 \text{ emissions}}{\text{Total transport work}}$$

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 applies 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 Energy Efficiency Operational Indicator (EEOI) is defined, in its most simple form, as the ratio of mass of CO_2 emitted per unit of transport work. As it varies according to the actual cargo carried, this indicator reflects the carbon intensity of the transport service rendered by each individual ship. Thus, it is highly influenced by the actual loading of vessels (including ballast voyages). Keeping everything else equal, ships with higher payload utilisation will therefore benefit from a lower EEOI.

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 operational efficiency at ship type level and 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*nautical 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.

4.2.2. Evolution of the operational efficiency of the monitored fleet

The evolution of the operational efficiency of the fleet was analysed by means of a graphical analysis, applied to both EEOI and AER indicators. To this end, the AER and EEOI per ship type have been plotted against the cargo carrying capacity (in DWT, GT or both). Regression curves with R2-values have then been calculated.

The analysis highlights that, also in 2023, the operational efficiency trends did not significantly change, as shown by the different reporting periods' regression curves overlap, resulting from the currently established technological and commercial status-quo of the maritime trade.

As a representative example, the graph below shows the EEOI graphical analysis for gas carriers. Ten ship types have shown robust R2 correlation values (above 0.6), representing 84% of total reported emissions in 2023. The graphs for the most significant ones are grouped in Annex 4.

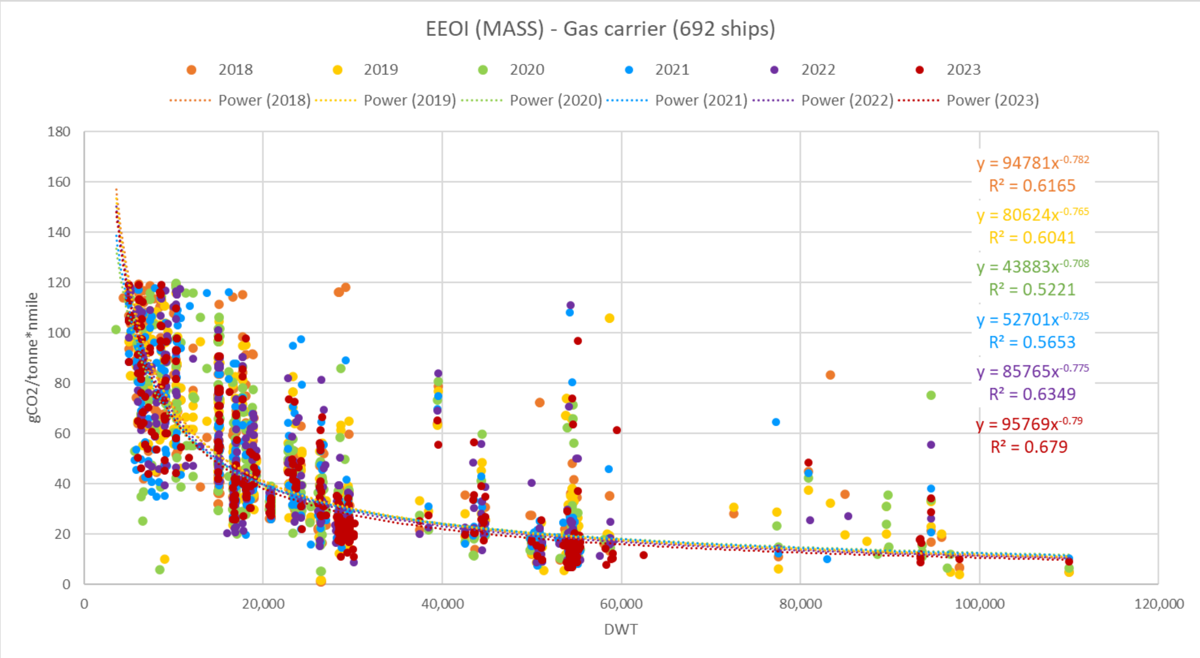

Figure 24: Plot of attained EEOI values of gas carriers over the reporting years and associated trendlines

5. Assessing the implementation of the EU Maritime MRV Regulation

With the aim of continuous improvement in the implementation of the EU maritime MRV Regulation, the Commission and the European Maritime Safety Agency support shipping companies and verifiers through different means, including guidance documents, webinars, and dedicated functional helpdesks. Periodic meetings are also organised through the year in which outstanding issues concerning the Regulation's implementation can be discussed.

5.1 Quality and completeness of submitted data

5.1.1 Outliers

Some of the verified emissions reports include a few outliers, i.e. relatively easily identifiable, obvious mistakes.[49] Figure 25 shows that both the number of emissions reports containing one or more outliers and the impact of outliers on total fleet CO_2 emissions has been consistently decreasing over the period 2018-2023, recording its lowest level in 2023. Only 54 reports (0.44% of total reports) contained one or more outliers in 2023, down from 465 (4% of total reports) in 2018, with the few outliers reported in 2023 concerning data elements which have no impact on the levels of reported emissions[50]. The emissions reports containing outliers accounted for only 0.16% of total reported emissions in 2023.

In 2023, 14 verifiers verified emissions reports containing 1 or more outliers and only 4 verifiers processed more emissions reports containing outliers compared to 2022.

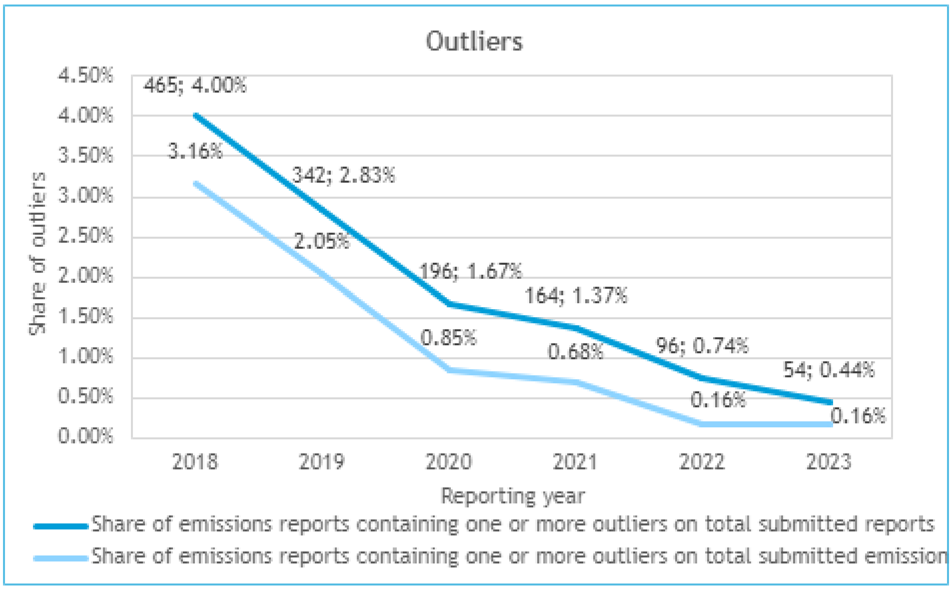

Figure 25: Quality of submitted data, impact of outliers

[49] Across the whole present report, in view of ensuring the accuracy of data, clear outliers identified during the analytical process have been discarded, as in previous years.

[50] Most of detected outliers concern ship (e.g. size) or cargo (e.g. split ballast/laden) details.

5.1.2 Non-compliant emissions reports and revisions

After the first reporting year, for which 149 cases were recorded, the number of initially non-compliant emission reports has continuously decreased over the years, down to only one case in 2023. The number of revisions required after first submission of the emissions report to the verifier has continuously decreased over time, accounting only for 40% of total submitted reports (down from 90% in 2018).

5.2 Punctuality

For the EU MRV reporting period 2023, shipping companies had to submit their verified emissions report to the Commission and the flag State by 30 April 2024. Only 53% of the emissions reports were submitted to the Commission by the deadline, a value in line with 2022 but notably lower than the highest one recorded in 2021 (65%). The share of emissions reports submitted by shipping companies for verification to the verifiers prior to the end of April has also worsened, down to 73% in 2023 from 80% in 2018.

The data over the period 2018-2023 confirms that the submission to the European Commission of a large share of verified emissions reports is often finalised after the deadline of 30 April, which still allows companies to obtain a valid document of compliance by 30 June, when the document of compliance of the previous compliance cycle is set to expire. By that date, 88% of the emissions reports for 2023 were submitted to the European Commission, which is lower than what recorded in 2021 (91%).

The worsening of punctuality indicators in respect of the reporting period 2023 can be explained by the considerable workload on shipping companies and verifiers brought by the revision of the existing monitoring plans (due by 1 April 2024) triggered by the entry into application of the new monitoring and reporting rules in 2024[51].

[51] As a consequence of the revision of the Maritime MRV system adopted with Regulation (EU) 2023/957, OJ L 130, 16.5.2023, p. 105, http://data.europa.eu/eli/reg/2023/957/oj.

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Annex 1 Abbreviations and definitions

Table 2 Abbreviations and definitions

Abbreviation	Meaning
AER	Annual Efficiency Ratio
AFIR	Alternative Fuels Infrastructure Regulation
BDN	Bunker Delivery Note
CII	Carbon Intensity Indicator
DCS	Data Collection System
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
GT	Gross tonnage
HFO	Heavy Fuel Oil
IAPP	International Air Pollution Prevention
IGU	International Gas Union

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
PSC	Port State Control
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)
SEEMP	Ship Energy Efficiency Management Plan
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).
UNCTAD	United Nations Conference on Trade and Development
VLSFO	Very Low Sulphur Fuel Oil

Annex 2 Outcomes of the sixth compliance cycle

A.2.1 Fuel/emissions monitoring methods

Under the EU MRV Regulation, companies can apply 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). Ships can also apply a combination of these methods.

