Vessel emissions & activity

The Nordic Association of Marine Insurers

Cefor

Contents

Introduction

Decarbonisation: more transparency through statistics

The common goal to increase insights about CO_2 emissions

Cefor is committed to promoting a more sustainable ocean industry and supports transparency to foster dialogue towards this common goal. This report is a follow-up of the first Cefor CO_2 report issued in 2023, analysing the CO_2 emissions by vessel types[1], age groups and sailed distance, based on 2021 CO_2 emission estimates kindly provided by OceanScore.

In 2022, the Poseidon Principles for Marine Insurance (PPMI) were inaugurated. As a PPMI affiliate member, Cefor supports increased transparency to achieve decarbonisation goals by gaining new insights. The findings in this report are based on Cefor NoMIS data[2], coupled with data from OceanScore who provided Cefor with 2021, 2022 and 2023 CO_2 emission estimates[3]. In this report, the emissions and targets are based on the original PPMI technical specification on all years. PPMI has recently changed the methodology. The 2023 figures to be published by PPMI in 2025 will be based on the new methodology. For consistency and comparability with the 2023 Cefor report, the calculations in this report follow the original PPMI methodology as explained in Chapter 5.

To see things in context, we further added information about the relation between a vessel's average age and distance sailed, and how vessel activity patterns changed over the past years.

In addition to analysing the climate alignment[4], this report also includes absolute CO_2 emissions and compares those of the NoMIS fleet to the world fleet. The world fleet keeps growing in line with world trade and ever larger vessels are added to the fleet. As the total CO_2 emissions of the world fleet need to reduce, this means that a vessel's climate alignment against the IMO target emission reduction trajectories will need to improve even more than if the size of the world fleet was stable over time. While monitoring vessel emission data may not in itself reduce emissions, it is an important tool to create actionable insights and form the basis for decisions.

[1] Cefor NoMIS vessel type groups. These may to some degree deviate from IMO GHG vessel segments.
[2] Nordic Marine Insurance Statistics (NoMIS) database, see 5. Data explanation
[3] After various data quality checks carried out by PPMI members and verified by Cefor, for PPMI reporting from 2023, OceanScore data is recognised as official alternative to emission data from shipowners.
[4] See 5. Data explanations.

Executive Summary

CO_2 emissions, climate alignment and vessel activity

Chapter 1 provides context about **vessel activity** by type, age and intervals of the distance sailed per year. It shows that the vessels sailing more than 120 000 nautical miles per year are older than vessels sailing shorter distances. Older vessels often have more powerful engines enabling them to sail faster and thus longer. The high speed increases the emissions per nautical miles[OBJ].

Chapter 2 compares **overall and average CO_2 emissions** and the distance sailed for different vessel segments over the years 2021 to 2023. For most segments, the total CO_2 emissions stayed relatively stable over the three-year period. This is similar for both the NoMIS and the world fleet. Container vessels show a 6.5% reduction in emissions in 2023 despite little change in the average distance sailed. The world fleet does not show a material reduction in total emissions for container vessels.

The most remarkable change shows the NoMIS fleet passenger segment, with a clear increase in absolute emissions, coupled with an increase in the average distance sailed and average speed. For this segment, the NoMIS fleet differs from the world fleet. This can be explained by a higher share of cruise vessels in the NoMIS passenger segment as compared to the world fleet.

Chapter 3 analyses the **alignment with IMO targets**. The misalignment with the targets increased from 2021 to 2022 and 2023. This is due to stricter targets in 2022 and 2023 than in 2021.

The data added for 2022 and 2023 largely confirms the findings of the first Cefor analysis for the relation between climate alignment and vessel type and age. For bulk, passenger and tank vessels, one can deduce that the younger the vessels are, the better is their climate alignment. This is not equally true for the car/RoRo and container segments. For these groups, the youngest vessels show a worse climate alignment than somewhat older vessels. This may be explained by a high post-pandemic demand for these segments inducing higher speed, which usually means higher emissions.

The climate alignment relative to the distance sailed shows the same trend for bulk and tank vessels for all three years, meaning vessels sailing longer distances have a better climate alignment. For container vessels, this also was the case in 2021, but the picture changed in 2022. Container vessels sailing longer distances showed a worse climate alignment in both 2022 and 2023. This may again be explained with higher travel speeds in connection with increased demand.

A new aspect explored in Chapter 4 is the analysis of a **potential correlation between claims and the vessel CO_2 emissions**. Large emissions originate typically from large vessels, old vessels and/or high activity, which also trigger higher annual claims costs. An analysis of the claim cost per vessel by CO_2 intervals for the largest vessel segments, as well as of the claim cost per CO_2 emission does however not give conclusive results for how to use vessel emissions for the prediction of claims costs.

1. Vessel activity patterns

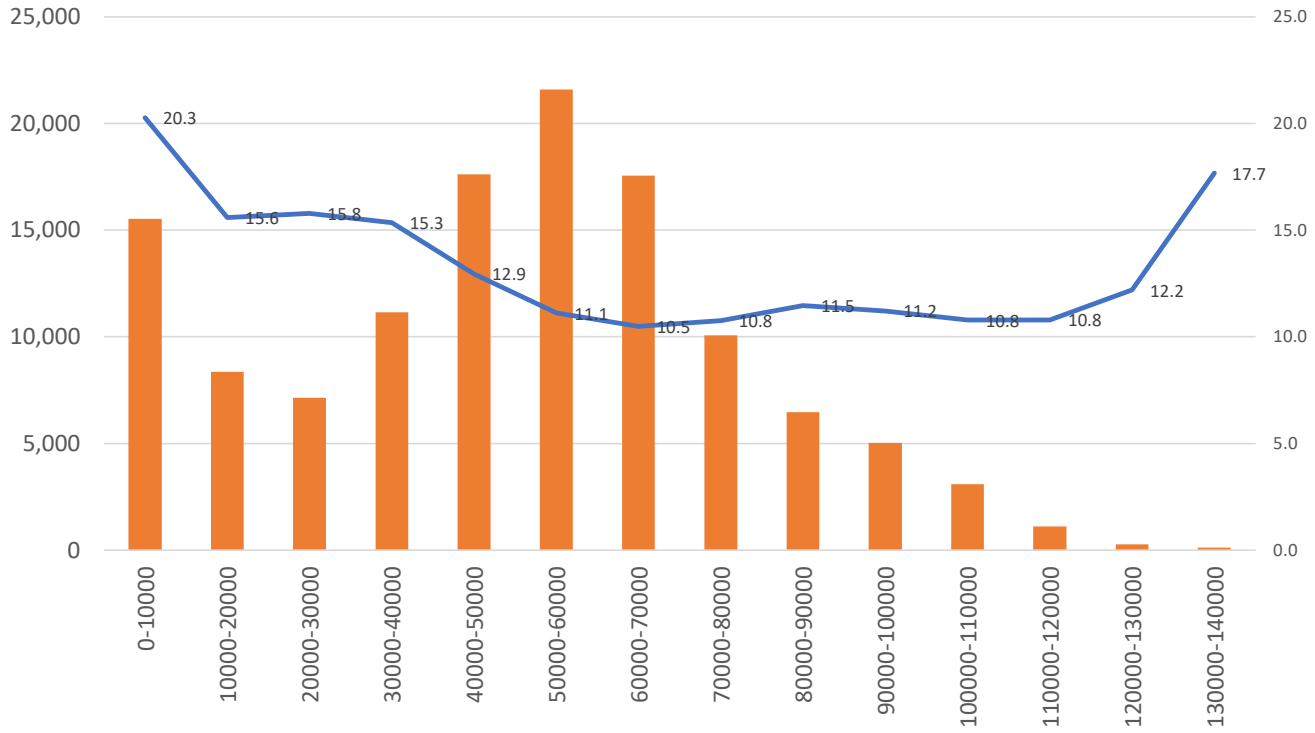
Behavioural aspects relevant for interpreting hull trends

