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**Full-length report**

*Accompanying the document*

**Report from the Commission**

**2020 Annual Report on CO<sub>2</sub> Emissions from Maritime Transport**

{C(2021) 6022 final}

# Second Annual MRV Report

on CO<sub>2</sub> emissions

## from Maritime Transport covering 2019 emissions



# **2020 Annual Report from the European Commission on CO<sub>2</sub> Emissions from Maritime Transport**

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## Executive Summary

### Key figures and findings

#### A report based on two full annual compliance cycles



**2015:** Adoption of Regulation (EU) 2015/757 on the monitoring, reporting and verification of CO<sub>2</sub> emissions from maritime transport.

**2017:** Preparation of monitoring plans.

**2018:** First reporting period

**2019:** Second reporting period & publication of information on 2018 data.

**2020:** Third reporting period & publication of information on 2019 data

#### Similar findings in 2019 compared to 2018, showing the consistency and robustness of the MRV reported data, notably in terms of:

|                                 |  |
|---------------------------------|--|
| <b>CO<sub>2</sub> emissions</b> | <p><b>&gt;144 million tonnes of CO<sub>2</sub></b></p> <ul style="list-style-type: none"> <li>• Slight increase of CO<sub>2</sub>: 144,6 million tonnes in 2019 compared to 138 million tonnes in 2018<sup>1</sup></li> <li>• Maritime transport remains a substantial CO<sub>2</sub> emitter representing 3-4% of total EU CO<sub>2</sub> emissions</li> <li>• By targeting ships above 5,000 gross tonnage, the EU MRV shipping Regulation covers around 90% of all CO<sub>2</sub> emissions, whilst only including around 55% of all ships calling into EEA ports. Apart from LNG carriers which increased their CO<sub>2</sub> emissions by 30% from 2018 to 2019, the distribution and variation of it across the different types of ships is very similar:             <ul style="list-style-type: none"> <li>• Container ships represented the largest share of total emissions, with 30% in 2019, compared to 31% in 2018.</li> <li>• Bulk carriers emitted approximately 12% of all reported CO<sub>2</sub> emissions</li> <li>• Ro-ro (roll-on/roll-off) and ro-pax (roll-on/roll-off passenger) ships together reported 21 million tonnes of CO<sub>2</sub> emissions in both reporting years (16% of emissions)</li> </ul> </li> </ul> |
|---------------------------------|--|

<sup>1</sup> 138 million tonnes refers to the emissions extracted on 23 September 2019 and used in the previous MRV report. However the comparisons of this report refer to 144,6 mill tonnes in 2019 and 144,2 in 2018 as they are the most updated figures at the time of data extraction (16 November 2020)

|                                     |  |
|-------------------------------------|--|
|                                     | <ul style="list-style-type: none"> <li>• Similar distribution of CO<sub>2</sub> emissions per type of voyages: <ul style="list-style-type: none"> <li>• 6-7% of CO<sub>2</sub> emissions happens within ports at berth</li> <li>• Around a third of CO<sub>2</sub> emissions are related to intra-EEA voyages</li> </ul> </li> </ul> <p>Around 60% of all CO<sub>2</sub> emissions are related to extra-EEA voyages, with slightly more emissions related to incoming voyages compared to outgoing voyages</p> |
| <b>Fuel consumption</b>             | <p><b>&gt;46 million tonnes of fuels consumed</b></p> <ul style="list-style-type: none"> <li>• 69% of the fuel consumed by the monitored fleet in 2019 was heavy fuel oil (HFO), compared to 71% in 2018</li> <li>• 22% marine gas oil and diesel</li> <li>• The consumption of liquefied natural gas (LNG) increased by one percentage point, from 4% to 5%.</li> </ul>   |
| <b>Fleet covered</b>                | <p><b>&gt;12,000 ships</b></p> <ul style="list-style-type: none"> <li>• The monitored fleet and its distribution per ship type, flag, fleet age, and ownership is almost identical. The monitored ships are relatively young, although there are large age disparities between ship types</li> <li>• Around two-thirds are non-EU flagged</li> <li>• More than half are owned by entities based in the EU.</li> </ul>  |
| <b>Number of shipping companies</b> | <p><b>&gt;1,600 companies</b></p> <ul style="list-style-type: none"> <li>• Around half of these are European companies</li> </ul>  |
| <b>Energy efficiency</b>            | <ul style="list-style-type: none"> <li>• Additional analysis of reported technical energy efficiency extended to ship types not covered in the previous report.</li> <li>• Speed variation between 2018 and 2019 is negligible</li> <li>• Additional analysis shows the performance of the ship types not covered in the previous report.</li> </ul>   |

## 1. Introduction

*This report has been prepared using data from the implementation of the EU Regulation on the monitoring, reporting and verification of CO<sub>2</sub> emissions from maritime transport. All information corresponding to 2019 emissions was extracted on 16 November 2020. Data provided or updated after this date is not reflected in this report.*

In view of presenting a robust analysis, based on stable figures and reflecting reality, *the 2018 data used for this report was extracted on 16 November 2020. This means that the 2018 figures used here might slightly differ from those published in the report on 2018 data, which was based on data extracted on 23 September 2019. For instance, the total CO<sub>2</sub> reported emissions in 2018 considered here are 144,2 million tonnes, while in the original report were 138 million tonnes.*

### 1.1 The new report

This is the Second report on CO<sub>2</sub> emissions data from ships entering and leaving EU ports, collected under the monitoring, verification and reporting (MRV) system for CO<sub>2</sub> emissions from maritime transport adopted in 2015 (Regulation (EU) 2015/757)<sup>1</sup>.

This legislation is the first step of a staged approach for the inclusion of maritime transport emissions in the EU's greenhouse gas (GHG) reductions commitments and the foundation for policy measures that are currently under development in the context of the European Green Deal. It has three key objectives:

- to collect **robust and verified CO<sub>2</sub> emission data**;
- to provide **transparency** and stimulate the uptake of energy efficiency investments and behaviours;
- to **support policy discussions** and implementation of policy tools.

The legislation requires shipping companies to track and report key information about CO<sub>2</sub> emissions, fuel consumption and other relevant information. This data is then checked by independent verifiers accredited by national accreditation bodies. The Commission subsequently publishes the verified data and drafts an Annual Report on CO<sub>2</sub> emissions from maritime transport. A detailed description of the MRV process can be found in the Appendix 2: The MRV system - The different steps of the MRV process of this report.

Throughout the whole process, transparency is key. The first set of MRV data, corresponding to 2018,

analysed in the 2019 MRV Annual Report, has contributed to an enhanced understanding of the climate impact of the shipping sector regarding CO<sub>2</sub> emissions. The published raw data has also been used by universities and research organisations, public authorities and other market actors for analyses and studies on the maritime sector and efficiencies of maritime transport.

The present report covers the second compliance cycle, i.e., 2019 emissions, and allows, for the first time, for a comparison of data from two reporting years. It builds on the previous report which provided an introduction and general information on emissions from shipping, the MRV system, and climate action at European and international level. The main interest of the present report is to detect and examine trends in emissions and energy efficiency characteristics, based on the first two reporting cycles, and to analyse the MRV process and its fit-for-purpose IT instrument developed (THETIS-MRV). This new report also complements the previous one by assessing the CO<sub>2</sub> emissions profiles of a broader range of ship categories.

In line with the MRV Regulation (art. 21 para. 5), this report includes an assessment of the impact of the maritime transport sector on the global climate, including CO<sub>2</sub> as well as air pollution related emissions from ships and effects. This analysis (Chapter 1.4) relies on the outcomes of the 4<sup>th</sup> Greenhouse Gas Study of the International Maritime Organization (IMO)<sup>2</sup>.

## Forthcoming report on environmental aspects of maritime transport

The European Environment Agency and the European Maritime Safety Agency will publish in September 2021 the European Maritime Transport Environmental Report on all the environmental aspects of maritime transport. This report, although

not based on individual ships' monitored and reported data, will also cover other ships' exhaust emissions with effects on air pollution including black carbon.

### SHIPPING – A KEY EUROPEAN INDUSTRY

International shipping is an essential part of European transport. It carries 75% of external EU trade, and 36% of intra-EU trade.

Shipping is an essential link in the global supply chain, and a **key part of the EU economy**. It is also one of the most **energy-efficient modes of transport** available. However, it continues to be a major greenhouse gas (GHG) emitter that is still largely dependent on fossil fuels

The **EU shipping industry directly employs around 640,000 people** and up to **2.1 million when including the whole supply chain**. The industry **contributed nearly EUR 54 billion to the EU GDP in 2018**.

**More than 400 million passengers** embark or disembark each year at EU ports. Shipping contributes to coastal economies and helps bring Europeans closer together.

The European maritime technology sector produces **around half of the world's marine equipment** each year.

The EU's share of worldwide shipbuilding production is in decline. Over 90% of shipbuilding activity takes place in China, the Republic of Korea and Japan. However, much of this activity relates to lower-end maritime technologies and, the **EU remains a global leader in the construction of sophisticated, higher added value-vessels**.

## 1.2 Context

### Action at EU level

As response to the climate- and environment-related challenges that constitute this generation's defining task, the European Union adopted, in December 2019, the European Green Deal which sets out a new growth strategy aiming to transform the EU into a sustainable, modern, competitive, and circular economy where economic growth is decoupled from resource use and where there are no net GHG emissions in 2050.<sup>3</sup> The goal set in the Green Deal is being enshrined in EU law through the European Climate Law which sets as well other intermediate goals.

As part of the Green Deal agenda, the Commission proposed, in September 2020, to raise the 2030 greenhouse gas emission reduction target, including emissions and removals, to at least 55% compared to 1990.<sup>4</sup> This is a substantial increase compared to the existing target of at least 40%. Raising the 2030 ambition helps give certainty to policymakers and

investors, so that decisions which will be taken in the coming years do not lock in emission levels inconsistent with the EU's 2050 climate-neutrality goal.<sup>5</sup>

Action is required across all sectors of the economy, including maritime transport where CO<sub>2</sub> emissions are projected to grow in the mid- to long-term driven by the growth in transport activity and the current heavy reliance on oil derivatives (despite energy efficiency improvements). International maritime transport activity is predicted to grow strongly in the future. Recent modelling results for the Sustainable and Smart Mobility Strategy demonstrate the significant emissions reduction gap that needs to be closed by 2030 and 2050, to contribute to the 2030 Climate Target Plan and the European Green Deal objectives.<sup>6</sup>

The Commission has started the process of developing detailed legislative proposals to ensure that the maritime transport sector contributes its fair share to

the EU climate efforts. All sectors need to contribute to setting the EU on a trajectory compatible with the objective to become a climate-neutral economy by 2050, but also, to implement the EU's commitments under the Paris Agreement.<sup>7</sup> According to the latest UNEP Gap Report international shipping (and aviation) must be completely decarbonised by around 2050 for the Paris Agreement's 1.5°C target and by 2070 for the 2°C target.<sup>8</sup>

As part of the package to deliver the European Green Deal<sup>2</sup>, the Commission proposed in July 2021 a series of measures to ensure that the maritime transport sector contributes to the EU's climate ambitions. These measures include extending the European emissions trading to maritime transport, a dedicated initiative to boost demand for sustainable alternative fuels (the FuelEU Maritime initiative), and revision of existing directives on energy taxation, alternative fuel infrastructures and renewable energy. In parallel, the Commission will continue supporting research and innovation towards the decarbonisation of maritime transport.