Table 3 Fuel monitoring methods

Share of ships that have applied method A-D alone or in combination; 2018 to 2023

	2018	2019	2020	2021	2022	2023
A	48%	51%	51%	51%	54%	56%
B	34%	32%	32%	31%	29%	33%
C	33%	30%	31%	31%	31%	30%
D	0%	0%	0%	0%	0%	0%
Ships applying one method only	85%	86%	87%	87%	87%	82%
Ships applying more than one method	15%	14%	13%	13%	13%	18%
Ships applying methods A and B	3%	3%	3%	2%	2%	3%
Ships applying method C only	21%	20%	20%	20%	20%	15%

A.2.2 Verifiers and National Accreditation Bodies

In the reporting period 2023, 19 different accredited verifiers performed verification activities required for the shipping companies' compliance with the EU Maritime MRV Regulation. The five largest of the verifiers covered around 72% of the emissions reports that were submitted in 2023. Eight different national accreditation bodies (NABs) have accredited the 19 verifiers active in the 2022 reporting period. Three of these NABs have accredited more than one verifier.

4 of the 19 verifiers are not located in an EEA country (see Table 5) and the highest number of verifiers is located in Greece (6 out of the 19).

Table 4 Number of verifiers accredited per National Accreditation Body

Number of verifiers accredited per National Accreditation Body in 2018 to 2023*

	National Accreditation Body	2018	2019	2020	2021	2022	2023
1	ACCREDIA – IT	1	2	1	1	1	2
2	COFRAC - FR	3	3	2	2	2	2
3	Croatian Accreditation Agency – HR	1	1	1	1	0	0
4	German Accreditation Body (DAkkS) – DE	5	5	5	5	5	5
5	The Danish Accreditation Fund (DANAK) – DK	0	0	0	1	0	0
6	Dutch Accreditation Council (RvA) - NL	1	1	1	1	1	1
7	Hellenic Accreditation System (ESYD) – EL	6	5	5	5	6	6
8	Polish Centre for Accreditation (PCA) – PL	1	1	1	1	1	1
9	Portuguese Institute for Accreditation (IPAC) – PT	1	1	1	1	1	1
10	Swedish Board for Accreditation and Conformity Assessment (Swedac) - SE	1	1	1	1	1	1
11	The United Kingdom Accreditation Service (UKAS) - UK	1	1	1	1	1	0
	Total	24	21	19	20	19	19

*Verifiers with the same accreditation number are considered as one verifier.

Table 5 Number of verifiers

Number of verifiers per country in 2018 to 2023

	Country	2018	2019	2020	2021	2022	2023
1	Croatia	1	1	1	1	0	0
2	France	2	2	2	2	2	2

3	Germany	3	3	3	3	3	3
4	Greece	6	5	5	5	6	6
5	Italy	1	1	1	1	1	1
6	Poland	1	1	1	1	1	1
7	Portugal	1	1	1	1	1	1
8	Sweden	1	1	1	1	1	1
9	United Kingdom	4	2	0	0	0	0
10	China	1	1	1	1	1	1
11	India	1	1	1	1	1	1
12	Japan	1	1	1	1	1	1
13	Republic of Korea	1	1	1	1	1	1
14	Russian Federation	0	0	0	1	0	0
	Total	**24**	**21**	**19**	**20**	**19**	**19**

A.2.3 Port State Control inspections

According to Article 19(2) of the EU MRV Regulation (2015/757) each Member State shall ensure that any inspection of a ship in a port under its jurisdiction carried out following Directive 2009/16/EC includes checking that a valid MRV Document of Compliance (DoC) is carried on board. Figure 26 provides an overview of the number and the outcome of the inspections of the MRV DoC during Port State Control (PSC) inspections in EEA Member States for the period 2019-2024 [52], which refers to the six compliance years associated to the reporting years 2018-2023.

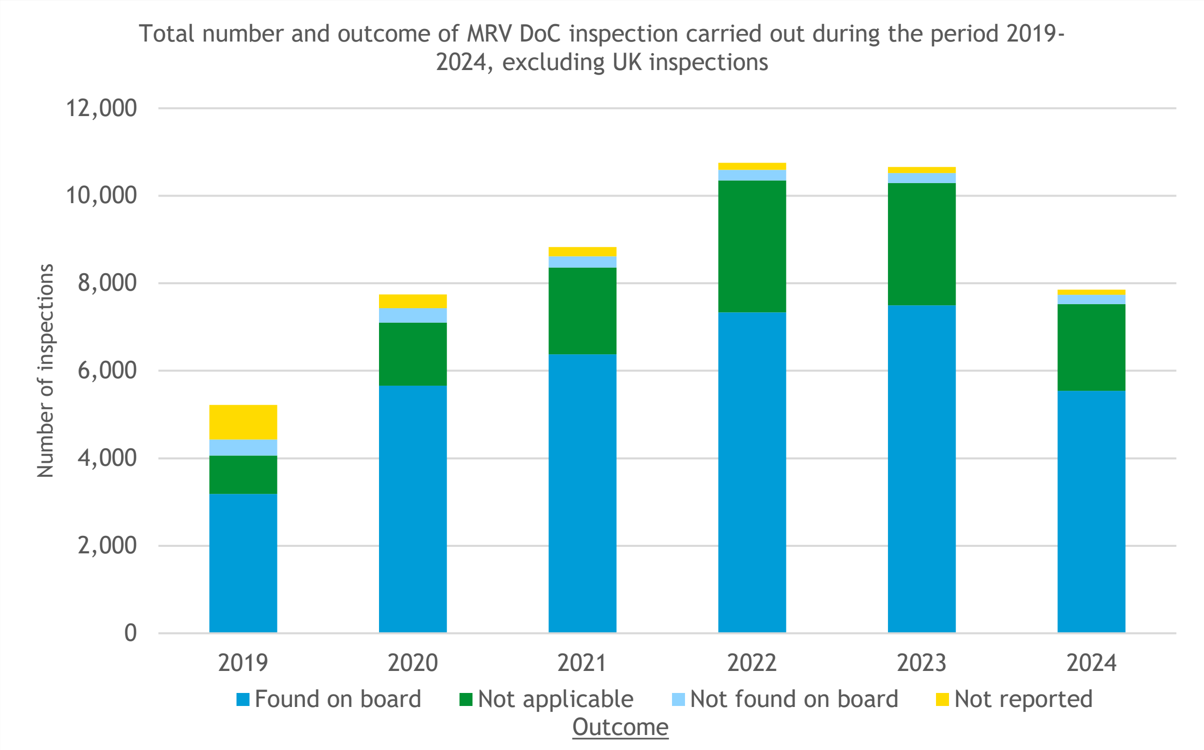

Figure 26: Total number and outcome of MRV DoC inspection as part of PSC inspection over the period 2019-2023

During the compliance checks carried out in respect of the first six reporting years, up to October 2024, 51 060 ships were inspected to confirm the presence of valid MRV DoC on board the ship. 70% of these ships were able to present a valid DoC, while 24% of the ships were not required to carry a valid MRV DoC onboard. On aggregate, over the six compliance cycles, only 3% of the inspected ships could not produce a valid DoC[53] . The yearly share of ships for which a valid DoC was not found onboard has considerably decreased after the first two compliance years, during which much higher values were registered (7% in 2019 and 4% in 2020) and is currently stabilised below/around 2/3%.

[52] The date includes the dataset available at the time of writing, thus referring to inspections carried out from January 2019 to early October 2024.

[53] The value 'not reported' refers to cases where the PSC inspector did not declare the outcome of the inspection with respect to the MRV DoC. Those accounted for around 3.5% of inspected ships over the period.

Annex 3 Main extra-EU flows

Table 6 provides the top 15 extra EU-27 flows by gross weight handled in main ports over the years 2018 to 2023, in millions of tonnes. Eleven of the flows are inward flows, while four are outward flows. The 15 countries related to these flows remained fairly stable over the last six years however for the first time in this period inwards flows from Algeria exceeded those from Canada, pushing Canada outside the top 15 in 2023. The position of other countries within the top 15 in terms of annual volume of the flow also varies over time. Compared to 2022, inflows from the United States (East Coast), Norway, Brazil, Egypt and Nigeria increased in 2023. On the other hand, inward flows from the United Kingdom, Russia (Baltic Sea), Türkiye and China decreased in 2023 compared to 2022. Inward flows from Russia (Black Sea) more than halved. Concerning outwards flows, the volumes of goods handled between the four countries is very consistent between 2022 and 2023.

The top maritime flows in goods were, in declining order, inward flows of goods from the East Coast of the United States – East Coast (8.5% of the total extra-EU seaborne transport in 2023), the outward flow to the United Kingdom (5.4%), the inward flows from Norway (5.3%), the United Kingdom (4.9%), Brazil (3.8%), China (3.7%), Türkiye (3.6%), Egypt (3.4%), the outward flow to the East Coast of the USA (2.6%), and the inward flow from the Black Sea area of Russia (2.2%).