Vessel activity patterns

Graph1.1 reveals that the oldest vessels typically sail on both the shortest and the longest distances. Vessels built after the EEDI regulation entered into force in 2013 typically have less powerful engines and are thus often not capable of sailing as fast as some of the old vessels. The maximum speed of a vessel also depends on the ship form coefficient which differs by vessel type. The average distance sailed per vessel per year in the NoMIS portfolio is about 55,000 nautical miles (nm), with container vessels having the highest average distance sailed of about 74,000 nm.

The circumference of the earth is 360 * 60 = 21,600 nautical miles (nm) along the equator. The vessels sailing more than 130,000 nm per year thus sail more than 6 times around the world, or around the world in two months.

1.1Average age & number of vessels per year by intervals of distance sailed (nm) Nomis fleet 2019-2023

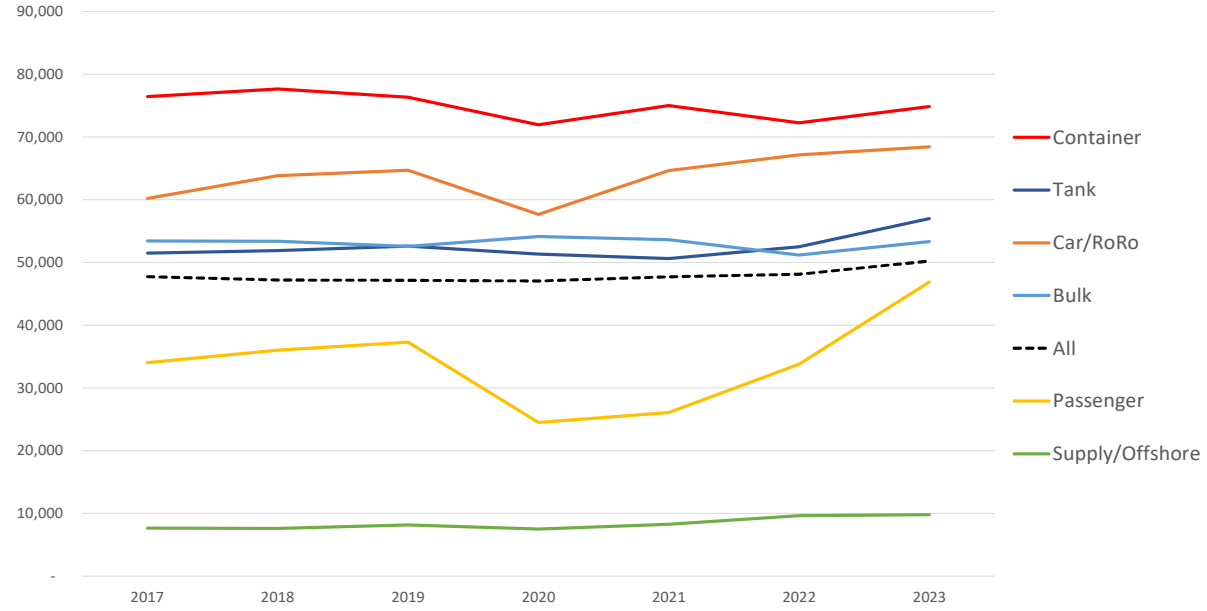


Average age: minor y, Number of vessels: major y, distance sailed intervals: x
Data source: NoMIS fleet: Cefor NoMIS database, distance sailed: Marine Benchmark

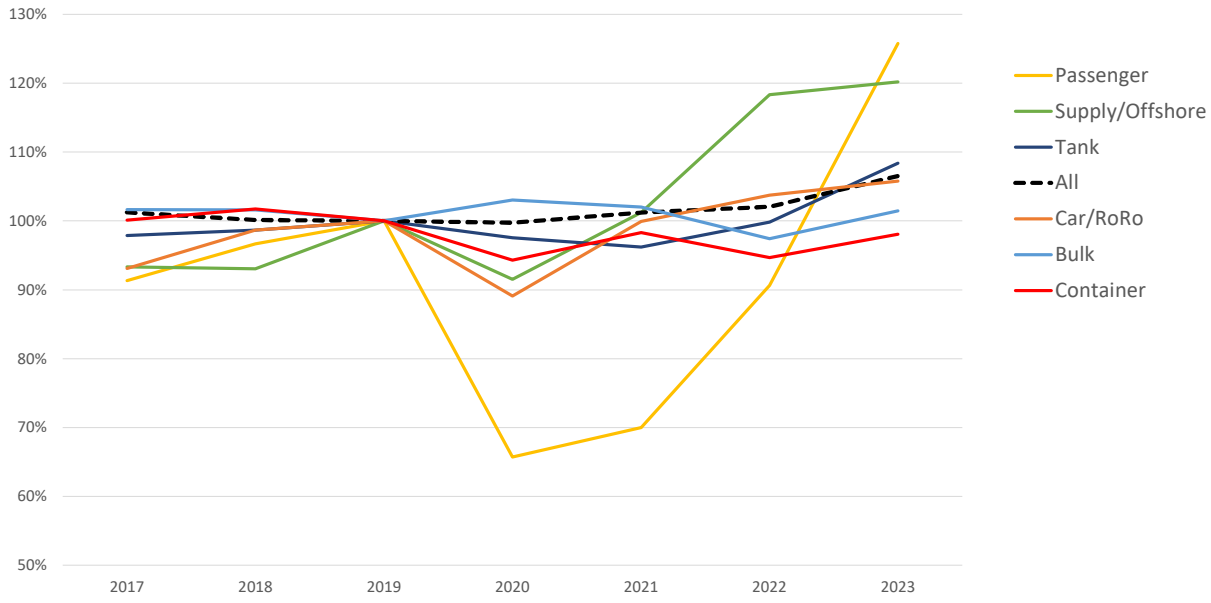
An increase or decrease in vessel activity and the distance sailed will naturally influence vessel emissions, both in absolute and relative terms. These effects do not need to be parallel. A longer travel distance would normally mean higher absolute CO_2 emissions but may on the other hand impact the calculated climate alignment favourably when emissions are related to the distance sailed (see formula explanations in Chapter 5.)