In addition, the Commission is committed to support the implementation of the initial IMO Strategy for GHG emission reductions, which needs to lead to effective and timely action (see below).

#### *International action: The initial IMO GHG Strategy*

In 2018, the IMO reached an agreement on an initial strategy to reduce greenhouse gas (GHG) emissions from international shipping, subject to a review in 2023. It contains a clear GHG emission reduction objective of at least 50% by 2050, compared to 2008 levels, with a view to phase out the GHG emissions of the sector as soon as possible in this century following a pathway of CO<sub>2</sub> emissions reduction consistent with the Paris Agreement temperature goals". It is accompanied by a comprehensive list of possible reduction measures, including short-term measures. "The timeline for short-term measures should prioritize potential early measures [...] with a view to achieve further reduction of GHG emissions from international shipping before 2023." The strategy sets an objective to "reduce CO<sub>2</sub> emissions per transport work, as an average across international shipping, by at least 40% by 2030 [...] compared to 2008". The following objectives are also referred to: "peak GHG emissions

<sup>2</sup> Communication COM(2021) 550 final

from international shipping as soon as possible" and to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008 whilst pursuing efforts towards phasing them out in line with the Paris Agreement.

In November 2020, MEPC 75<sup>3</sup> approved amendments to MARPOL<sup>4</sup> Annex VI, including a framework for technical and operational carbon intensity improvements, Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII).

The operational approach introduces required operational carbon intensity indicators and a rating system classifying ships in different categories (A, B, C, D, E). to be recorded in the ship's Ship Energy Efficiency Management Plan (SEEMP). A ship rated D for three consecutive years, or E, would lose its Statement of Compliance unless it submits to the Administration a corrective action plan for verification, to show how the required index (C or above) would be achieved.

Amendments to the Energy Efficiency Design Index (EEDI) regulation were also adopted at MEPC 75. They will noticeably advance phase 3 from 2025 to 2022 for certain ship types.

#### *Impact of the COVID-19 crisis*

The slight delay observed in 2020 reporting is similar to the previous year so companies overcome difficulties encountered due to the COVID pandemic. Nevertheless, the measures put in place to stop the spreading of the coronavirus in EU Member States might have prevented on-site inspections by verifiers. Impacts of the pandemic and the resulting slowdown of international shipping activities and CO<sub>2</sub> emissions from the maritime transport sector, are likely to be reflected in 2020 data which will be published in 2021.

## 1.3 Scope

#### *The scope of the MRV Regulation*

The monitoring, reporting, and verification obligation applies to ships above 5,000 gross tonnage (GT) loading or unloading cargo or passengers at ports in the European Economic Area (EEA). The Regulation is

<sup>3</sup> MEPC75: 75 session of the IMO Marine Environment Protection Committee

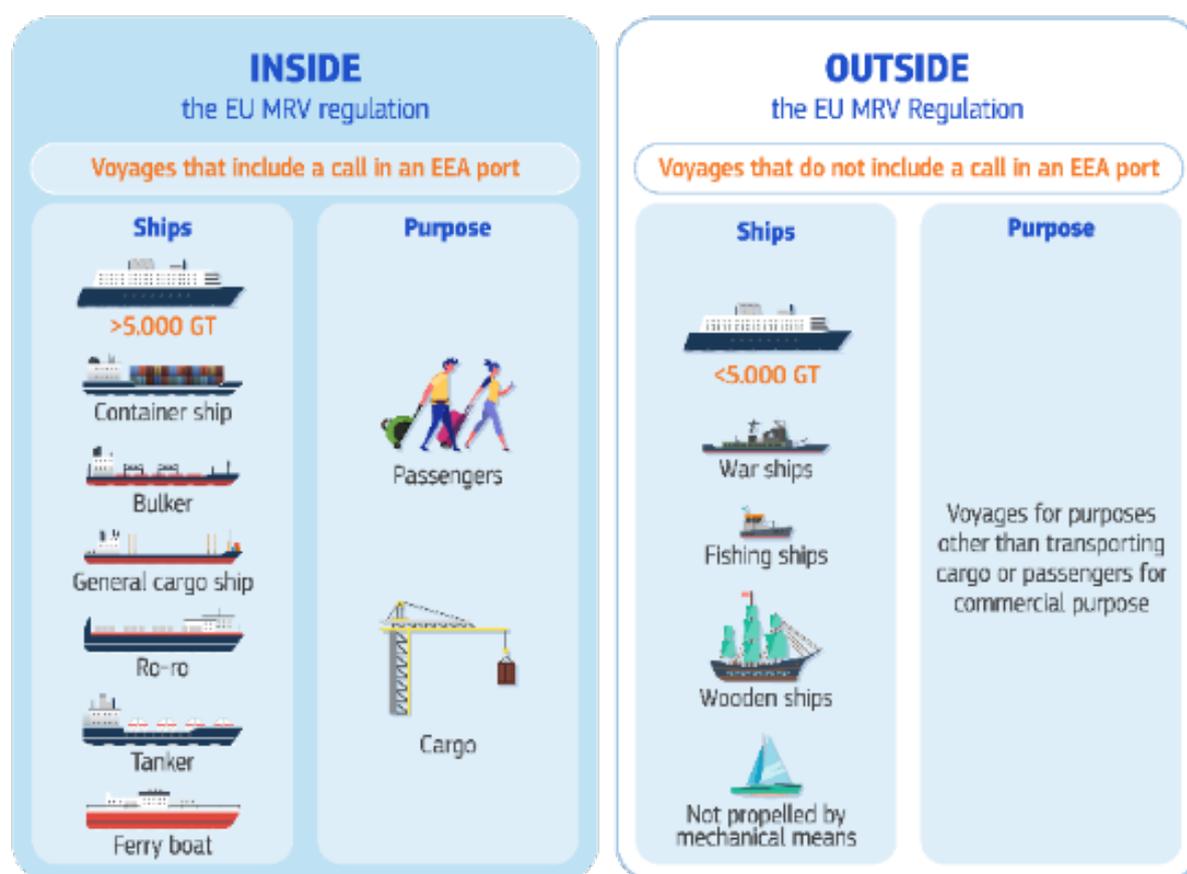
<sup>4</sup> MARPOL: International Convention for the Prevention of Pollution from Ships adopted at IMO on 1973

flag-neutral, which means that ships have to monitor and report their emissions regardless of their flag.

Despite limiting the monitoring requirements to large ships, the Regulation covers around 90% of all CO<sub>2</sub> emissions, whilst only including around 55% of all ships calling into EEA ports. For proportionality and subsidiarity reasons, military vessels, naval auxiliaries, fish-catching or fish-processing ships are excluded from the Regulation.

The Regulation covers CO<sub>2</sub> emissions produced when a ship carries out a voyage from or to a port in the EEA when transporting goods or passengers for commercial purposes. For instance, it covers emissions from a ship that goes from Rotterdam to Shanghai. The Regulation also applies to emissions produced when a ship sails from Shanghai to Rotterdam.

Figure 1: Scope of the EU MRV Regulation



However, if a ship departs from Shanghai for Rotterdam and makes a stop at another port (e.g. the port of Singapore) for cargo or passenger operations, only the emissions related to the last leg of the voyage (in this case Singapore-Rotterdam) will be reported in the system. Voyages that take place within the EEA are also covered, such as a ship travelling from Le Havre to Rotterdam, or from Ghent to Antwerp (domestic

voyages). Emissions occurring when the ship is securely moored or anchored at a port (at berth) whilst loading, unloading or hoteling are also covered.

It should be noted that only voyages that serve the purpose of transporting passengers or cargo for commercial purposes are included.

## 1.4 Impact of maritime transport on global warming

The Intergovernmental Panel on Climate Change (IPCC) defines two broad categories of climate forcers: “long-lived GHGs, such as CO<sub>2</sub> and nitrous oxide (N<sub>2</sub>O), whose warming impact depends primarily on the total cumulative amount emitted over the past century or the entire industrial epoch; and short-lived climate forcers (SLCFs), such as methane and black carbon, whose warming impact depends primarily on current and recent annual emission rates. These different dependencies affect the emissions reductions required of individual forcers to limit warming to 1.5°C or any other level.”<sup>9</sup> The different ways in which different types of climate forcers have to be taken into account when calculating aggregate emissions result from the different characteristics of the forcers. “Emissions of long-lived greenhouse gases such as CO<sub>2</sub> and nitrous oxide (N<sub>2</sub>O) have a very persistent impact on radiative forcing, lasting from over a century to hundreds of thousands of years (for CO<sub>2</sub>). The radiative forcing impact of short-lived climate forcers (SLCFs) such as methane (CH<sub>4</sub>) and aerosols, in contrast, persist for at most about a decade (in the case of methane) down to only a few days.”<sup>10</sup>

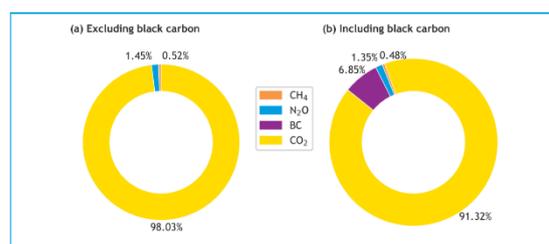
The IPCC’s Special Report continues to explain that “whatever method is used to relate emissions of different greenhouse gases, scenarios achieving stable global mean surface temperature, *added*, well below 2°C require both near-zero net emissions of long-lived greenhouse gases and deep reductions in warming SLCFs, in part to compensate for the reductions in cooling SLCFs that are expected to accompany reductions in CO<sub>2</sub> emissions.”<sup>11</sup>

Greenhouse gases (GHGs) coming from ships include for the most part CO<sub>2</sub> as the result of the combustion of mainly fossil fuels in the ship’s combustion machinery (i.e., engines, auxiliary engines, boilers, etc.). Methane (CH<sub>4</sub>) may be emitted to the atmosphere on ships using gas or dual fuel engines or from the cargo tanks in Liquefied Natural Gas (LNG) carriers. Refrigerants are used for air conditioning and for cargo cooling processes and various gases are used including Hydro Fluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur Hexafluoride (SF<sub>6</sub>).” Other air polluting emissions of ships include sulphur oxides (SO<sub>x</sub>), nitrogen oxides (NO<sub>x</sub>) and fine and ultrafine particulate matters including black carbon (BC). SO<sub>x</sub>

and NO<sub>x</sub> are precursors of particulate matters responsible for the negative impacts on human health and polluting water when deposited. In the Arctic region, in particular, direct emissions of black carbon from shipping are also significant drivers of warming.