Table 6 Top 15 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	2021	2022	2023
Inward flows to EU ports from non-EU ports						
USA: East coast	91,3	106,5	100,0	106,0	147,4	172,5
NORWAY	86,0	90,0	80,7	81,8	89,7	107,7
UNITED KINGDOM	105,0	104,8	108,9	101,1	106,5	98,7
BRAZIL	86,5	76,2	68,5	74,6	76,3	77,0
CHINA	61,6	65,9	61,6	72,1	79,1	75,6
TÜRKIYE	73,2	82,2	81,3	92,2	88,7	73,5
EGYPT	50,0	54,2	47,5	44,4	54,1	68,7
RUSSIA: BLACK SEA	78,6	81,3	83,2	79,3	71,6	44,5
NIGERIA	35,0	46,2	39,4	34,4	32,7	38,8
LIBYA	28,1	28,0	9,1	32,9	26,3	35,9
ALGERIA	25,7	28,4	27,6	27,8	25,1	35,5
Outward flows from EU ports to non-EU ports						
UNITED KINGDOM	114,0	108,3	101,6	117,7	109,9	108,4
USA: East coast	52,6	53,3	47,5	57,1	54,2	53,5
TÜRKIYE	46,1	48,0	48,9	49,2	45,5	43,4
CHINA	42,0	51,2	57,4	53,7	41,2	40,9

Source: Eurostat (2024)

Annex 4 Technical and operational efficiency of the monitored fleet

A.4.1 Technical efficiency (related to Section 4.1.1.)

Table 7 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 7 Number of ships which reported their EEDI, EIV or 'not applicable' in 2023

Technical efficiency indicators reported per ship type

Ship type	# of ships which reported their EEDI in 2023	# of ships which reported their EEXI in 2023	# of ships which reported their EIV in 2023	# of ships that reported 'Not applicable' in 2023
Bulk carrier	906	1 595	885	25
Chemical tanker	404	547	307	19
Combination carrier	0	2	4	0
Container ship	212	1 384	213	3
Container/Ro-ro cargo ship	9	13	35	0
Gas carrier	74	192	51	1
General cargo ship	136	504	359	5
LNG carrier	84	190	78	1
Oil tanker	515	911	381	11
Other ship types	2	10	142	129
Passenger ship	31	156	7	11
Refrigerated cargo carrier	11	70	51	0
Ro-Pax ship	12	140	196	32
Ro-ro ship	15	135	59	0
Vehicle carrier	48	242	156	0
Total	**4 459**	**6 091**	**2 924**	**237**

Evolution of the Technical Efficiency of the monitored fleet – graphical analysis

The figures below plot the Estimated Index Value (EIV) and Energy Efficiency Design Index (EEDI) values for nine ship types in the six reporting years (2018 to 2023) against the size of the relevant ships measured in deadweight tonnage (see dots with a different colour per year). As in previous annual reports, only graphs with robust R2-indicator (>0.6) for the correlation between EEDI/EIV and the respective cargo carrying capacity have been included in this report.

The EIV/EEDI trendlines for 2018 to 2023 for the following ship types clearly overlap, which indicates that the technical efficiency of these subsegments of the fleet has not significantly changed. The ship types included in this graphical analysis represents in emissions terms, 74% of total reported emissions in 2023.

The correlation values are generally increasing over the years, with nearly all ship types showing a higher correlation value in 2023 than in 2018.

The ship types for which the sample is too small (below 25 occurrences) or the regression line not reliable enough to draw conclusions (e.g. due to high variability/scatter) have not been shown.

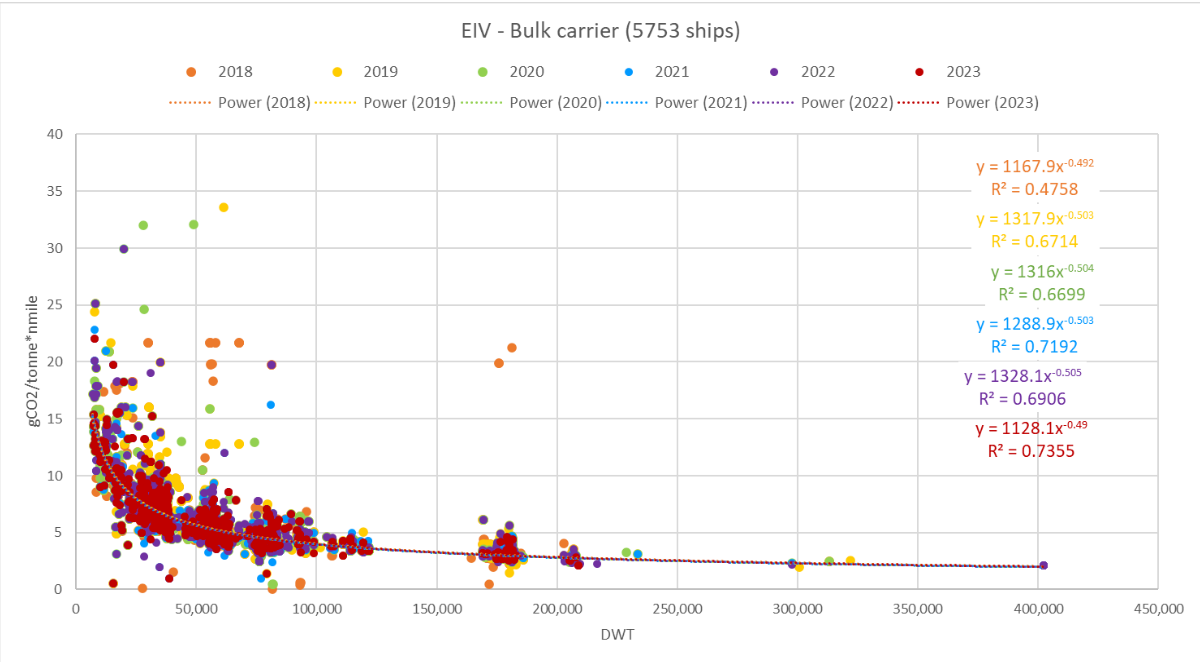

Figure 27: Plot of attained EIV values of bulk carriers over the reporting years and associated trendlines

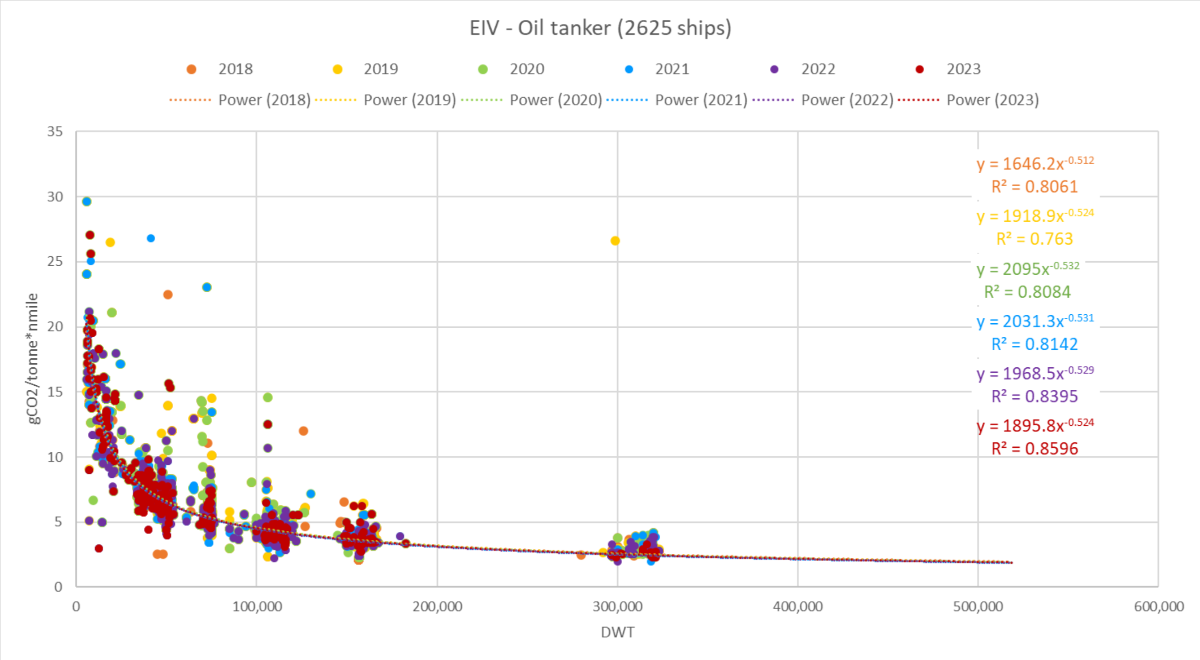

Figure 28: Plot of attained EIV values of oil tankers over the reporting years and associated trendlines