Graphs 1.2 and 1.3 reflect the activity pattern of the NoMIS fleet, i.e. all vessels reported into the NoMIS database, coupled with vessel activity data by Marine Benchmark.

1.2: Average distance sailed (nm) per year, per segment, NoMIS fleet



1.3: Index of av. distance sailed per year, per type, 2019 = 100%, NoMIS fleet



2. Vessel CO_2 emissions

CO_2 emissions in absolute terms (CO_2 tonnes)

The statistics in the following chapters are produced with the kind support of OceanScore[5] who made CO_2 emission estimates for the years 2021, 2022 and 2023 available to Cefor. The estimates are based on the original PPMI methodology and is thus not updated in line with the new specifications for the 2023 reporting. The data comprises both measured CO_2 emissions per vessel[6] as well as modelled emission estimates for vessels lacking measured data. Estimates from OceanScore may also be used by signatories to the PPMI to calculate portfolio alignment in the upcoming 2024 annual disclosure report.

This comprehensive data enabled Cefor to analyse both absolute emissions and the climate alignment of the NoMIS portfolio against a net-zero reduction target in 2050 and gain valuable insights into the relation between the calculated climate alignment by vessel types, vessel age and distance sailed.

In this chapter we both look at the absolute and average CO_2 emissions for the main vessel segments over the past three years. While bulk, car/RoRo, cargo and tank[7] vessels show similar average CO_2 emissions over the years 2021 to 2023 or a minor reduction in 2023, the picture differs for container and passenger vessels.

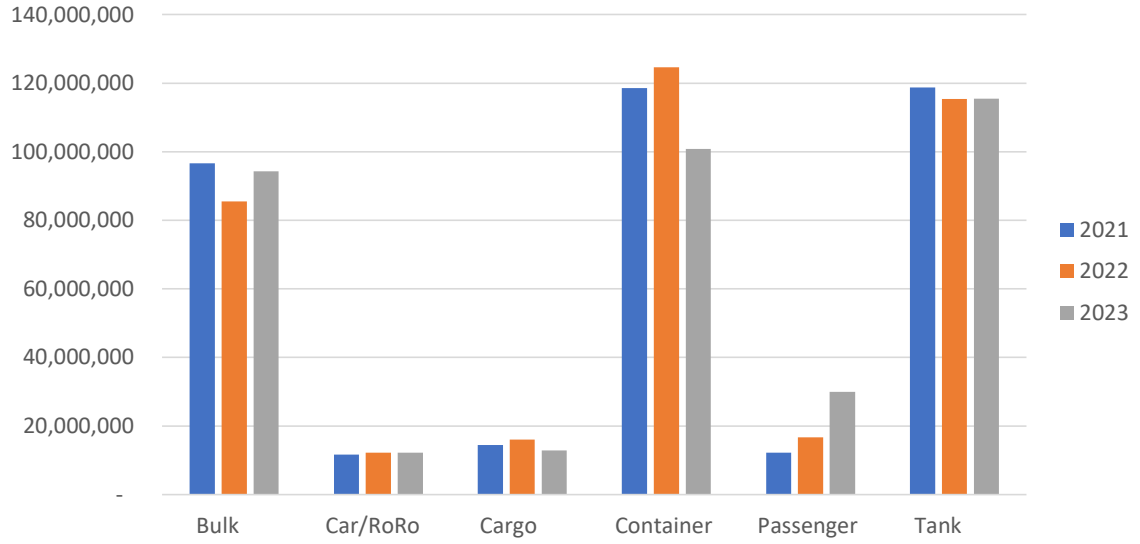
Container vessels show some reduction in average CO_2 emission over the years 2021 to 2023, while the average distance sailed only showed a small decrease from 2021 to 2022 and then stayed stable in 2023. Both the figures for the world fleet and the NoMIS fleet indicate that CO_2 emissions from container vessels had some downward trend relative to the distance sailed. One should though keep in mind that figures for this segment may change again for 2024. Rerouting of container vessels on a larger scale around the Cape of Good Hope instead of passing the Suez Canal first gained traction from December 2023 and thus will not have had significant impact on 2023 emission data.

Passenger vessels in the NoMIS portfolio showed a clear increase in CO_2 emissions, which corresponds with an increase in both the distance sailed and the average travel speed from 2021 to 2023. Comparing the NoMIS fleet to the world fleet, cruise vessels represent a higher – and increasing - share of the NoMIS passenger segment (2023: 34%), while their share of the world fleet is rather stable at 19-20%. As the activity pattern of cruise vessels differs from local passenger vessels and was strongly influenced by the pandemic and the post-pandemic upswing, this explains the difference between the trend between the NoMIS fleet from the world fleet.

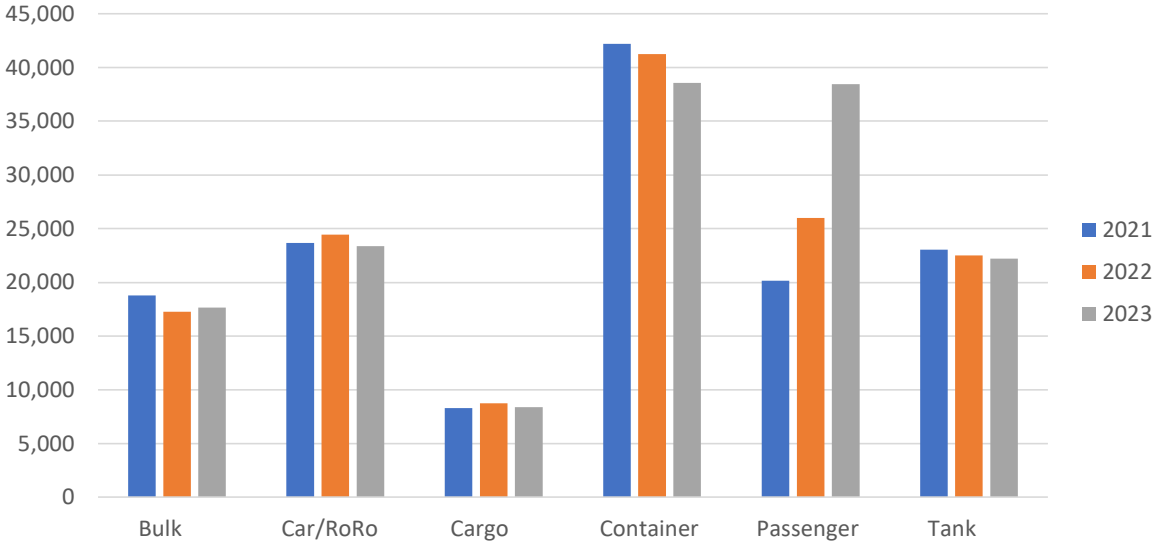
Data sources graphs on pages 8 and 9: NoMIS fleet: Cefor NoMIS database, World fleet: OceanScore, CO_2 emissions & distance sailed: OceanScore, speed: Marine Benchmark