In November 2020, MEPC 75 approved the 4<sup>th</sup> IMO GHG study. The study covers the emissions from shipping for the period 2012-2018. The GHG shipping emissions – including carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O), expressed in CO<sub>2</sub> equivalent (CO<sub>2</sub>e) and including all shipping (international, domestic and fishing) have increased from 977 million tonnes in 2012 to 1,076 million tonnes in 2018, representing a 9.6% increase.

**Figure 2: Contribution of different GHG emissions expressed in CO<sub>2</sub>e to voyage-based international GHG emissions in 2018<sup>5</sup>**



The share of shipping emissions in global anthropogenic emissions has increased from 2.76% in 2012 to 2.89% in 2018. CO<sub>2</sub> emissions from international shipping have increased by 5.6% during the same period<sup>6</sup>. The differentiation

<sup>5</sup> 4<sup>th</sup> IMO GHG Study

In 2018, the contribution from each of the GHG emissions (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O) to overall CO<sub>2</sub>-equivalent emissions is 98.03, 0.52, 1.45% respectively when considering voyage-based international emissions, where the vessel-based proportions differ marginally (98.12, 0.44 and 1.44%). If Black Carbon emissions are also included in the calculation of CO<sub>2</sub>-equivalents, using a 100-year GWP of 900, these shares become 91.32, 0.48, 1.35% (for CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O), with BC representing the second most significant contribution at 6.84%, for voyage-based international emissions (where shares are 91.17, 0.41, 1.34 and 7.08%, respectively, for vessel-based international emissions)

<sup>6</sup> When the allocation is based on voyages, CO<sub>2</sub> emissions from non-international shipping have increased by 46% during this period. In 2018, CO<sub>2</sub> emissions from

between domestic and international voyages was for the first time done on a voyage basis<sup>7</sup>. The 2018 dataset from the EU MRV regulation was noticeably used to validate the modelling. CO<sub>2</sub> emissions from ships above 5,000 GT calling in European Economic Area (EEA) ports are estimated to represent around 13% of all global shipping GHG emissions.

Methane emissions increased by 150% over the period studied 2012 -2018, far greater than the use of LNG as a marine fuel. SO<sub>x</sub> and Particulate Matter (PM) emissions increased, respectively by 5.5% 3.6%.

Total NO<sub>x</sub> emissions also increased during the period, by 1.2%. For international shipping, NO<sub>x</sub> emissions increased from 16.9 to 17.1 million tonnes, SO<sub>x</sub> emissions from 9.1 to 9.6 million tonnes, PM<sub>2.5</sub> from 1.304 million tonnes to 1.351 million tonnes. Because of the increasing trends of air pollutants, the IMO introduced the global sulphur limit of 0,50% globally as of 2020 and the EU Smart and Sustainable Mobility Strategy foresees to extend the introduction of Emissions Control Areas (ECAs) for both SO<sub>x</sub> and NO<sub>x</sub> in all EU waters.

Black Carbon emissions were estimated for the first time. They have increased by 11.6% for total shipping during this period (i.e. from 59 to 62 kilo tonnes). The impact of BC in Arctic waters is critical due to the fragility of its environment.

The overall carbon intensity, as an average across international shipping, was 21% and 29% better than in 2008, measured in Annual Efficiency Ratio (AER) and Energy Efficiency Operational Indicator (EEOI), respectively. When comparing IMO DCS 2019 with 2008, these share increase to 31.5% and 42.7% for AER and EEOI respectively. Increasing average ship size has had a dominant role in carbon intensity reductions. Operating speeds also remain a key driver for trends in emissions. However, under certain market conditions, operating speeds could increase again in the future, leading to increased GHG emissions.

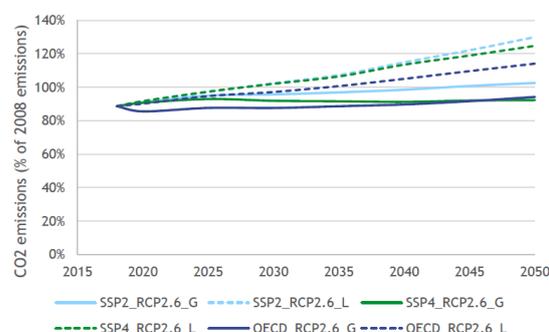
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international shipping represented 70% of total shipping emissions

<sup>7</sup> When the allocation is based on vessels, CO<sub>2</sub> emissions from international shipping have increased by 8,4% and non-international shipping by 20%. In 2018 CO<sub>2</sub> emissions from international shipping represented 87% of total shipping emissions.

According to the fourth IMO GHG study, global CO<sub>2</sub> emissions are 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.

**Figure 3: Projections of maritime ship emissions as a percentage of 2008 emissions<sup>8</sup>**



The differences in the BAU emission projections are caused by differences in transport-work projections which, in turn, are caused by differences in socio-economic projections and different methods to establish the relation between transport work and independent variables like per capita GDP, population and primary energy demand. The emissions are for total shipping. It is expected that the share of domestic and international emissions will not change.

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<sup>8</sup> 4th IMO GHG Study

## 2. Outcomes of the second compliance cycle

### 2.1 Feedback from each step of the compliance cycle

A detailed description of each step of the compliance cycle is provided in the Appendix 2 of this report.

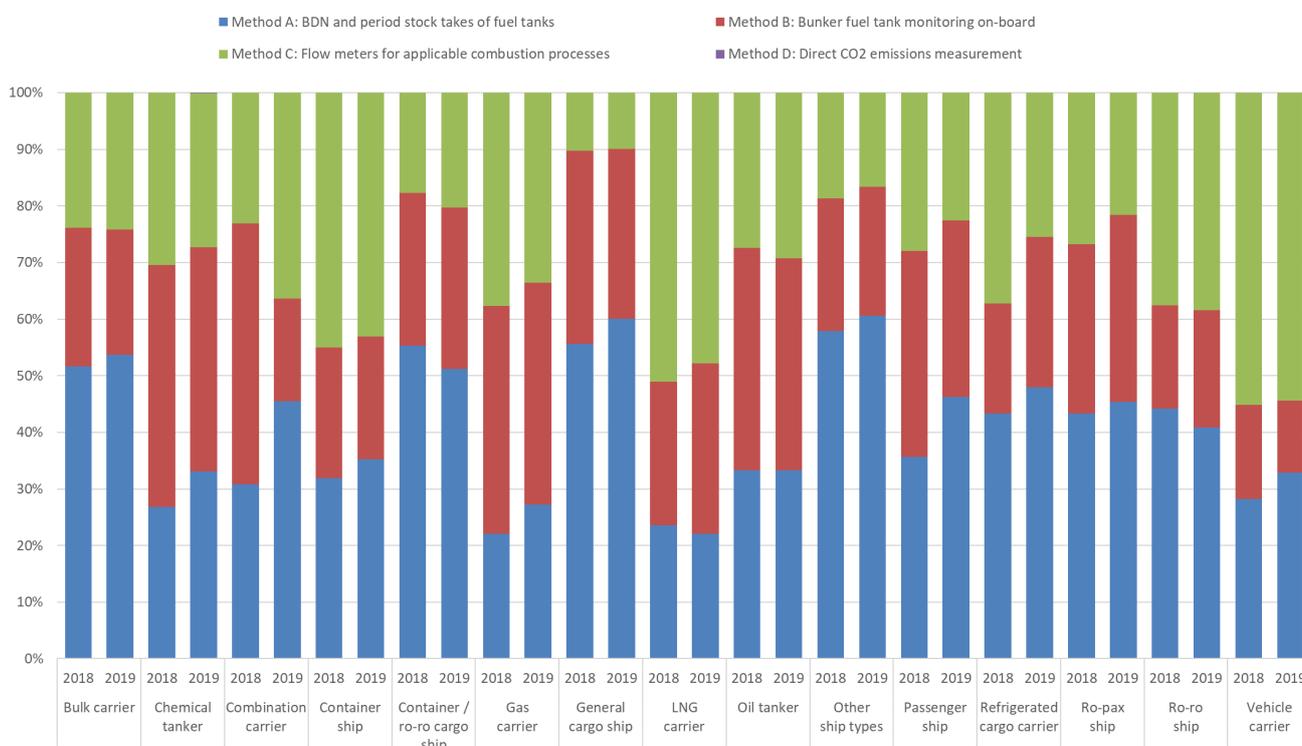
#### 2.1.1 Step 1: Producing a Monitoring Plan

##### Monitoring methods

Just like in the first reporting period, in the second period, companies relied on the following monitoring methods: Bunker Fuel Delivery Note (BDN) and period stock takes of fuel tanks (Method A), bunker

fuel tank monitoring on-board (Method B), and flow meters for applicable combustion processes (Method C). The rare use of direct CO<sub>2</sub> emissions measuring (Method D) is possibly due to its complexity. The vast majority of companies used default values for the level of uncertainty associated with fuel monitoring, following the guidance and best practice document elaborated by the MRV Implementation Sub-Group of the European Sustainable Shipping Forum (ESSF).

Figure 4: Monitoring methods used in emission reports



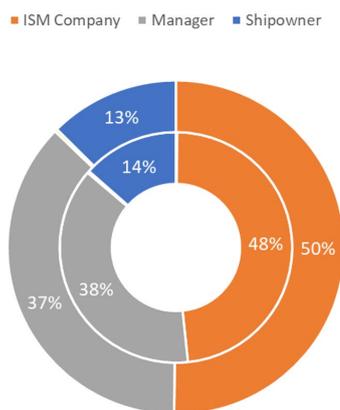
##### Companies

With 1,668 shipping companies reporting emissions for 2019, the number of companies has not considerably changed compared to 2018 (1,610). In both reporting cycles, 2018 and 2019, the vast

majority of emission reports was prepared by ISM companies<sup>9</sup>, managers or shipowners (Figure 5).