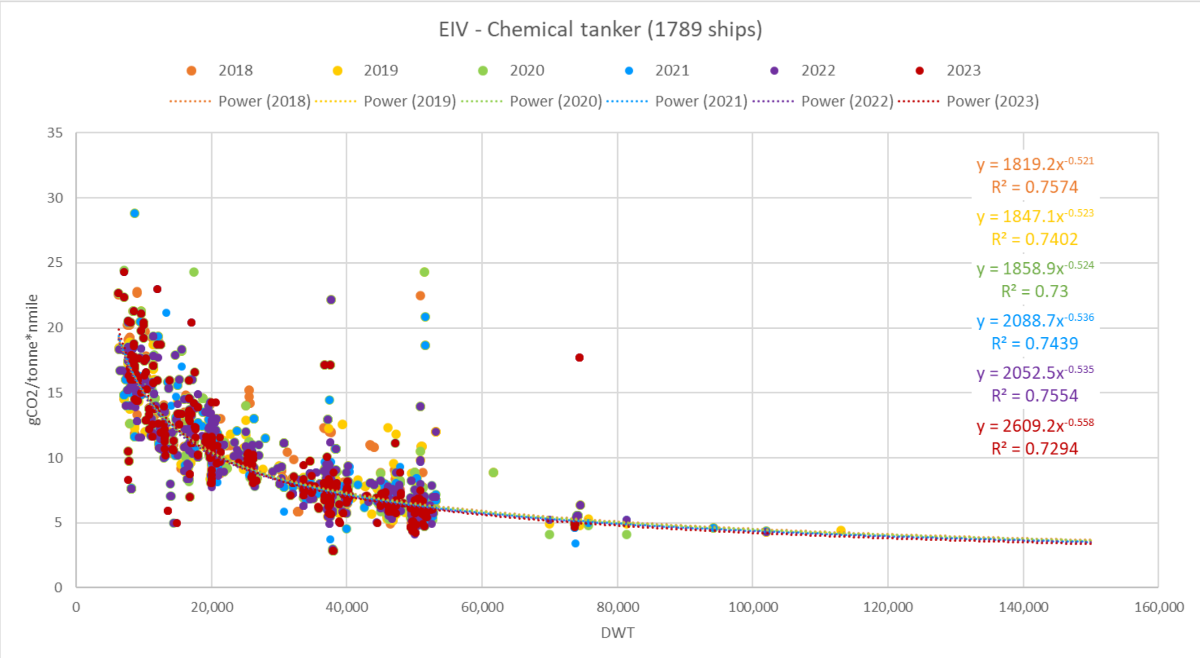

Figure 29: Plot of attained EIV values of chemical tankers over the reporting years and associated trendlines

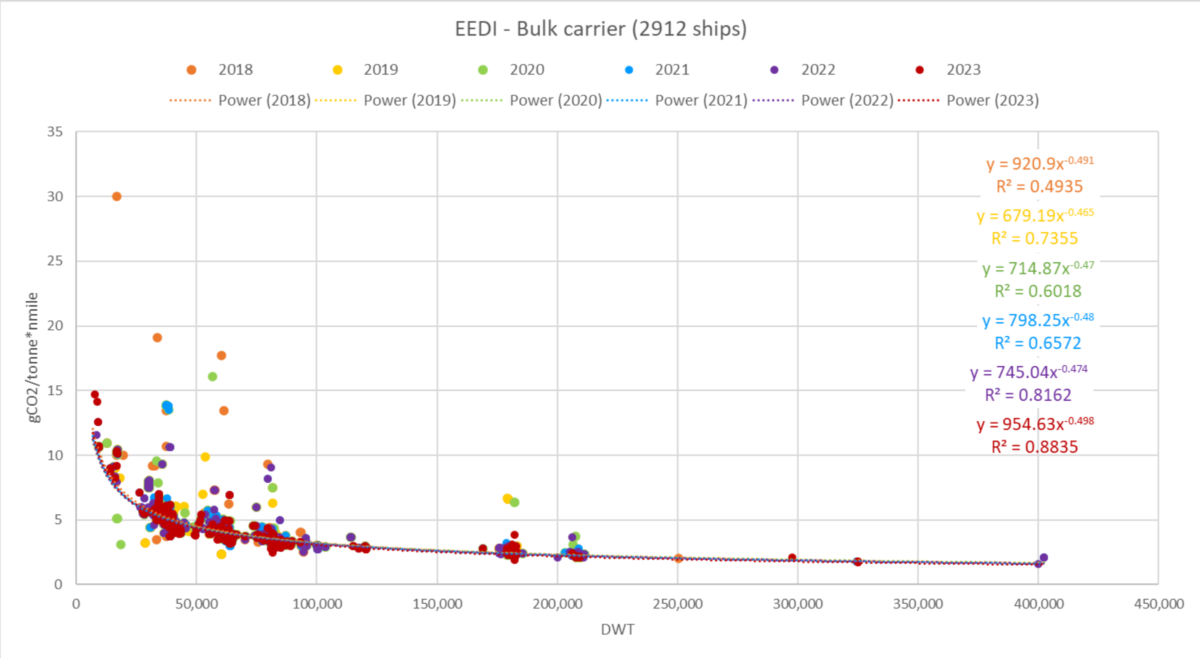

Figure 30: Plot of attained EEDI values of bulk carriers over the reporting years and associated trendlines

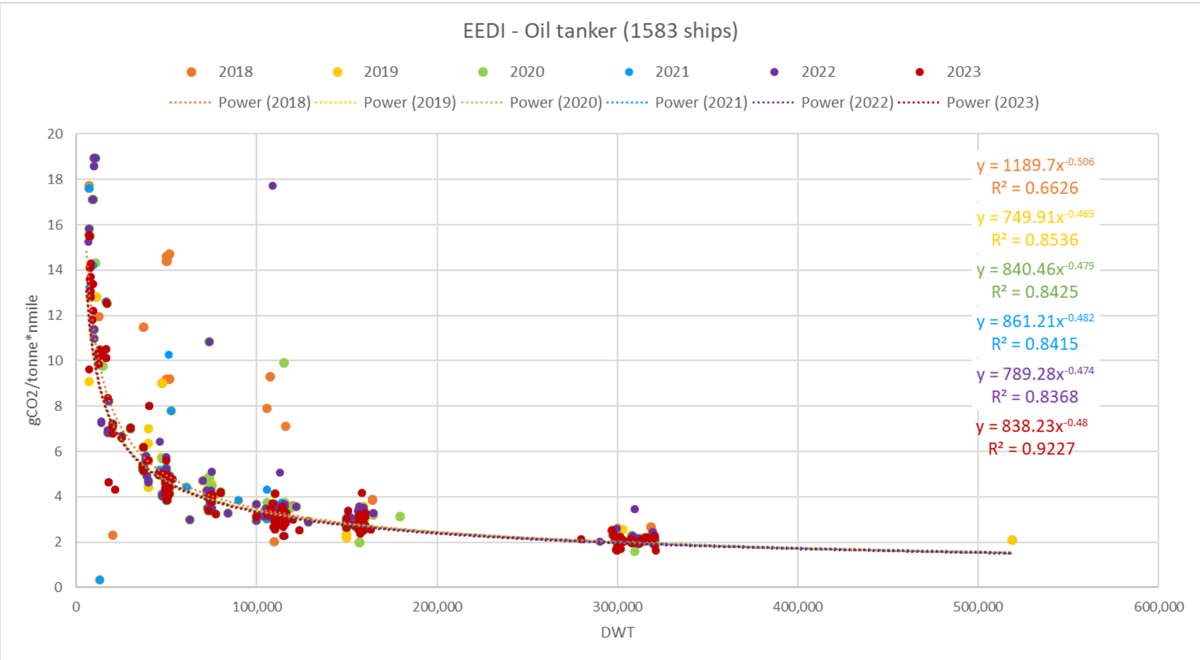

Figure 31: Plot of attained EEDI values of oil tankers over the reporting years and associated trendlines

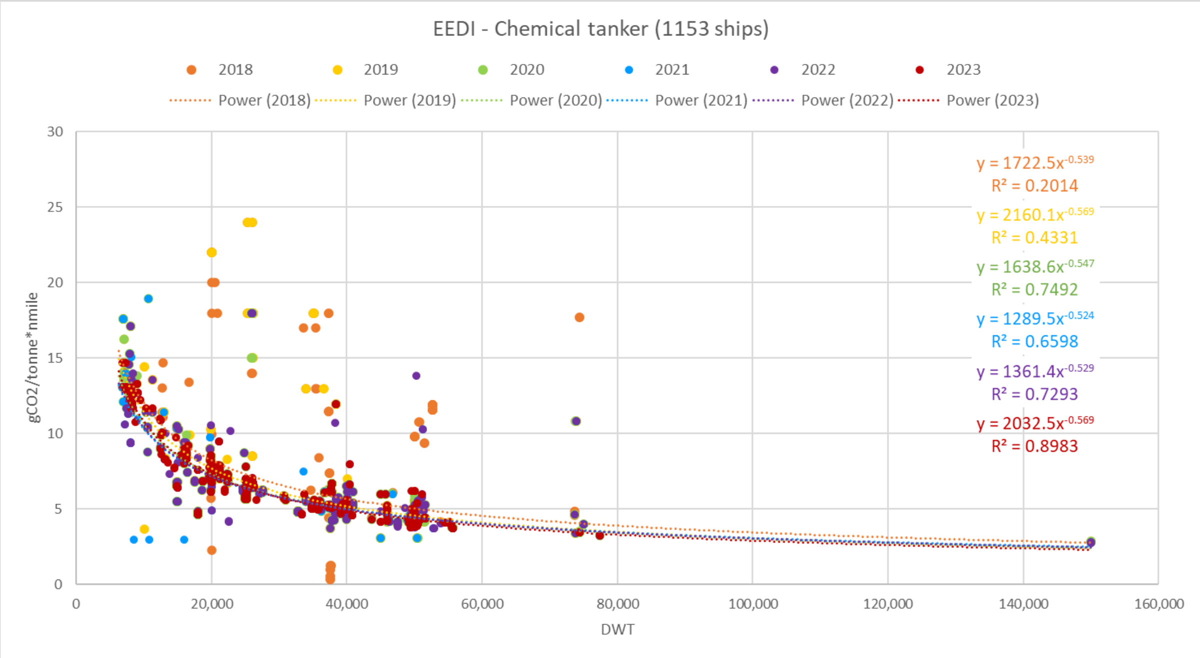

Figure 32: Plot of attained EEDI values of chemical tankers over the reporting years and associated trendlines