[5] https://oceanscore.com/
[6] based on EU MRV data, see also here: https://mrv.emsa.europa.eu/#public/emission-report
[7] In this analysis, the 'tank' segment combines Chemical/Product, LNG/LPG and other tank vessels

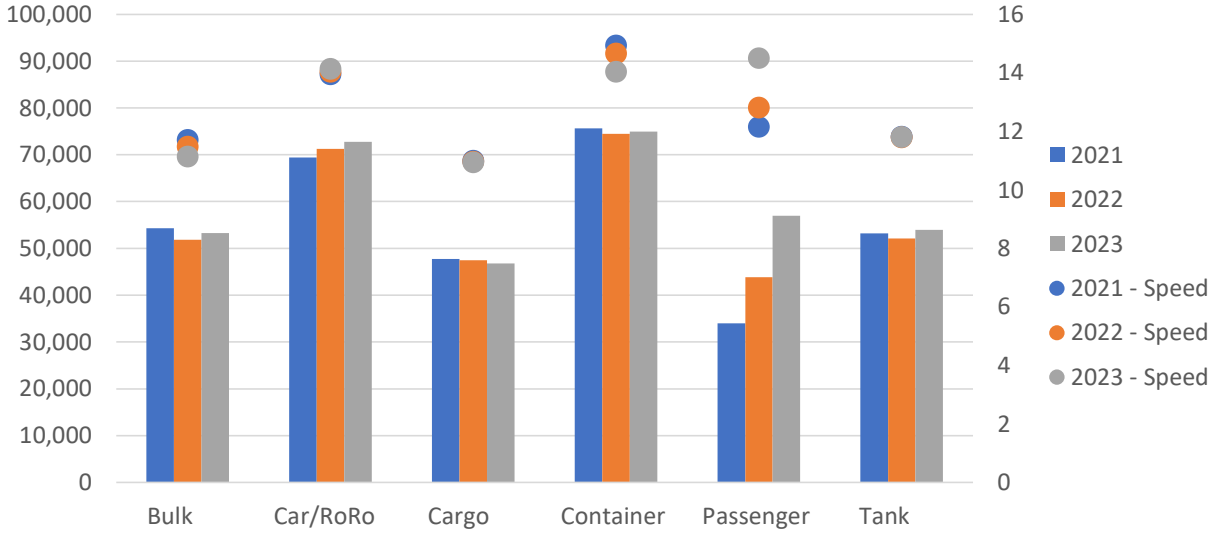
2.1.a: NoMIS fleet: Total CO_2 emissions by vessel type, 2021-2023



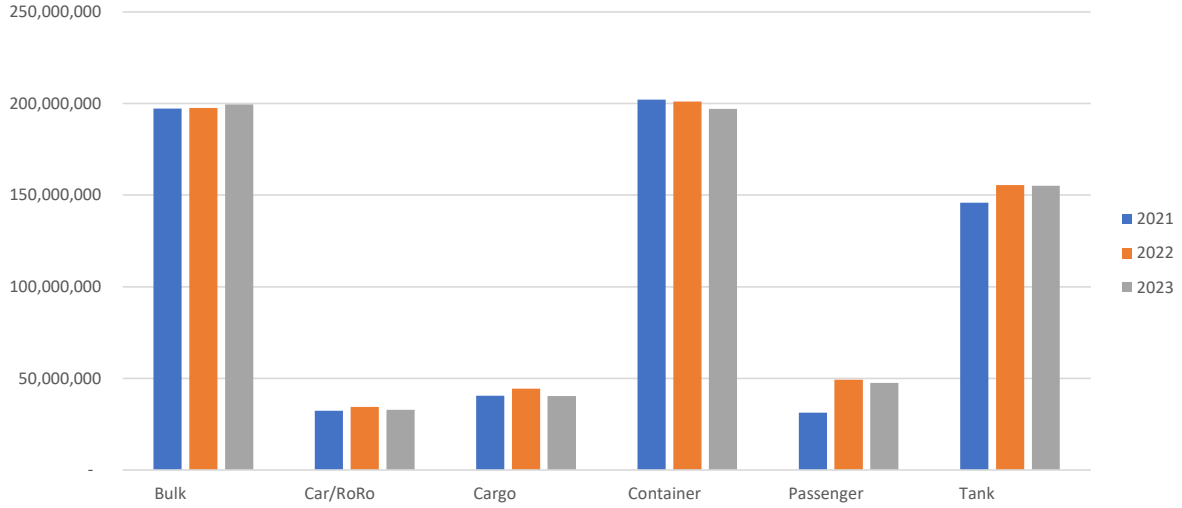
2.1.b: NoMIS fleet: Average CO_2 emissions per year by vessel type, 2021-2023



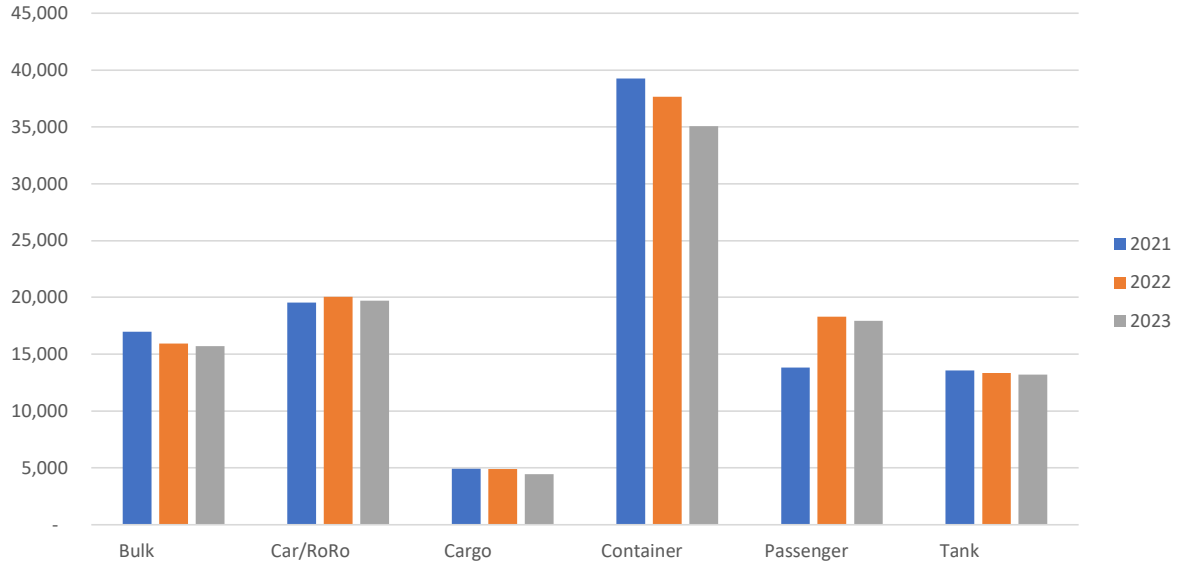
2.1.b: NoMIS fleet: Average distance (nm) & speed by vessel type, 2021-2023