<sup>9</sup> ISM Company means the legal entity managing the Vessel in compliance with the International Safety Management (ISM) and International Ship and Port Facility (ISPS) Codes.

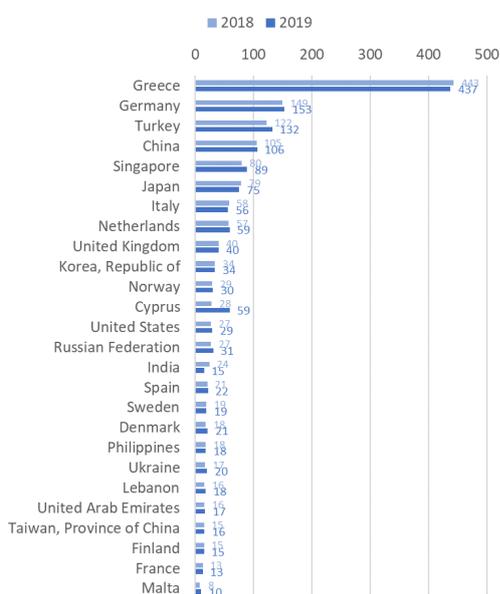
**Figure 5: Type of companies (Inner-circle 2018, Outer-circle 2019)**



To further understand the share of ISM companies, a comparison of the EU MRV data set with MARINFO<sup>10</sup> was carried out, concluding that around 90% of the companies reporting could be identified as ISM companies.

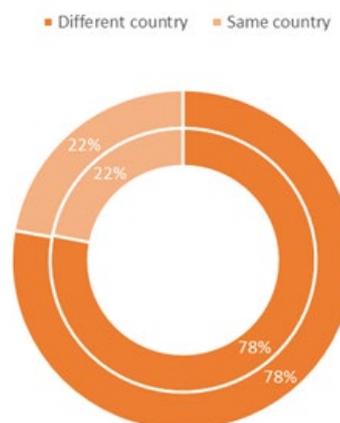
Figure 6 shows the country of origin of the companies, which, in almost 80% of the cases, is different from the country of the flag under which individual ships of these companies fly (Figure 7).

**Figure 6: Number of companies per country (not per flag) (excluding countries with less than 10 companies)**



<sup>10</sup> MARINFO: EMSA’s database that contains data purchased from HIS Markit & trade, among other sources

**Figure 7: Relation between company country and flag (inner-circle 2018, Outer-circle 2019)**



No significant change occurred in terms of the country of origin of companies between the first two reporting cycles. In both reporting periods, 57% of the companies are European (EU-28 and EEA), with 28% in 2018 and 26% in 2019 coming from Greece and 9% in both reporting periods from Germany. Turkey is the third most important country in terms of number of companies. It is followed by China, Singapore and Japan that represent 60% of all shipping companies.

*Monitoring plans*

7,747 monitoring plans were registered in the THETIS-MRV system, representing an increase of 2,179 (40%) from 2018 (5,568 plans registered). It should be noticed that registering the monitoring plan in the THETIS-MRV system is voluntary, and the majority of the companies does not pursue the full process up to submission and assessment by the verifier.

### 2.1.2. Step 2: Monitoring and Reporting

While drafting Emissions Reports, companies can include information on differentiated criteria important to clarify the interpretation of their CO<sub>2</sub> emissions and energy efficiency indicators. Apart from the differentiation between freight and passenger transport, which is mandatory for Ro-Pax ships, companies can, voluntarily, distinguish voyages without cargo (ballast) from voyages with cargo (laden). In addition, chemical tankers can single out fuel consumption and CO<sub>2</sub> emissions related to cargo heating, and oil tankers and other ship types, the fuel consumption and CO<sub>2</sub> emissions related to dynamic positioning.

There are no important differences when comparing 2018 and 2019 voluntary reporting. In 2019, almost 20% of the Emission Reports included voluntary differentiated criteria in their fuel consumption records. 11.5% of the Emission Reports included voluntarily reported CO<sub>2</sub> data related to on-laden and 8% to on-ballast voyages, which is a slight increase compared to 2018.

The voluntary reporting based on differentiating criteria increased over 12% for bulk carriers, ro-pax ships, chemical and oil tankers, container ships and LNG carriers, but decreased for general cargo ships

between the first and the second reporting cycle. Contrary to 2018 where a negligible number of vehicle carriers reported voluntary information based on differentiated criteria, voluntary reporting was used in around 250 cases in 2019, differentiating between on laden and ballast voyages.

Additional information to facilitate the understanding of the reported average operational energy efficiency indicators was reported in only 50 emissions reports out of 12,154 in 2018 (0.4%) and even less in 2019 where only four Emission Reports out of 12,114 (0.03%) included this type of information. Voluntary information on the average density of cargo transported was reported by 5 ships, from 2 companies, in 2018. All of them were chemical tankers. No ship reported average cargo density in 2019.

17% of the monitored ships voluntarily reported Ice Class in 2019, compared to 16% in 2018. More than half of these ships have ice class IA, which means that they are capable of navigating in difficult ice conditions, with the assistance of icebreakers when necessary (Figure 9).

Figure 8: Use of differentiated criteria when reporting fuel consumption

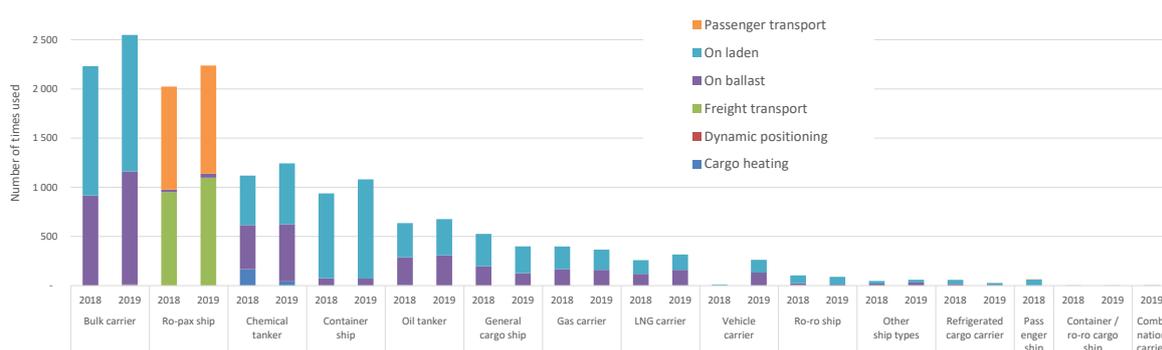
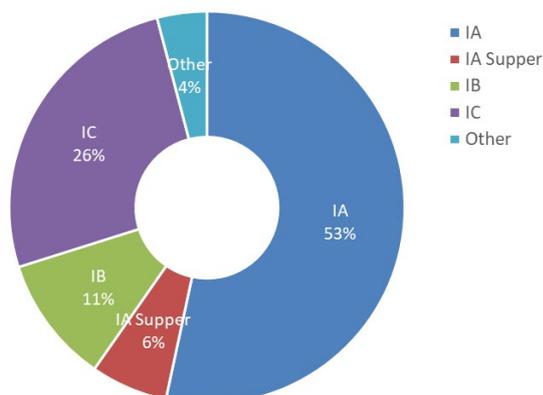


Figure 9: Distribution of reported ice class<sup>11</sup>

### 2.1.3 Step 3: Providing an Emission Report

13,830 emissions reports were drafted for 2019, compared to 15,447 for 2018. From these, 22% in 2018 and 12% in 2019 were not finally submitted to the Commission and/or did not result in the issuance of a document of compliance. Emission reports not submitted include namely two situations, those that stayed as a draft that have not been concluded, and those verified as satisfactory but not submitted by the company to the Commission, most probably because lack of awareness of the full process.

Around one fifth of the emissions reports was created after the deadline for verification (30 April 2020), more concretely 19% of emissions reports for 2018 and 23% for 2019 were created after the deadline. Slight delay observed in 2020 reporting is similar to the previous year so companies overcome difficulties encountered due to the COVID pandemic.

### 2.1.4 Step 4: Verification of Emission Reports and Submission to the Commission

With 12,117 emission reports successfully verified and submitted to the Commission through the IT instrument developed for the MRV maritime, THETIS-MRV, for 2019, the numbers of emission reports of the first two reporting years are very similar and reflect consistency in the number of ships calling EU ports.

<sup>11</sup> Ice class denominations from Implementing Regulation 2016/1927 on templates (Annex II, part A, paragraph 5.)

### National Accreditation Bodies

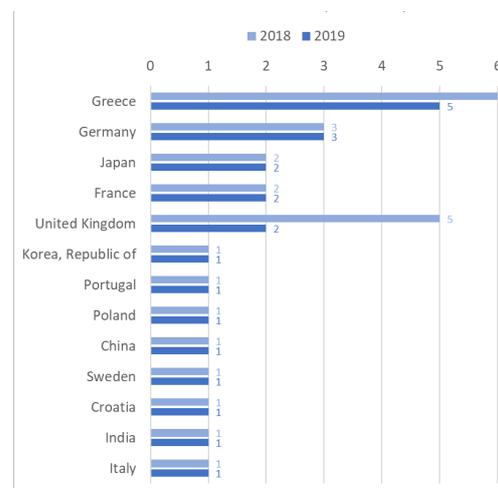
Accreditation is the confirmation by an officially recognised authority that a verifier and its personnel have the competence and the ability to perform the required verification activities. National accreditation bodies are the only ones allowed to provide such accreditation.

Figure 10 illustrates that accreditation activities in both reporting cycles have mainly involved five national accreditation bodies.

### Accredited Verifiers

In regard to the numbers of accredited verifiers per Member State, whereas in all other countries the numbers remained constant, (except in Greece where the number of verifiers decreased from 6 to 5), the number of accredited verifiers in the UK decreased from 5 to 2 between 2018 and 2019, probably due to the anticipation of the United Kingdom's withdrawal from the European Union.