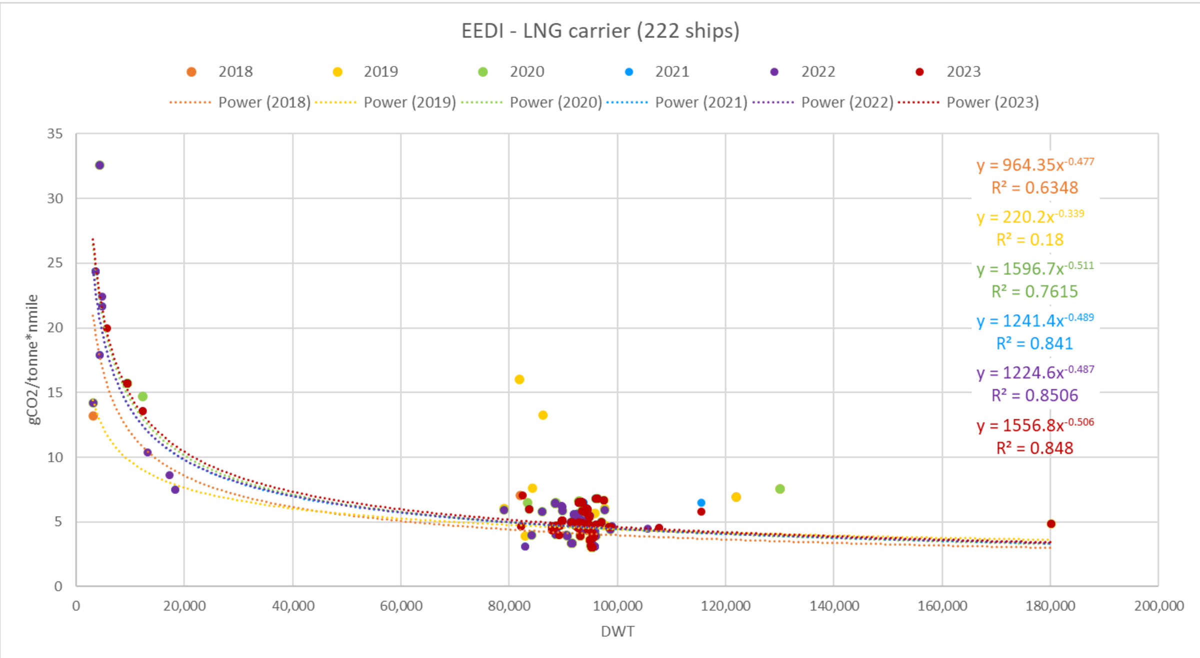

Figure 33: Plot of attained EEDI values of LNG carriers over the reporting years and associated trendlines

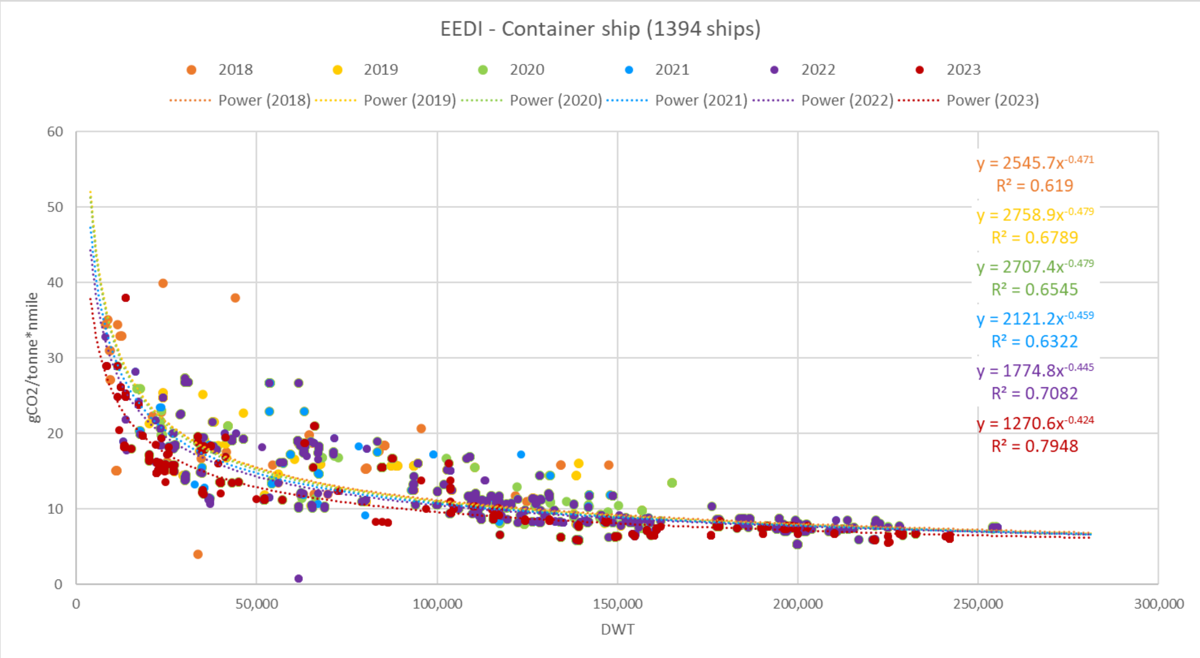

Figure 34: Plot of attained EEDI values of container ships over the reporting years and associated trendlines

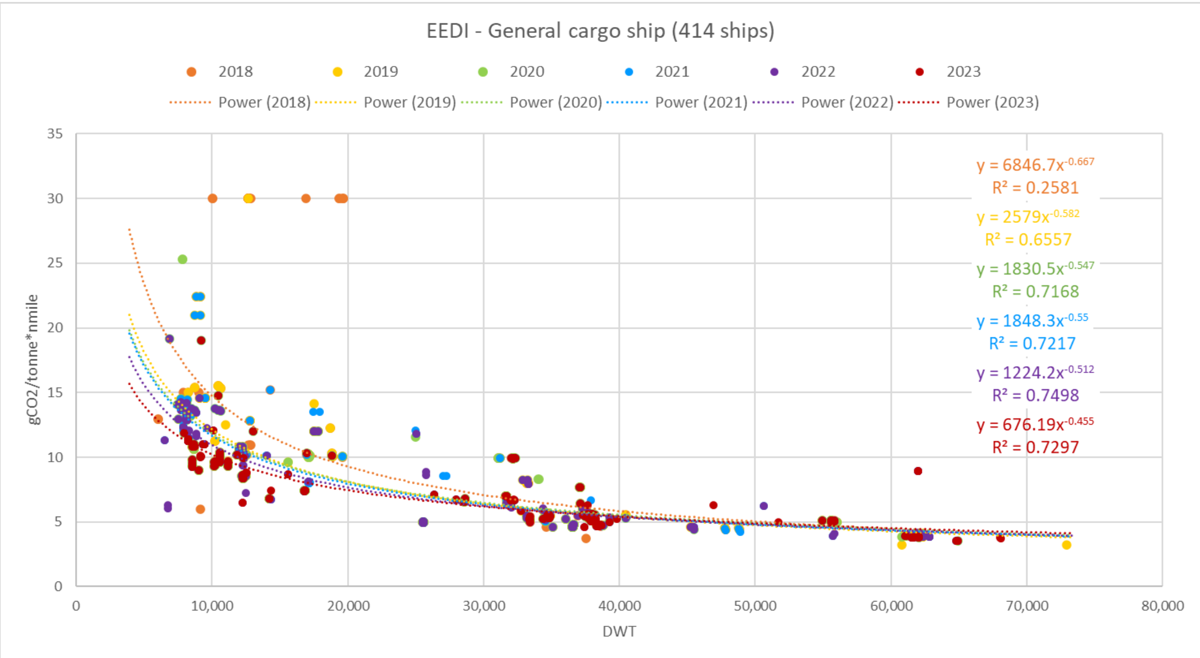

Figure 35: Plot of attained EEDI values of general cargo ships over the reporting years and associated trendlines

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

Operational efficiency 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 carriers 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'[54].

Table 8 gives an overview of the different operational efficiency indicators and metrics that were reported in 2023. The table hereunder only shows the CO_2 efficiency indicators. The corresponding energy efficiency indicators are not presented in the table, but the same 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	Indicator Units	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

[54] 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

The figures below plot values for the Energy Efficiency Operational Indicator (EEOI) and the Annual Efficiency Ratio (AER) for eleven ship types in the six reporting years (2018 to 2023), against the size of the relevant ships - measured in deadweight tonnage or gross tonnage (see dots with a different colour per year)[55].

The EEOI/AER trendlines for 2018 to 2023 for most ship types clearly overlap, which indicates that the operational efficiency of these subsegments of the fleet has not significantly changed. The ship types included in this graphical analysis cover ten out of the fifteen unique ship types reporting under the EU MRV system, representing 84% of total reported emissions in 2023 (up from 74% in 2022).

The correlation values are generally increasing over the years, with almost all ship types showing a higher correlation value in 2023 than in 2018.

The ship types for which the sample is too small (<25 occurrences), or the regression line is not reliable enough to draw conclusions (e.g. due to high variability/scatter), have not been shown [56].