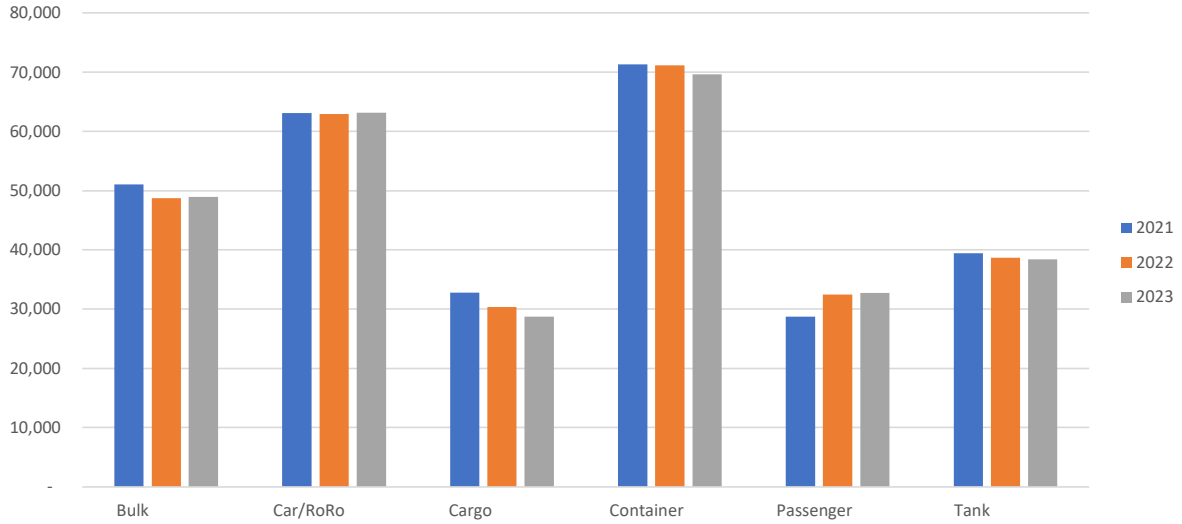
2.2.a: World fleet: Total CO_2 emissions per year by vessel type, 2021-2023



2.2.b: World fleet: Average CO_2 emissions per year by vessel type, 2021-2023



2.2.c: Average distance sailed (nm) by vessel type, 2021-2023, World fleet



3. Climate alignment

for the NoMIS fleet, by vessel type, age, distance sailed

For explanations about the data and how 'climate alignment' is measured, see Chapter 5 'Data sources and explanations'.

A positive alignment delta means the vessel is misaligned (above the decarbonisation trajectory), a negative or zero alignment score means the vessel is aligned (respectively, below or on the decarbonisation trajectory). Or said in other words: the higher the climate alignment delta, the greater is the mismatch between a vessel's or vessel segment's emissions per nautical mile in relation to the emission reduction goals as represented by the emission reduction curves proposed by IMO.

The climate alignment in the graphs in this article is measured against a zero-emission target in 2050.

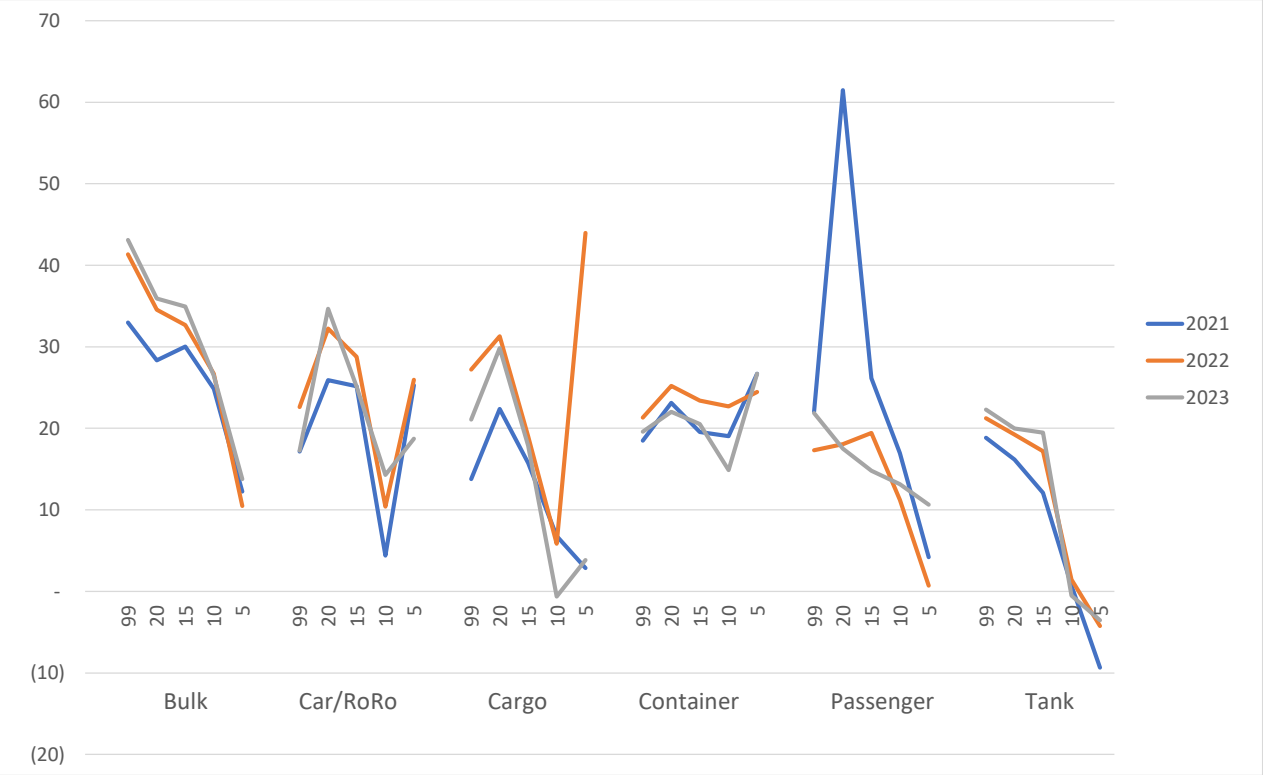
The overall climate alignment percentage for all vessels in the NoMIS fleet which could be matched with CO_2 emission data from OceanScore was calculated as follows per year (weighted with dwt, against the 100% trajectory):

	Vessel count – NoMIS fleet	Climate alignment – NoMIS fleet
2021	17,644	15.7%
2022	17,532	19.3%
2023	17,500	20.1%

The overall climate alignment for the NoMIS fleet has deteriorated from 2021 to 2023. The climate alignment percent figures are calculated relative to the emission reduction trajectories set out by IMO. This means that to achieve the same climate alignment over several years, a year-on-year reduction in CO_2 emissions per nautical mile of about 3,4% is necessary. In this perspective, the development from 2022 to 2023 shows signs of improvement – although not sufficient to meet the IMO targets.