Figure 10: Number of accredited verifiers per country



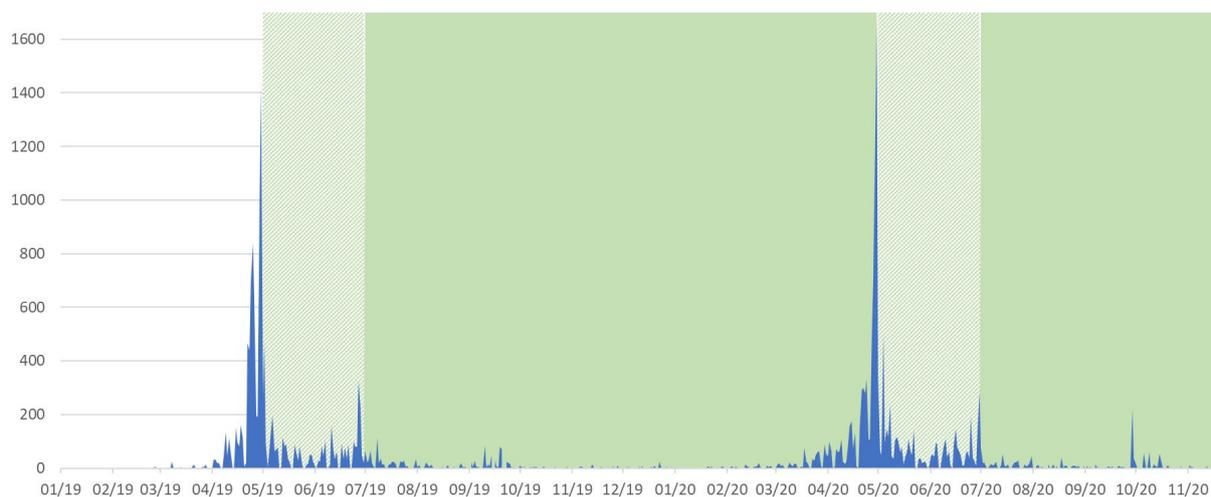
Because of late submissions of emissions reports by the companies to the verifiers – around 30% of the submissions to verifiers happened after the 30 April deadline in both reporting cycles (Figure 11) – some of the verifications also occurred late. More concretely 35% of the assessed reports for 2018 and 37% for 2019 were verified as satisfactory after the deadline.

Consequently, the submission of the verified emissions reports to the Commission was also delayed, namely in 45% of the cases in 2018 and 42% in 2019.

While there have been some delays in the verification process of 2019 emissions data in

2020, data from 12117 ships was submitted in 2020 despite coronavirus pandemic impact.

**Figure 11: Distribution over time of the submission of Emission Reports to the Commission**



### 2.1.5 Step 5: Issuing a Document of Compliance

On the date of extraction, 12,113 documents of compliance had been issued for 2019, matching the figure from the previous year (12,136). Most of the Documents of Compliance were issued before the 30 June deadline.

### 2.1.6 Step 6: Publication of information and Annual Report

The Commission published the reported emissions data on 30 June 2020. Due to the late submission of some reports, the total number of emissions reported increased slightly (8%) after the publication date, but has stabilised at the time of extracting the data for this report.

### 2.1.7 Continuous enforcement activities throughout the EU MRV process

#### *Inspections by Port State Control Authorities*

Due to the COVID-19 pandemic, some Member States have reduced or suspended their inspections.

Around 58% of the 12.000 ships were inspected by Port Control authorities. The vast majority of Port inspections (done in 2020) showed that Documents of Compliance were on-board of inspected vessels (approximately 70%). In around 20% of the cases a Document of Compliance was not found on board. However, a Document of Compliance not found on board might not necessarily represent a non-compliance situation as e.g. a ship that had no relevant EEA calls in a reporting period does not have to carry on-board a document of compliance for that reporting period. In the remaining 10% of the cases, the port State Control Authorities did not report the presence of the DoC, or the MRV regulation was not of application to those ships. The follow-up actions based on these inspections are regulated by national law and are not recorded in the Inspection report.

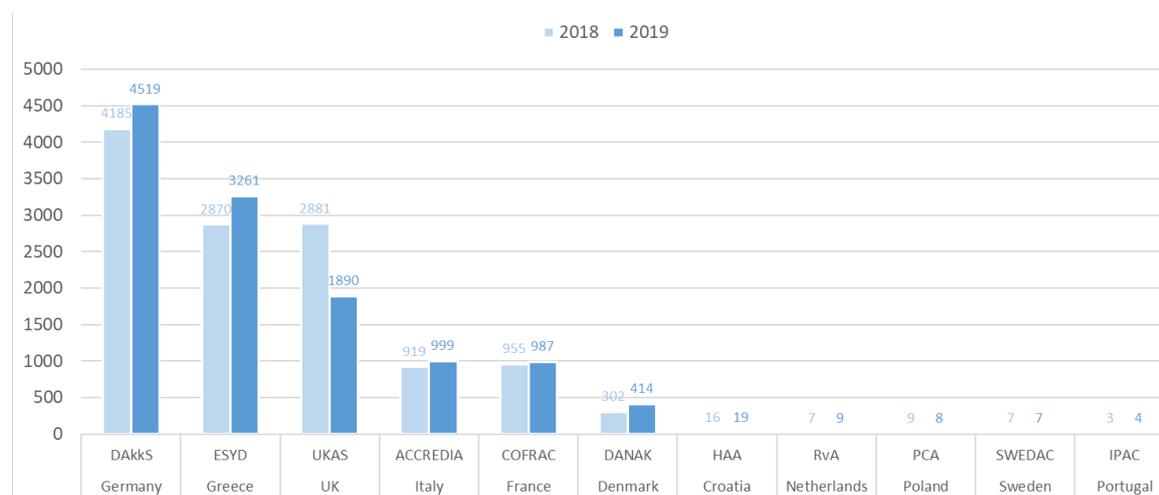
#### *National Accreditation Bodies*

Figure 12 illustrates that accreditation activities in both reporting cycles have mainly involved six national accreditation bodies of which German, Greek and British accreditation bodies were responsible for around 80% of the total number of emissions reports.

The role of UK decreased in 2019, whereas the role of all other big accreditation bodies increased in

terms of number of Emissions Reports.

**Figure 12: Number of Emission Reports per national accreditation body**



### *European Commission*

The Commission is responsible for monitoring the implementation of the EU MRV Regulation. As such, it has continued playing its role in close cooperation with national authorities on the proper implementation and enforcement and, with EMSA

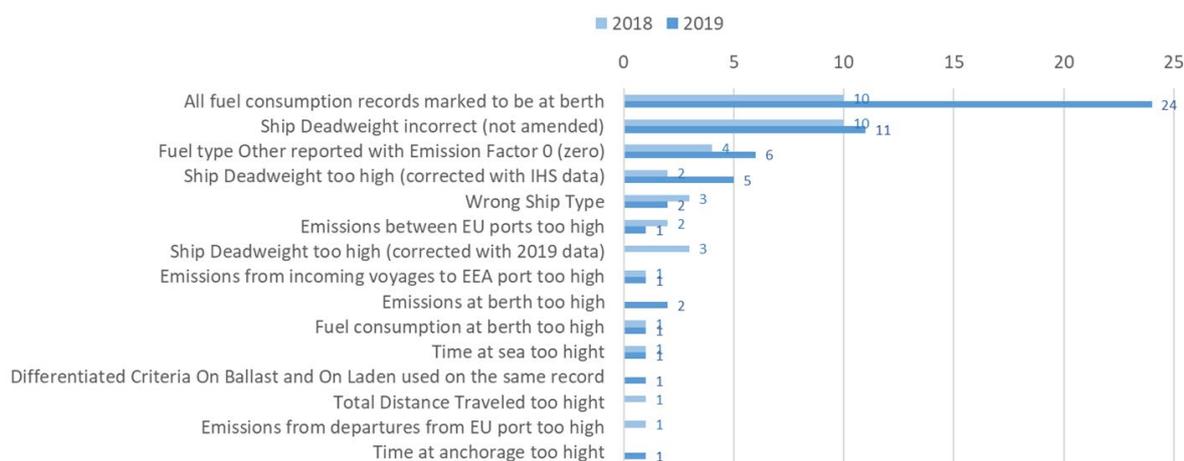
making key information on CO<sub>2</sub> emissions publicly available and preparing this annual report to assess the maritime transport sector's overall impact on the global climate.

## 2.2. Quality and completeness of EU MRV data

While assessing the dataset for this report, inconsistencies detected in 2018 and in 2019 were marginal and concerned less than 0.44% of all Emissions reports. Nevertheless, those records have

been filtered out whenever relevant to avoid wrong assessment of the data set. An overview of the detected minor incorrectness is shown in the graph below.

**Figure 13: Number of minor detected incorrectness's in Emission Reports**



## 2.3 Modifications in THETIS-MRV to improve implementation

The Commission and EMSA, after having consulted EU Member States and relevant Industry stakeholders over the first two reporting periods, have implemented and planned different measures aiming at improving the MRV system

- The THETIS-MRV software has been modified to include warning and error messages when companies are entering seemingly incorrect or incomplete data, implementing a quality control check before the company can submit the Emission Report (ER) to the verifier, as well as to prevent the company to submit an ER with incomplete reporting period, etc.
- An enforcement module for THETIS-MRV will be implemented in THETIS-EU to support port State Control Authorities in 2021.
- With the objective of facilitating the implementation of the Regulation, the Commission aims to pursue the coordination and cooperation between all market actors.
- As a support to users, and in view of improving the quality of datasets and accuracy of the Emission Reports, the Frequently Asked Questions available at EMSA's website will be updated.
- The Commission has launched a dedicated study to follow-up how the regulation is being implemented in Member States (e.g. launch of national penalty procedures following non-compliance).

### 3. The monitored fleet at a glance

More than 12,100 ships have reported verified emissions under the MRV system for 2019, just like for 2018. This section analyses whether any significant changes in the composition of the monitored fleet occurred between 2018 and 2019. The analysis shows that the monitored fleet and its distribution per ship type, flag, fleet age and ownerships is almost identical. Furthermore, the monitored ships are relatively young, although there are large disparities between ship types. Around two thirds of the ships are non-EU flagged and, more than half of them are owned by entities based in the EU.

The ship types are presented in line with the IHS *statcode5*<sup>12</sup>, and this report works, as much as possible, with the same level of aggregation as that used in the IMO GHG Studies. There is no significant deviation of the 2019 monitored fleet from the fleet monitored in 2018, the comparison with the world fleet remains the same or very similar to last year's report and is therefore not repeated here. The 2019 report concluded that the monitored fleet is representative for the world fleet. For more information, please see the 2019 MRV report on maritime transport.