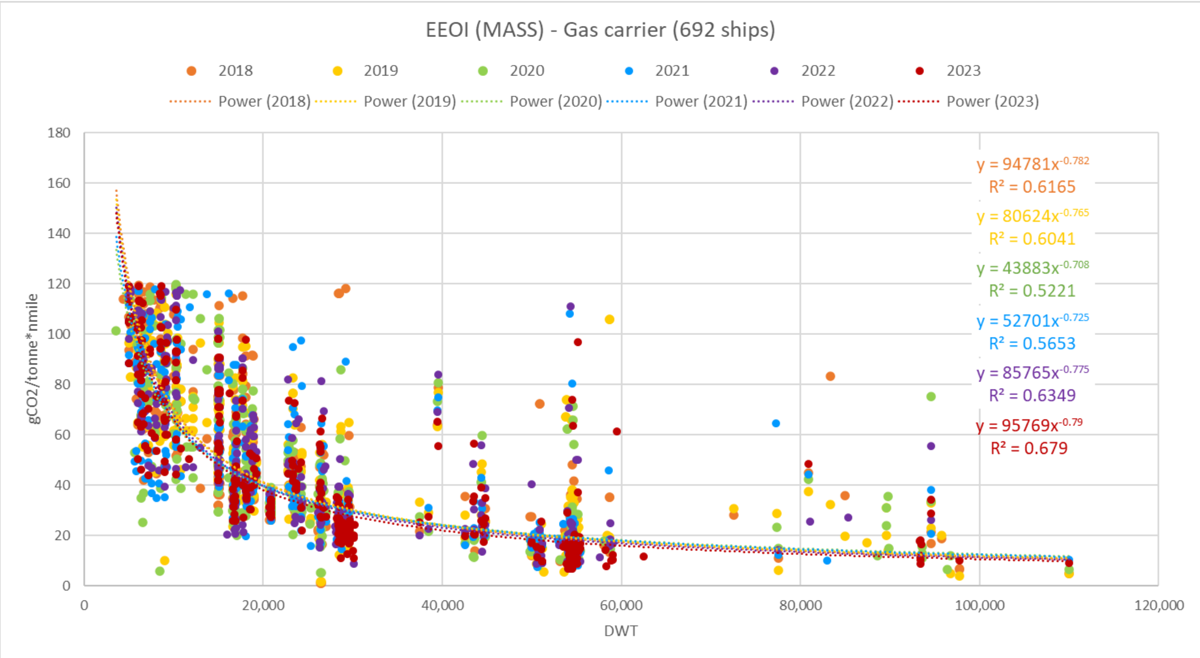

Figure 36: Plot of attained EEOI values of gas carriers over the reporting years and associated trendlines

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[55] As in previous annual reports, only graphs with a robust R2-indicator (>0.6) for the correlation between EEOI/AER and the respective cargo carrying capacity have been included in this report.

[56] For passenger ships (cruise liners) and Ro-Pax vessels no EEOI/AER regression curve is presented since the long-lasting effects of the COVID-19 pandemic impacting the period 2020-2022 resulted in higher and more fluctuant EEOI and AER values for these types of vessels, limiting therefore the interest of applying a regression analysis.

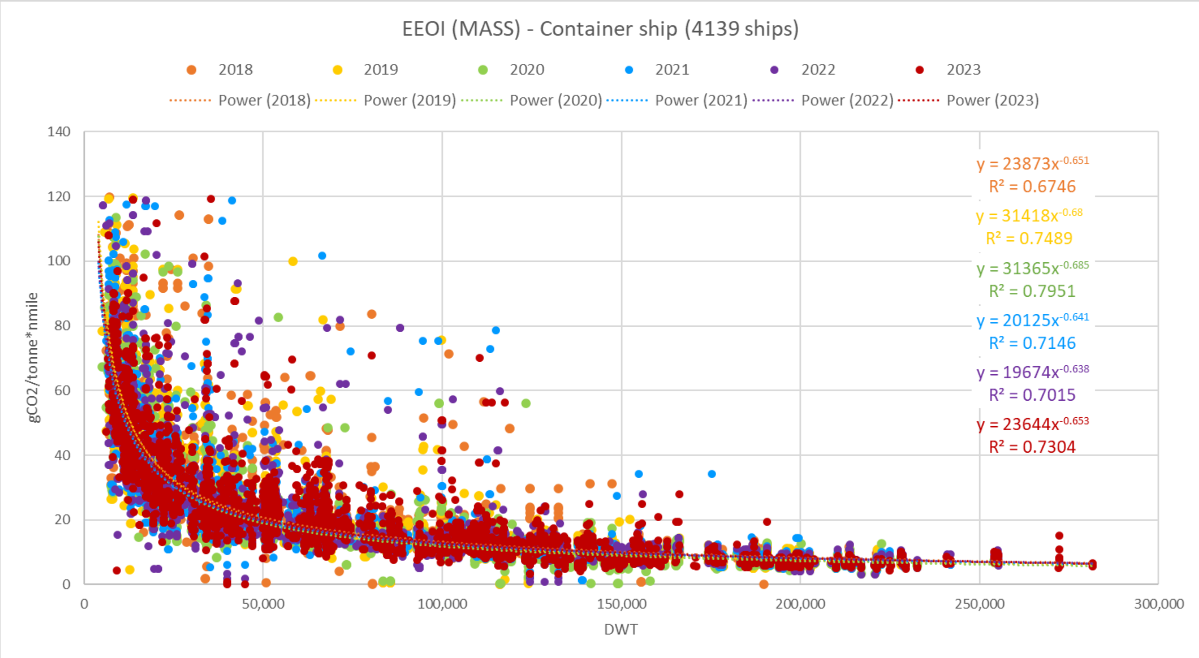

Figure 37: Plot of attained EEOI values of container ships over the reporting years and associated trendlines

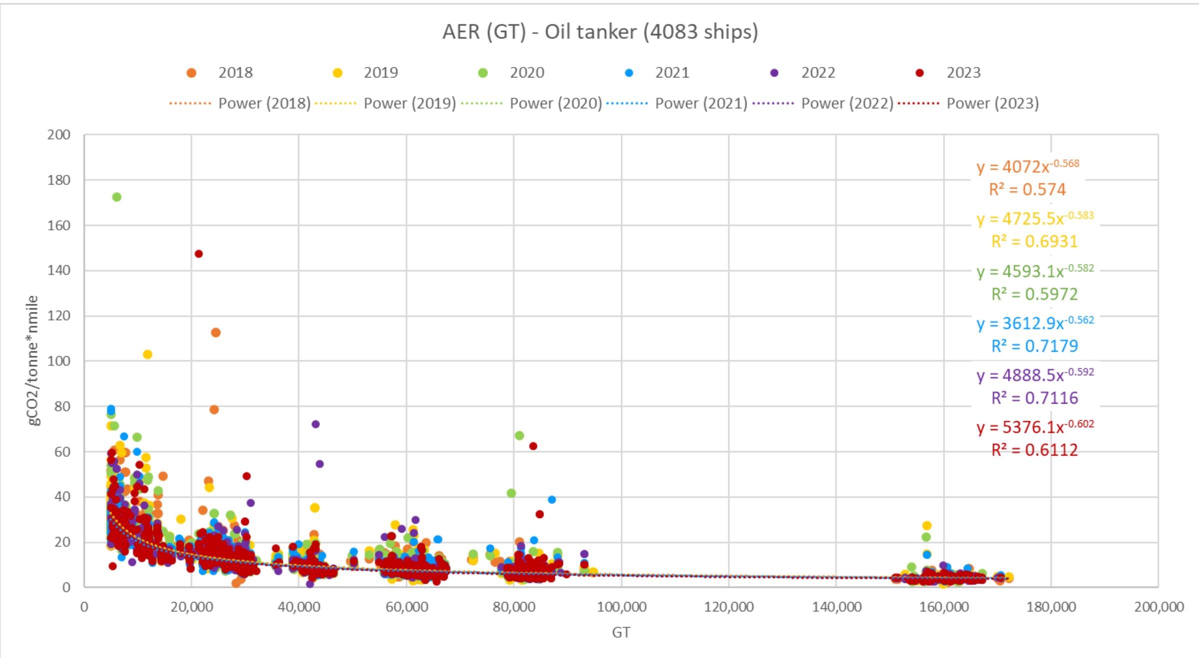

Figure 38: Plot of attained AER values of oil tankers over the reporting years and associated trendlines

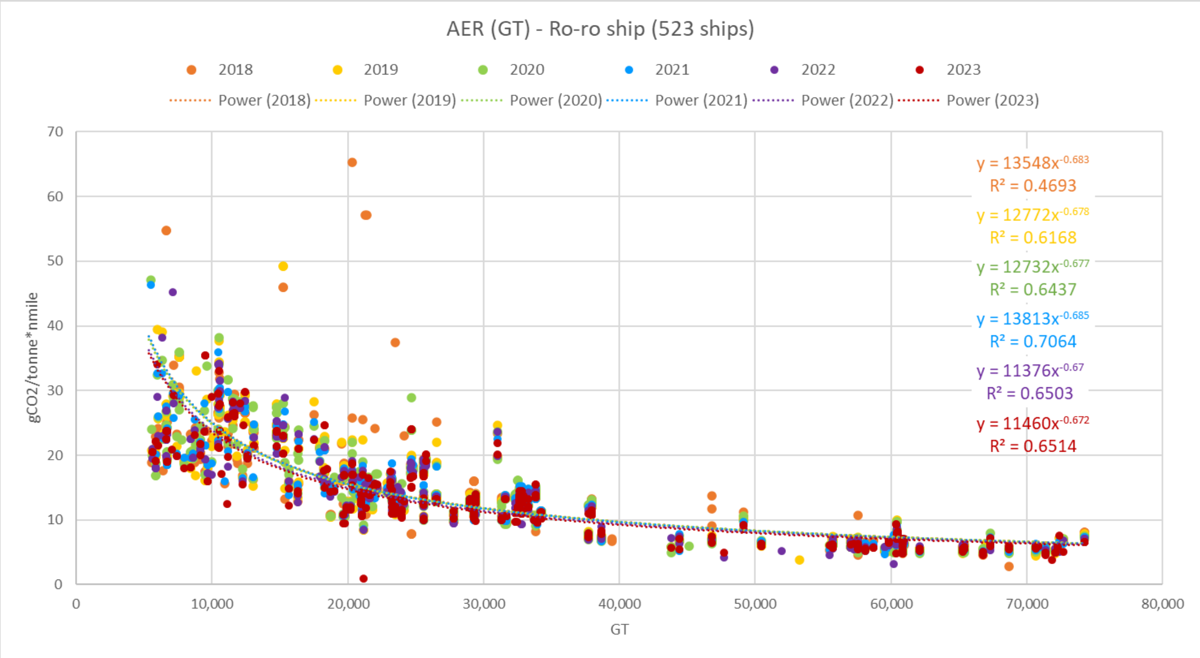

Figure 39: Plot of attained AER values of general ro-ro ships over the reporting years and associated trendlines