The statistics in this report are solely derived by analysing the NoMIS portfolio against CO_2 emission estimates kindly provided by OceanScore to the Cefor administration. The statistics do not include vessel emission data individual Cefor members may have reported for the Poseidon Principles for Marine Insurance reports.

3.1: Average climate alignment 2021 (%, weighted with dwt), 2021-2023 NoMIS fleet, by vessel types and age intervals

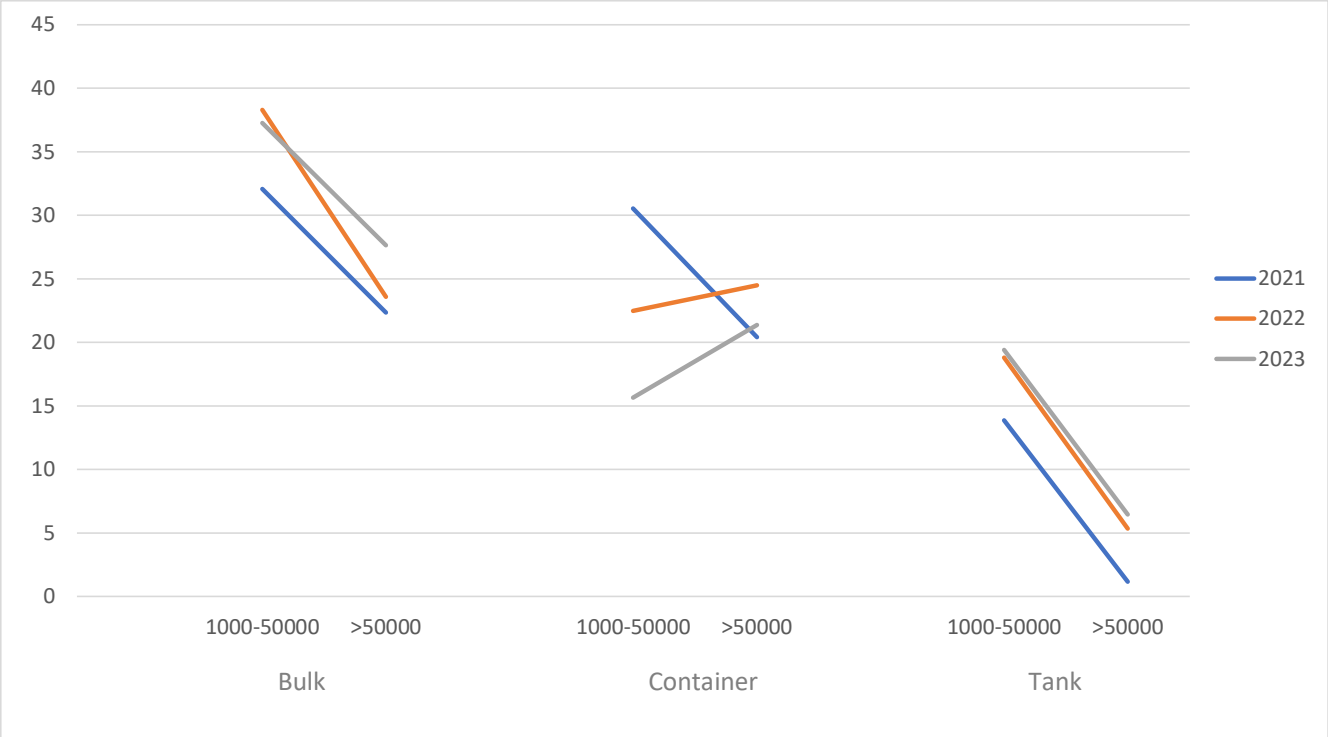


Graph 3.1 shows the average climate alignment by vessel segment and age group for the years 2021 to 2023. The climate alignment in most vessel segments is best for the youngest vessels. This holds particularly true for tank vessels. This is partly due to stronger engines in vessels built before the EEDI regulation entered into force (2013), wear-and-tear and technological progress.

For container, all age groups have a similar and relatively high percentage figure, which signifies a comparably bad alignment.

It is unclear why tankers perform better than bulk carriers in terms of climate alignment for all age groups. If the targets are correctly calibrated, this implies that tankers have achieved a larger reduction in emissions per nautical miles since 2012.

3.2. Average climate alignment (%, weighted with dwt) 2021-2023 NoMIS fleet, by vessel type and distance sailed



Graph 3.2 shows clearly that the distance sailed plays a relevant role in the calculation of the climate alignment according to the given formulas. One aspect is that vessels which are e.g. in waiting positions outside of ports or otherwise less active may have lower emissions in absolute terms, but higher emissions per nautical mile and thus a higher climate alignment percent figure (meaning they are less aligned with the decarbonisation trajectory).

While the picture is relative consistent over the years 2021 to 2023 for bulk and tank vessels, it differs for container vessels. Over the years from 2021 to 2023, the climate alignment for container vessels sailing the longest distances deteriorated and was worse than for container vessels sailing shorter distances.

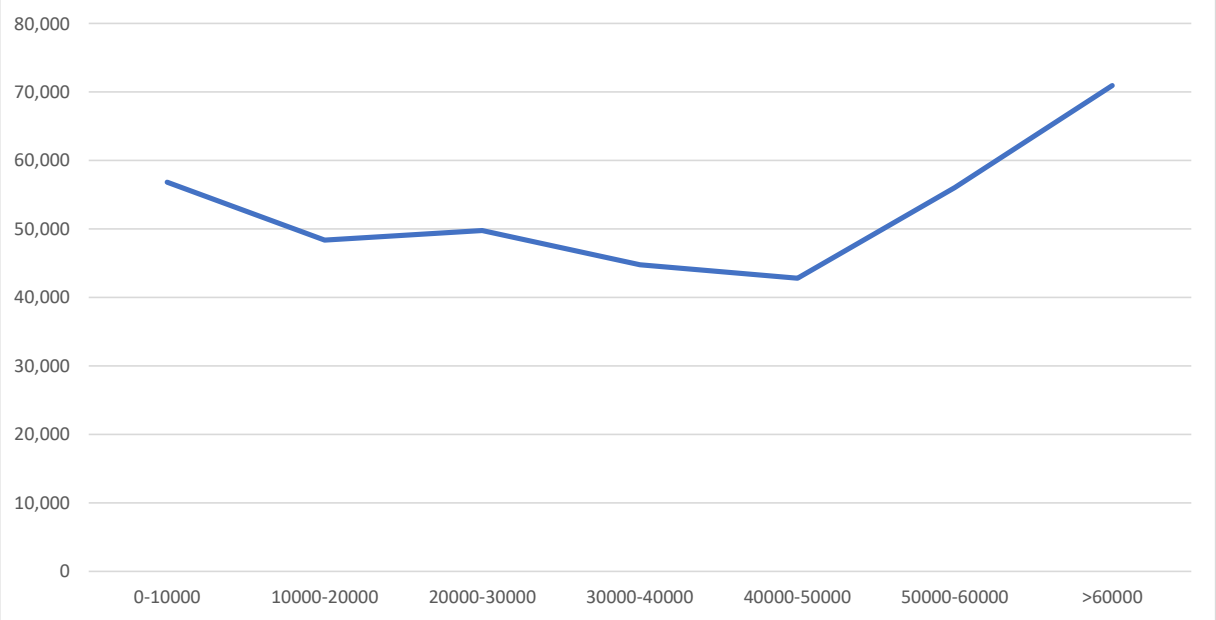
4. Correlation claims and CO_2?