#### 3.1 Distribution per ship type

As in the first reporting cycle, over 80% of the 2019 monitored fleet is represented by only five types of ships, namely bulk carriers, oil tankers, container ships, chemical tankers, and general cargo ships. The importance of those ship types within the monitored fleet, in particular those carrying dry and liquid bulk goods, reflect the amount of goods handled in EU ports. Like in the previous years, almost 60% of total cargo handled in the main EU ports in 2019 consisted of liquid and dry bulk goods. Containerised goods accounted for around 24% of all cargo handled.<sup>12</sup> The distribution of ship types within the fleet has, nevertheless, changed to some extent between 2018 and 2019. The biggest relative changes were observed for LNG carriers (increase of 20.8%), which highlights the rise of European LNG

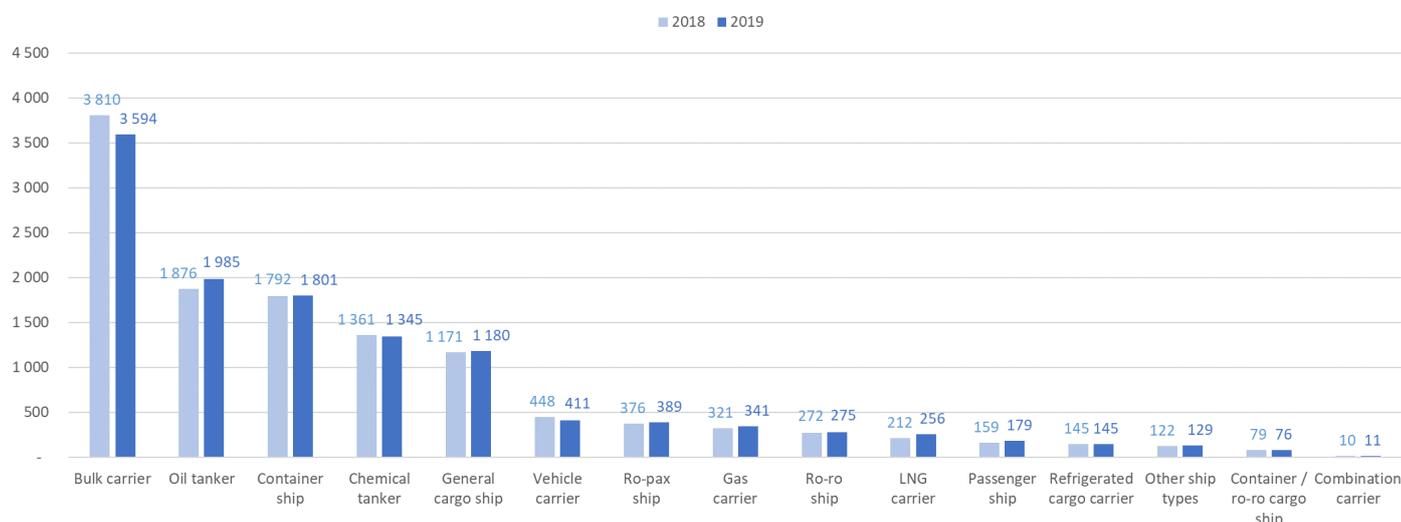
imports in 2019 compared to 2018. Overall, the number of ER increased for most types of ships.

Bulk carriers, designed to transport unpackaged dry bulk cargo, such as grains and cement, are the most common ship type within the monitored fleet. Oil tankers represent 16% of the monitored ships in 2019 (compared to 15% in 2018).

Chemical tankers represented 11% of the monitored fleet in both reporting years and general cargo ships constituted 10% of the monitored ships in 2018 and 2019. Other ship types represent together 18% of the monitored fleet and include vehicle carriers, LNG carriers, passenger ships, ro-ro (roll-on/roll-off ferries carrying cars and other wheeled cargo) and ro-pax ships (roll-on/roll-off passenger vessels), container/ro-ro ships, combination carriers, gas carriers and refrigerated cargo carriers and others.

<sup>12</sup> HIS StatCode 5: Ship type Coding System for cargo ships

Figure 14: Number of Emission Reports submitted to the Commission per ship type



The graph above shows that there are no drastic changes in the number of emission reports submitted by the different ship types when comparing the 2018 and 2019 data.

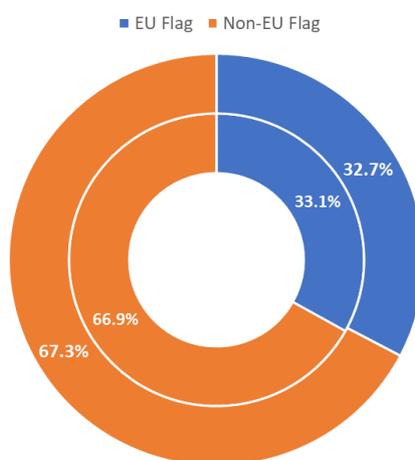
### 3.2 Distribution per flag

Around two-thirds of the monitored fleet is non-EU-flagged, with the Marshall Islands, Liberia and

Panama covering almost 40% of all non-EU flagged ships in both reporting years.

In a world fleet perspective, EU-flagged ships represent more than 20% and non-EU-flagged ships continue to represent close to 80%.

Figure 15: Shares of EU-flagged and non-EU-flagged ships (Inner-circle 2018, Outer-circle 2019)



### 3.3 Fleet age distribution

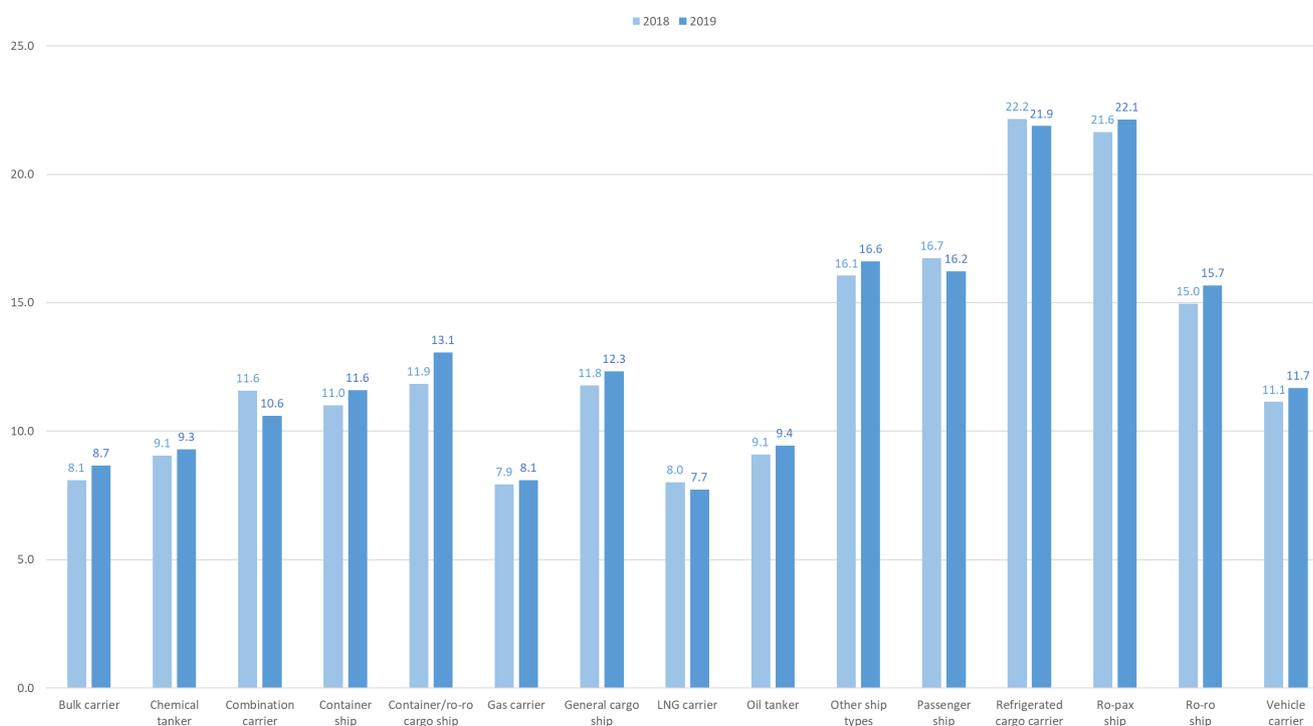
For this analysis, the age of a ship is calculated from the date the ship was built until the reporting date (16 November 2020). For 2018, the age is then calculated by subtracting one year from the 2019 age.

The age of the ships is an important factor in assessing CO<sub>2</sub> emissions from maritime transport, since younger vessels tend to be more energy efficient. The fleet age in 2019 is very similar to the 2018 data. There are, however, important disparities among ship types. Chemical tankers, oil tankers, LNG

carriers, bulk carriers and gas carriers are currently those types with the highest rate of newly built ships (average age ranging between 8 and 10 years), while refrigerated cargo ships, passenger ships, ro-pax and ro-ro ships are generally much older (16 to 22 years).

The chart below shows that there are minimal differences in the average ship age from built date by ship type between 2018 and 2019.

Figure 16: Average ship age in each reporting period

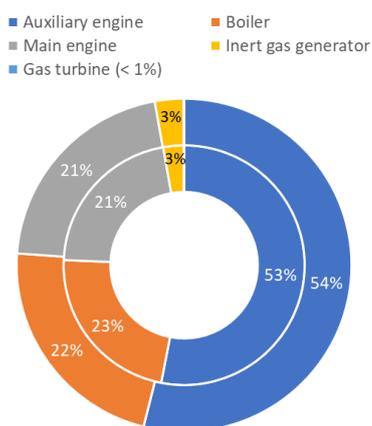


### 3.4 Type of emission sources

Engines on board ships are amongst the largest types of engines in the world, and their size and characteristics directly influence fuel consumption and CO<sub>2</sub> emissions. Ships typically contain several engines for different purposes. The main engine turns the ship's propeller and move the ship through the water, whilst auxiliary engines aim at powering the ship's electrical systems, and a number of other machinery items providing additional essential

services such as gas insertion, heat and steam production, and incineration.

**Figure 17: Type of emission sources (Inner-circle 2018, Outer-circle 2019)**



The shares of these emission sources have been the same or very similar for 2018 and 2019 (see figure above). Auxiliary engines constitute more than half of the emission sources reported.