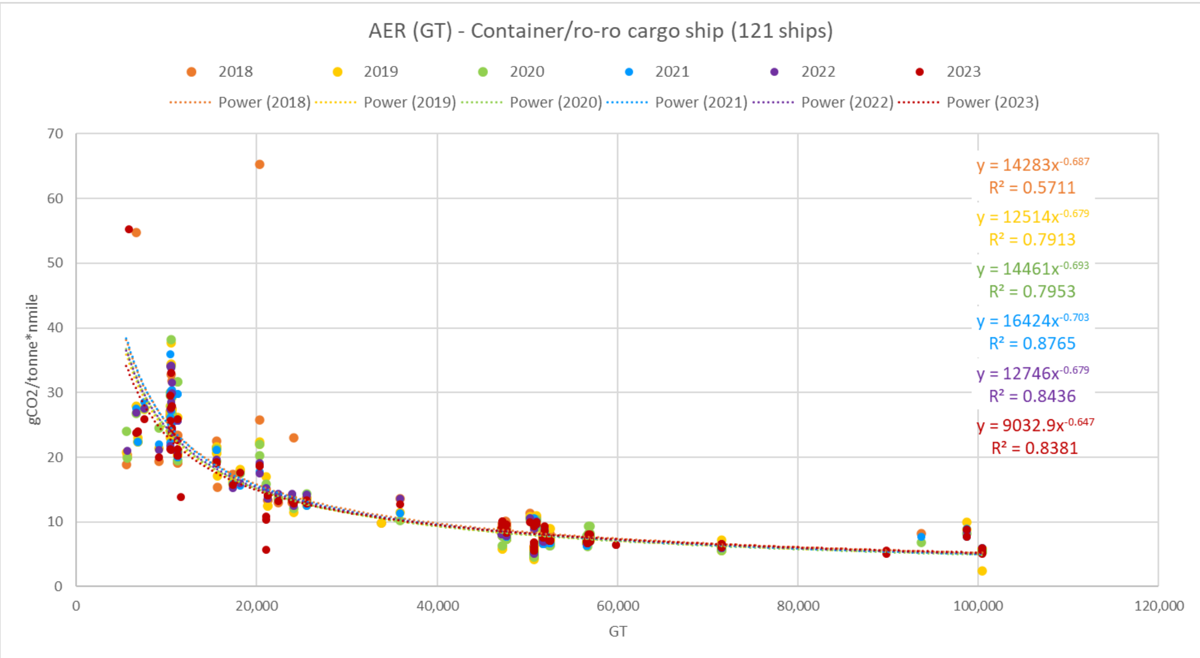

Figure 40: Plot of attained AER values of container-ro-ro cargo ships over the reporting years and associated trendlines

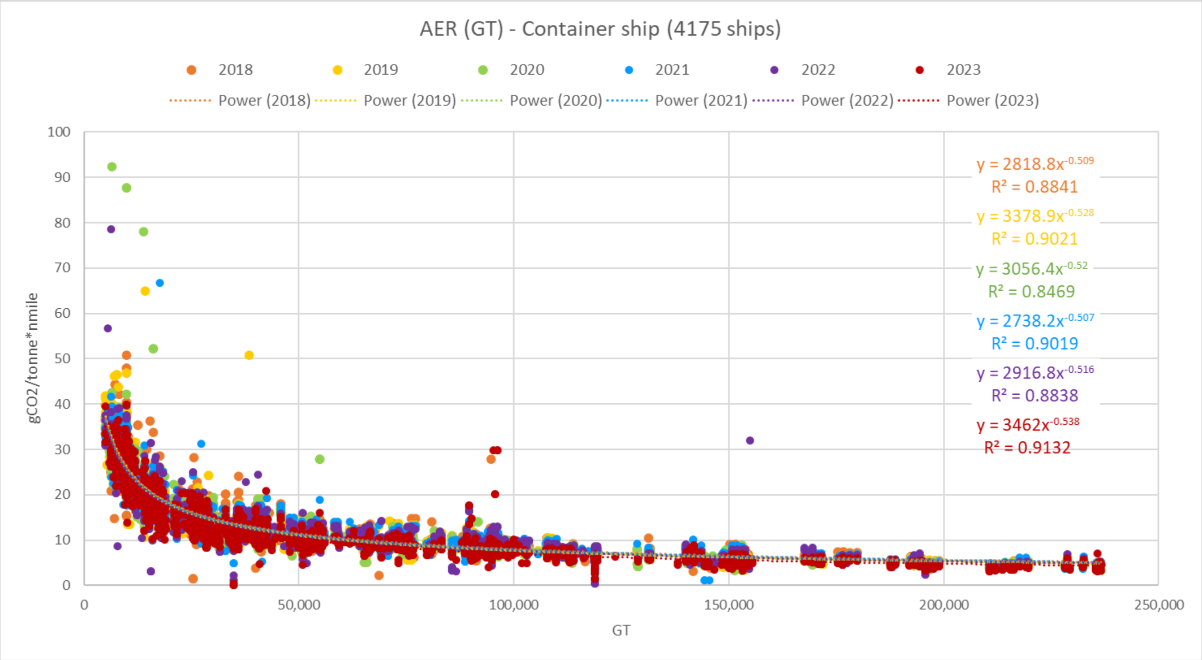

Figure 41: Plot of attained AER values of container ships over the reporting years and associated trendlines

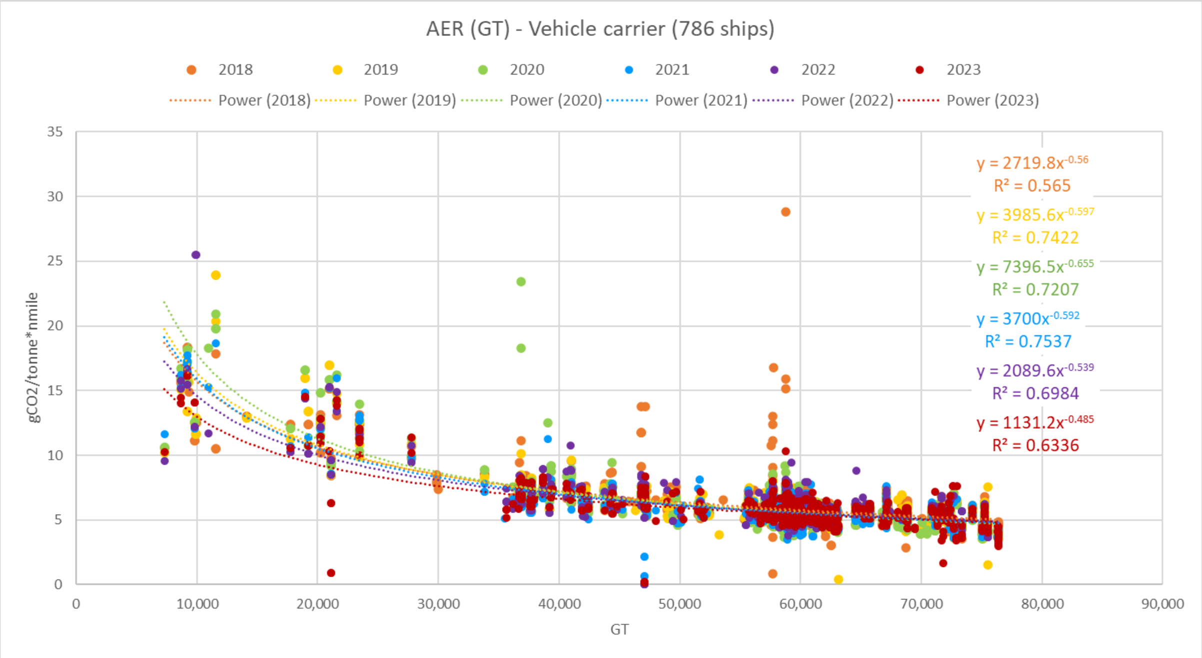

Figure 42: Plot of attained AER values of vehicle carriers over the reporting years and associated trendlines