From the regular Cefor NoMIS statistics publications it is well known that the claim cost per vessel differs by vessel types. Could there potentially be a correlation between claims and the vessel CO_2 emissions, and hence use vessel emissions for the prediction of claims costs? A complicating factor is that claims can affect the absolute emissions. Vessels undergoing repairs will have lower absolute emissions - but higher emissions per nautical mile – than trading vessels. This suggests that the potential predictive power of the emissions might be higher – or differ – when relating claims to emissions in the year prior to the insurance coverage

Large emissions equal large use of energy (or less efficient use of energy). Large use of energy is associated with large vessels, old vessels, wear and tear and/or high activity, all of which trigger higher claims costs than smaller, younger, better maintained or less active vessels. There are considerable benefits of scale in terms of CO_2 emissions (large vessels emit less per ton-mile) but this also applies to claims (the cost of a claim is not proportionate to the size of a vessel).

The graphs in this chapter are derived from claims covered under the same underwriting year as the year of the CO_2 emissions[8]. Our analysis did not reveal significant differences related to correlation, and the graphs do not give conclusive results to use vessel emissions for the prediction of claims costs. The graphs give however insights into how claims costs differ for different vessel segments by the size of CO_2 emissions and relative to CO_2 emissions.

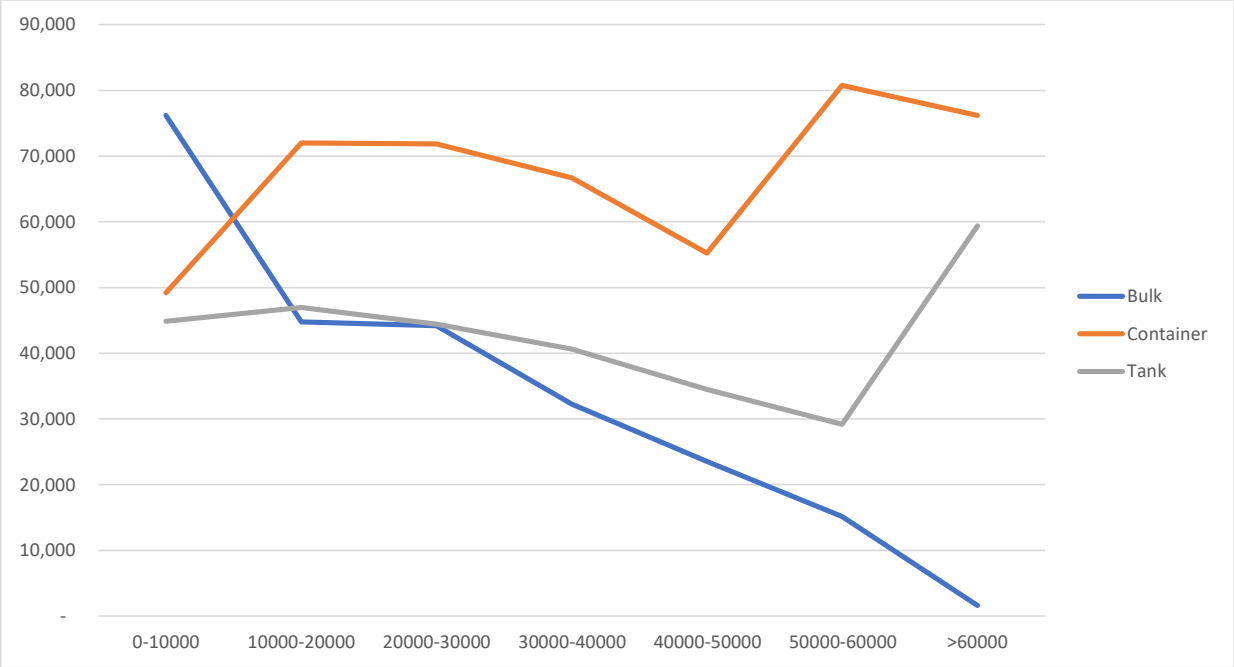
4.1 Claim cost per vessel (USD) by intervals of CO_2 tonnes emissions, Bulk, container, tank, years 2021-2023



[8] All claims as reported into the Cefor NoMIS database.

Graph 4.1 shows that the claim cost per vessel decreases slightly with increasing CO_2 emissions but increases sharply for vessels with the largest annual emissions. As the top emission intervals >50,000 CO_2 tonnes typically are dominated by container vessels, the reason for the higher claim cost per vessel in these intervals could be a different vessel portfolio mix, with a higher share of container vessels as compared to the lower emission intervals. Similar graph split by each of the three vessel types is presented in graph 4.2. and indicates a negative correlation between emissions and claim cost per vessels for bulk carriers.