Container ships and passenger ships remain the two ship types with the highest average main propulsion power at the Maximum Continuous Rating (MCR),

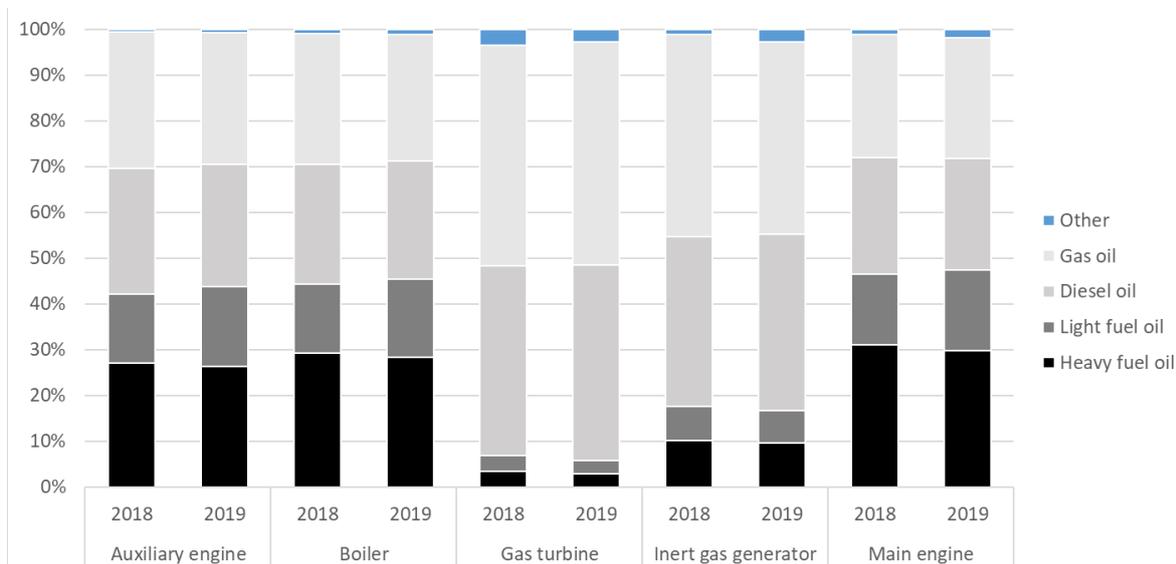
with around almost 37,000 kW and 39,000 kW engines, respectively (see table in Appendix 3). They are followed by LNG carriers, whose average main engine power increased from 32,668 kW in 2018 to 34,186 kW in 2019, and Ro-pax ships (almost 25,000 kW on average).

General cargo ships (almost 6,000 kW), chemical tankers (around 7,000 kW) and gas carriers (around 9,000 kW) have reported the less powerful main engines.

The design and operation of container and passenger ships explain why they have, in general, more powerful engines compared to other ship types. For instance, they operate at higher speeds (comparing with bulkers, average speed for containers is 30% higher and passenger ships 15% higher) in line with the specific business model and standards associated with their industry.

The following graphs shows the percentage of fuel types used per emission source in both reporting periods.

**Figure 18: Fuel types per emission sources<sup>13</sup>**



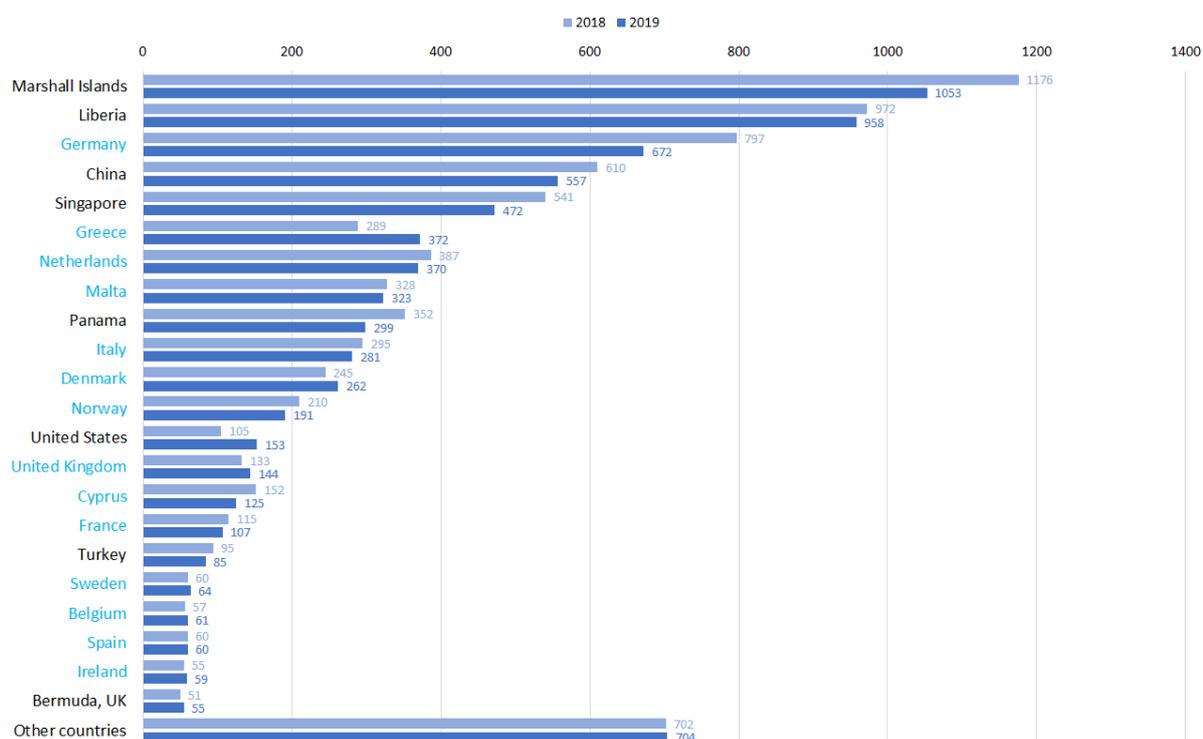
<sup>13</sup> For the purpose of graphic representation, the category “Other” includes Liquefied Natural Gas (LNG), Ethanol, Liquefied petroleum gas (Butane), Liquefied petroleum gas (Propane) and Methanol on top of the “other” category as per reporting requirements

### 3.5 Distribution per ownership

The field “Owner country” is not mandatory in the Emission Report, therefore, not all companies have reported it. Nevertheless, slightly more than 60%

reported the Owner country in both reporting periods.

Figure 19: Number of ships per ship owner country



## 4. The monitored voyages at a glance<sup>14</sup>

<sup>14</sup> This section relies on data from THETIS-MRV and MARINFO (IHS Markit & Trade) to better understand the characteristics of the voyages monitored under the EU MRV system

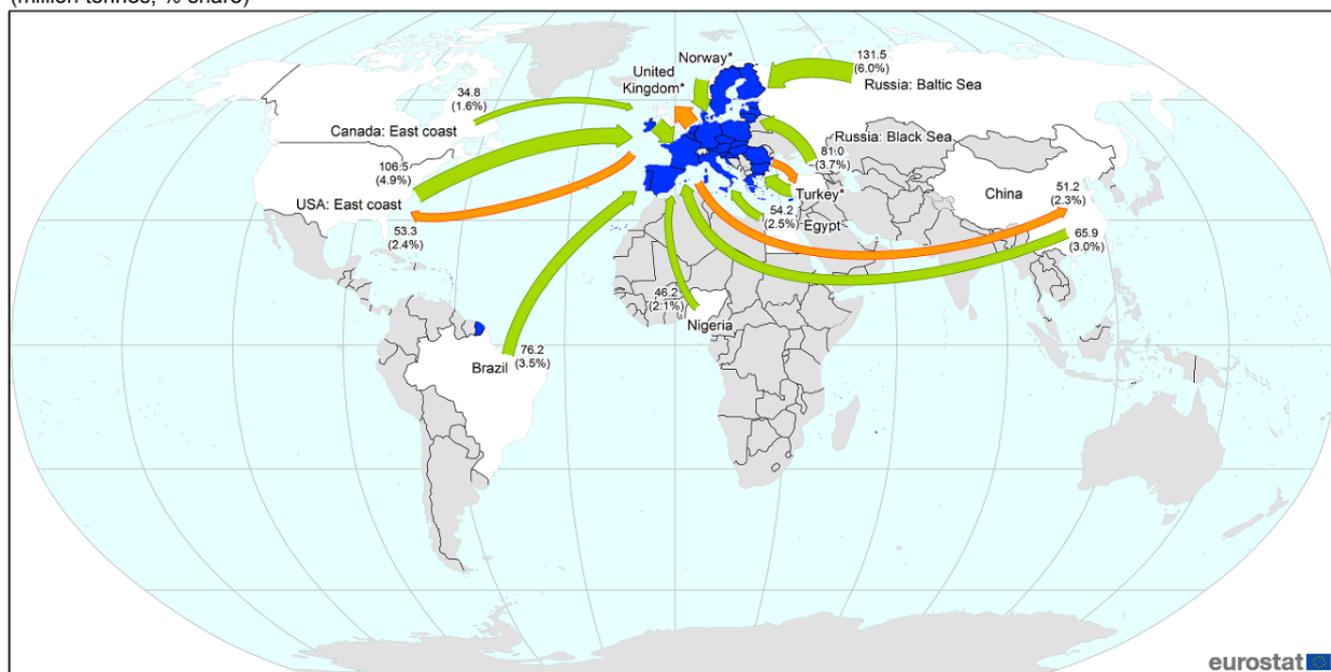
### 4.1 Main shipping routes

Similarly to what was reported previously, MRV voyages analysis continues to largely corroborate the information provided by official trade statistics (Eurostat) in terms of EU flows by gross weight of freight handled in main ports (see Figure 20). It shows the high demand of waterborne transport services between the EU and countries such as Russia, USA, Canada, Brazil, China, United Arab Emirates, South Korea, etc. It also reflects the main routes followed by the large international deep-sea

ships such as large containerships, oil tankers or bulk carriers. In addition, this analysis also highlights the number of the voyages between EU Member States and neighboring non-EU countries such as Norway, Turkey and the UK. This analysis has also showed that a number of ships perform more than one port call in their departure country before calling a port in the EEA. For instance, a large deep-sea container may get cargo from different ports in China and/or India, before coming to Europe.

Figure 20: Main extra EU flows

#### Main extra EU flows by gross weight of freight handled in main ports, EU-27, 2019 (million tonnes, % share)



eurostat

Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat  
Cartography: GISCO 12/2020  
Projection: Robinson

- ➔ Inward flows to EU ports from non-EU ports
- ➔ Outward flows from EU ports to non-EU ports

\* United Kingdom, inward: 104.8 (4.8%), outward: 108.3 (4.9%); Norway, inward: 90.0 (4.1%); Turkey, inward: 82.1 (3.7%), outward 47.9 (2.2%)

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the European Union.  
Kosovo: This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.  
Palestine: This designation shall not be construed as recognition of a State of Palestine and is without prejudice to the individual positions of the Member States on this issue.