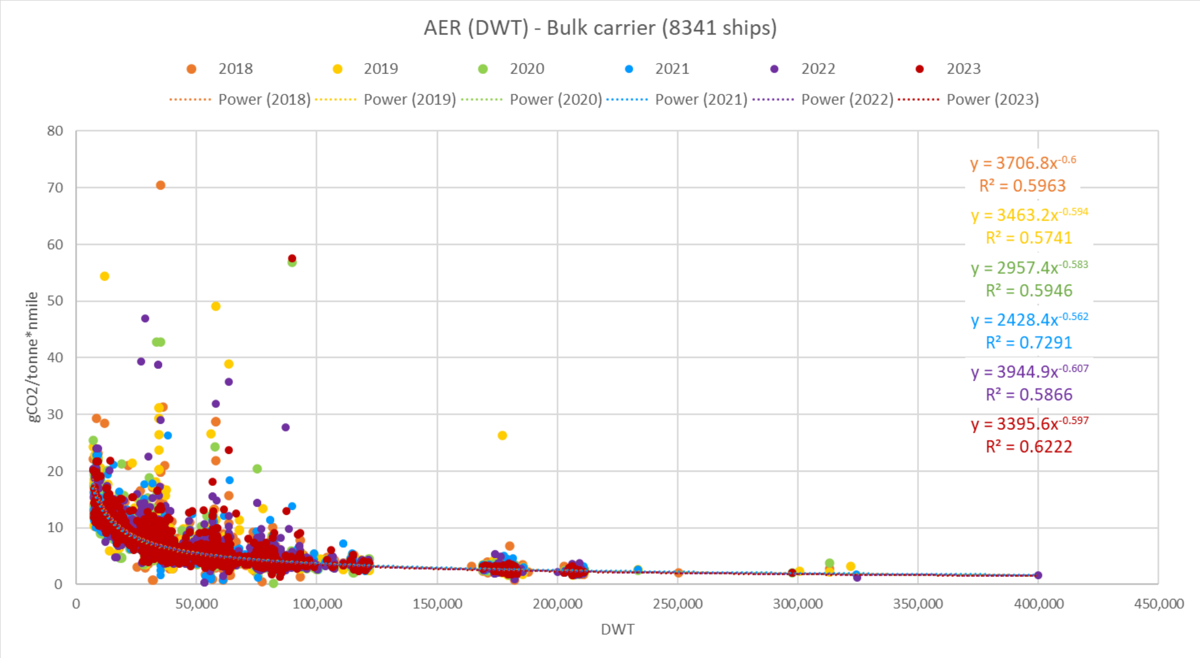

Figure 43: Plot of attained AER values of bulk carriers over the reporting years and associated trendlines

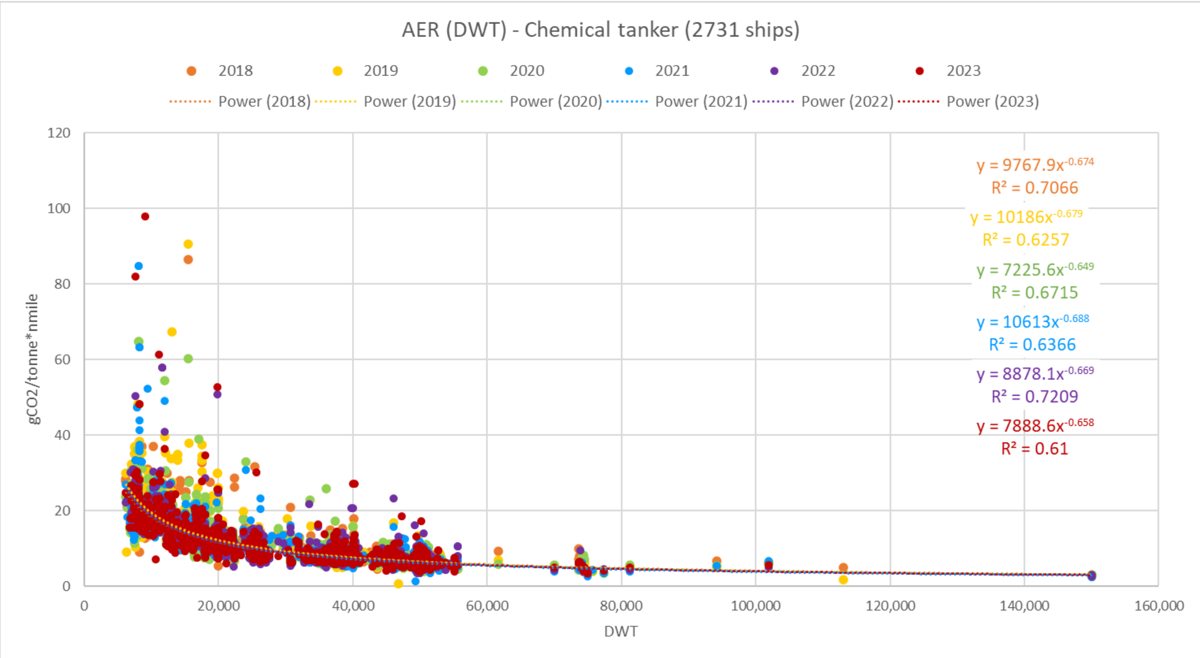

Figure 44: Plot of attained AER values of chemical tankers over the reporting years and associated trendlines

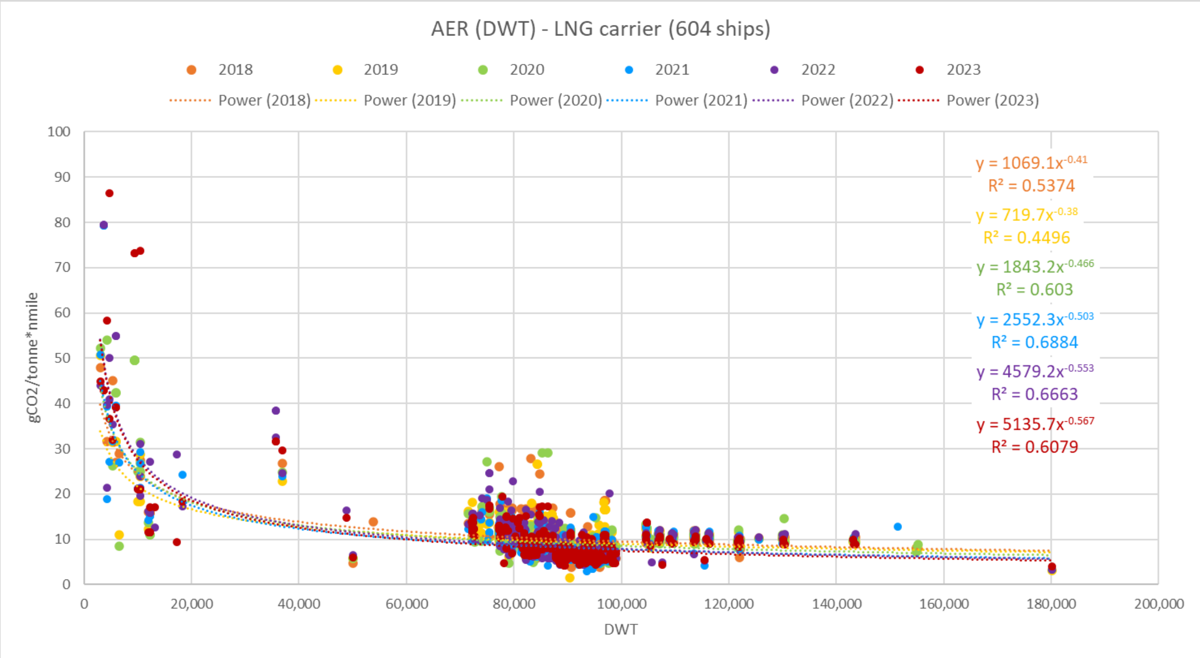

Figure 45: Plot of attained AER values of LNG carriers over the reporting years and associated trendlines

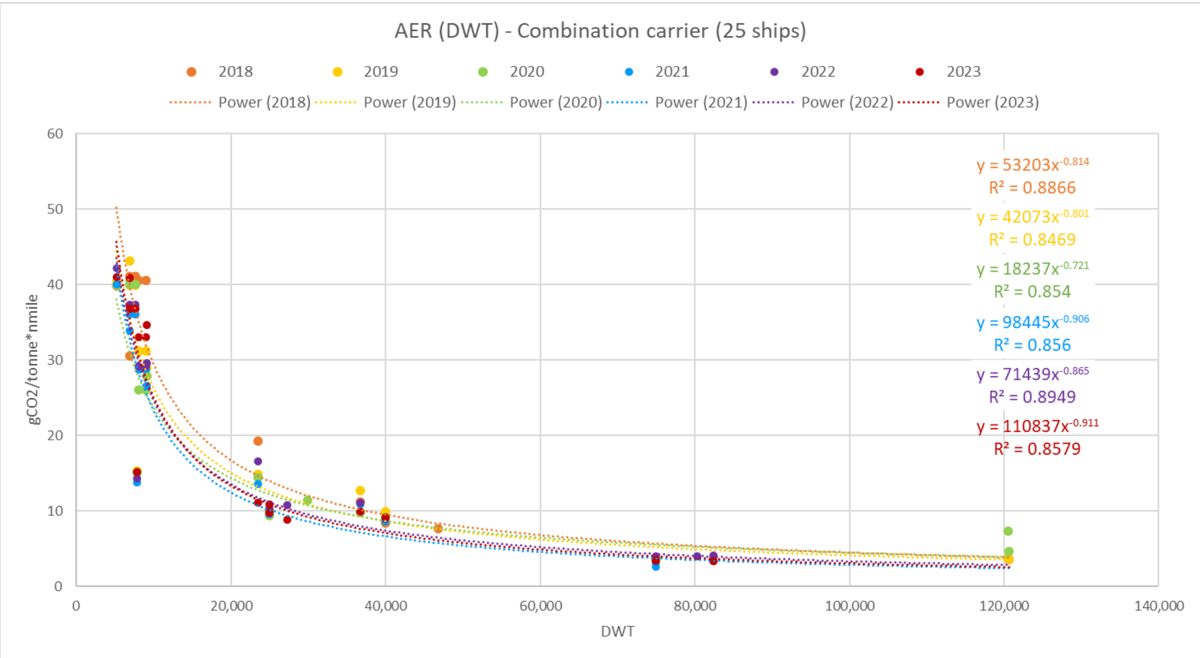

Figure 50: Plot of attained AER values of combination carrier ships over the reporting years and associated trendlines

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