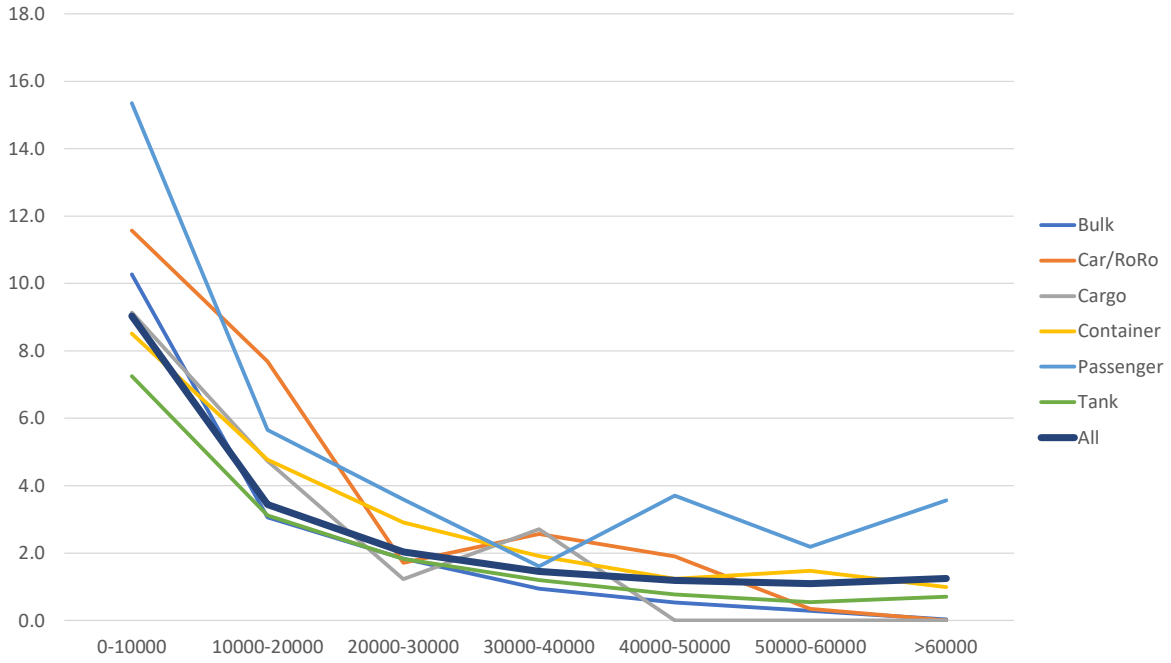
4.2 Claim cost per vessel (USD) by intervals of CO_2 tonnes emissions, Bulk, container, tank, years 2021-2023



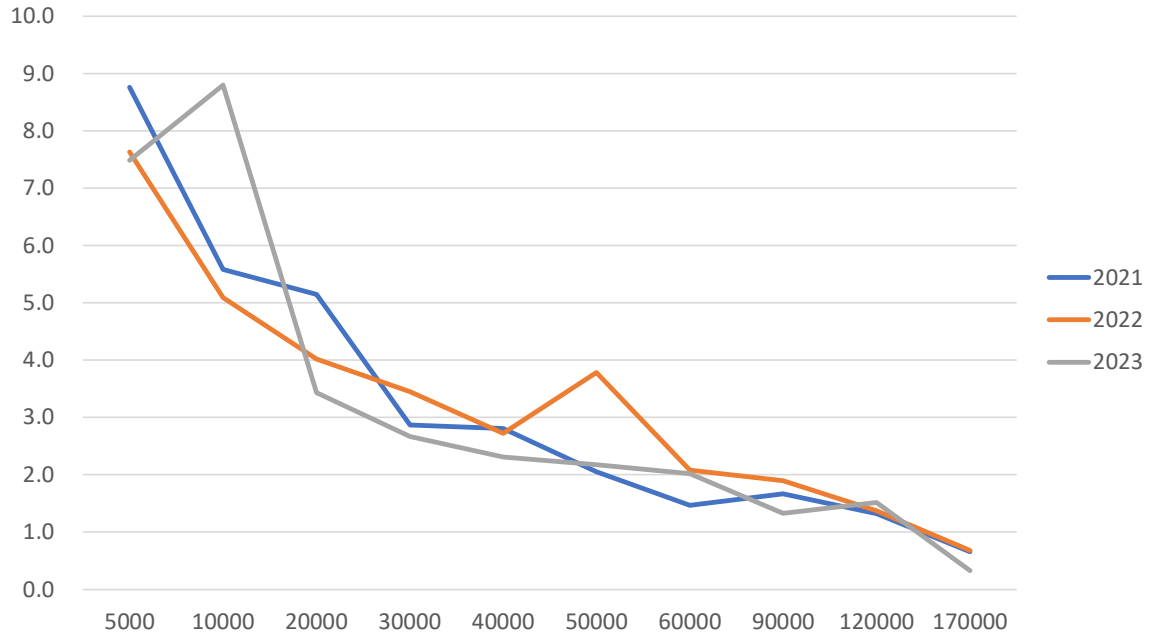
Graphs 4.3 and 4.4 show the claim cost per CO_2 emissions. These are highest for vessels with less emissions, while vessels with the highest emissions have a more favourable ratio of claims to emissions.

They also show that container, car/RoRo, cargo and passenger vessels perform worse than tank and bulk carriers, which is much in line with Cefor's regular statistics for the annual claim cost per vessel.

4.3 Claim cost per CO_2 (USD), by vessel type and intervals of CO_2 tonnes emissions, years 2021-2023



4.4 Claim cost per CO_2, by intervals of gross tons, years 2021-2023



5. Data sources and explanations

Relevant links related to CO_2 emissions, measurement methods and the Poseidon Principles for Marine Insurance:

- IMO GHG (Greenhouse Gas) Strategy
- Poseidon Principles for Marine Insurance
- PPMI Annual Disclosure Report January 2023
- PPMI Annual Disclosure Report January 2024
- Transition Trends: International Shipping Emissions 2018-2022 (November 2024)

The Poseidon Principles for Marine Insurance use the following calculation formulas:

Annual efficiency ratio (AER) = unit grams of CO_2 per tonne-mile = $Sum_i\ C_i$ / Sum_i (dwt * D_i)

where

C_i = carbon emissions for voyage i computed using the fuel consumption and carbon factor of each type of fuel

dwt = deadweight at maximum summer draught of the vessel

D_i = distance sailed over voyage i

The AER is computed for all voyages performed over a calendar year.

Climate alignment = percentage difference between a vessel's carbon intensity and the intensity on the decarbonisation trajectory at the same point in time (e.g. year). It is expressed as (+/-) %.

In mathematical terms, the climate alignment of a vessel i at the reported time is

$Delta_i = (x_i – r_s)/ r_s * 100$

where

x_i = carbon intensity of the vessel, i.e. the computed AER

r_s = required carbon intensity for the ship type and size class for the reported year based on the decarbonisation trajectory
Multiplication by 100 to convert into percentage terms

The target AER is between 2 and 20 grams of CO_2 per tonne-mile depending on vessel type and size. The distance from Shanghai to Hamburg is 14 480 nm (through the Suez Canal). Transporting 1 kg this voyage thus generates 2 to 20 times * 14,480 gram = 29-290 gram of CO2 if the vessel is fully laden both ways. This is the equivalent of almost 10-100 gram of fuel – so we need at least 1-10% of the weight of the cargo in fuel on this voyage.

NoMIS fleet / Nordic Marine Insurance Statistics

All statistics in this report marked as 'NoMIS fleet' are derived from the vessel portfolio reported by Cefor members into the Nordic Marine Insurance Statistics database (NoMIS).

For more information about the NoMIS database and its representativity in relation to the world fleet can be found on this page or in the 2023 Cefor annual stats report.

Further statistics

Detailed half-yearly updated hull trend reports are available from the Cefor website:
cefor.no/statistics/nomis/

In addition to the regular standard NoMIS stats reports, Cefor issues special analyses on topics of current interest which can be found here:
cefor.no/statistics/analysis-with-special-focus/

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