## 4.2 Fleet speed

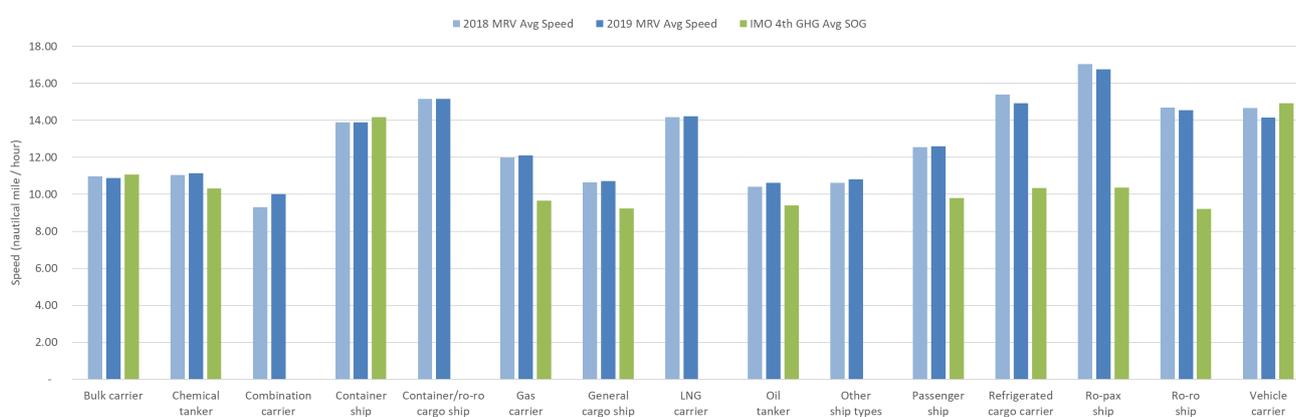
Speed is a key operational indicator, as it has a direct effect on the fuel consumption and CO<sub>2</sub> emissions. The relationship between speed and emissions is typically an exponential one. A speed reduction of 10% can lead to a reduction of CO<sub>2</sub> emission of around 20%.

Speed is a parameter that is difficult to compare between different ship types as it reflects different ship designs and business models. However, speed evolution over time is an important indicator to explain variation in the operational energy efficiency of ships.

In this context, the average fleets' speed (2018 & 2019) has been calculated based on the monitored fleet reported figures (time spent at sea and distance travelled) after clear outliers have been removed.

The graph below shows figures calculated from MRV 2018 and 2019 reporting periods, in comparison with the 4th IMO GHG Study (Automatic Identification System Speed Over Ground - AIS SOG) observed data from 2018.

Figure 21: Average speed by ship type



Because not all ship types in the EU MRV framework have a clear link with IMO GHG Study ship types' codification, those where a link cannot be established do not have information on the IMO GHG Study average SOG.

Considering the values obtained, two main observations could be made:

1. THETIS-MRV speed variation between 2018 and 2019 is negligible;
2. when comparing THETIS-MRV with 4th IMO GHG Study data, the International deep-sea 'liners

trade' such as tankers, bulkers, containerships and vehicle carriers have very similar values, while those ship categories (type & size) more engaged in the regional/national regular traffic trades such as passenger, ro-ro and ro-pax ships, show a significant difference. In relation to the last, this could be explained by a stronger demand and busiest market in the EU.

## 4.3 Time spent at sea

Different ship types are at sea for varying amounts of time in relation to EEA related voyages.

In total, bulk carriers spent the longest total time at sea in the context of the EU MRV regulation with circa six million hours during 2019. However, bulk

carriers have reported circa 1600 hours on average, reflecting the high share of their total voyages that falls outside the scope of the Regulation.

In comparison, ro-ro ships spent a total of around 1.2 million hours at sea during 2019, but reported

the longest average time at sea per ship, at almost 4,500 hours. This can be explained by the fact that most of their voyages take place within the EEA, and are therefore reported in the EU MRV system.

Out of the total time spent at sea, some ship types spent significant time at anchorage. Time at anchorage refers to the time when a ship is anchored in designated areas. It is reported on a voluntary basis.

Notably, bulk carriers spent over half a million hours at anchorage, as did oil tankers and chemical tankers. In contrast, ro-pax, ro-ro and passenger ships have reported very little time at anchorage.

Figures below shows that there are no major changes between 2018 and 2019 reporting periods.

Figure 22: Total time at sea by ship type

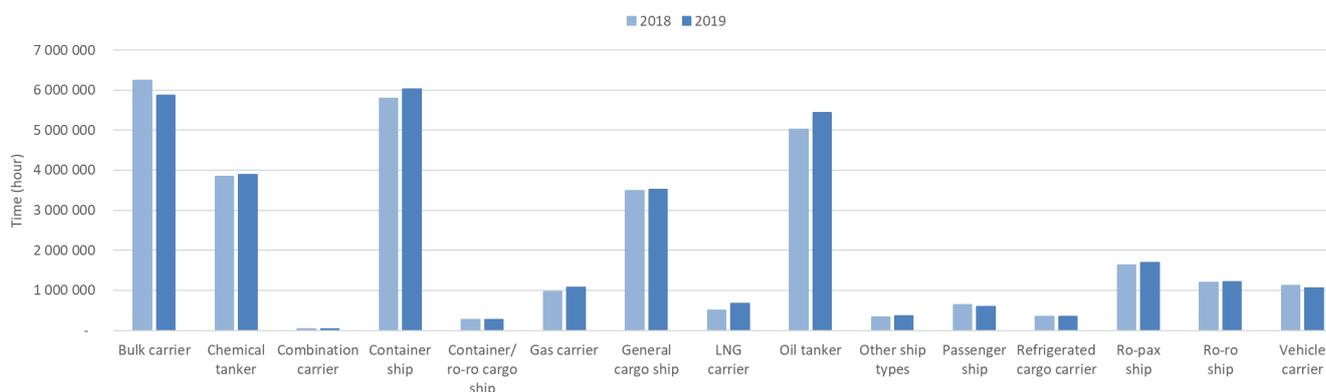
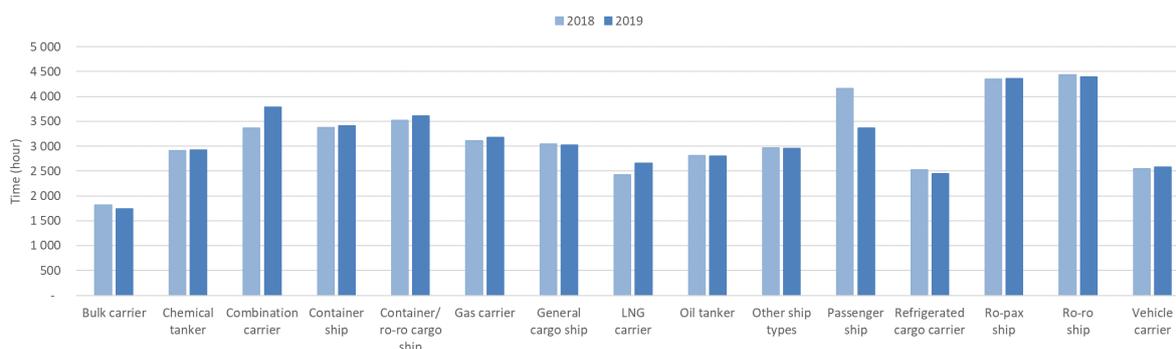


Figure 23: Average time at sea per ship type



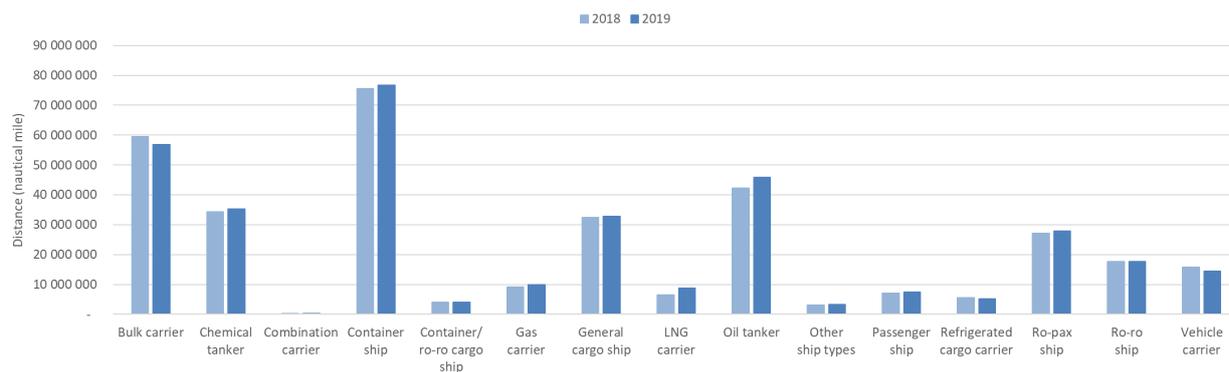
#### 4.4 Total distance travelled

In terms of distance travelled, container ships have reported the longest total distance travelled cumulatively with more than 70 million nautical miles reported in the EU MRV system. Due to their lower speed, bulk carriers have travelled a shorter distance (around 55 million nautical miles) despite

having spent more time at sea. Taken together, oil tankers, chemical tankers and general cargo ships have reported around a third of the total distance travelled reported in the EU MRV system.

Figures below shows that there are no major changes between 2018 and 2019 reporting periods.

Figure 24: Total distance travelled by ship type



## 5. CO<sub>2</sub> emissions and related fuel consumption from the monitored fleet

### 5.1 Overall CO<sub>2</sub> emissions

In total, the monitored fleet emitted 144.6 million tonnes of CO<sub>2</sub> emissions in 2019, which is equal to the emissions in 2018.

These emissions originated from 12,117 ships in 2019, compared to 12,154 ships in 2018. This means that while the amount of CO<sub>2</sub> emitted was nearly equal, the number of monitored ships has slightly decreased between the two reporting cycles. Fewer ships emitted almost the same amount of CO<sub>2</sub> in 2019. This does not mean that the ships became less efficient. It could be due to different reasons: the same ships called EEA ports more often in 2019, different fleet calling at EEA ports, different trading demands, etc.

In the MRV system, CO<sub>2</sub> emissions are calculated based on fuel consumption at individual ship level and based on specific emission factors defined for every fuel type.

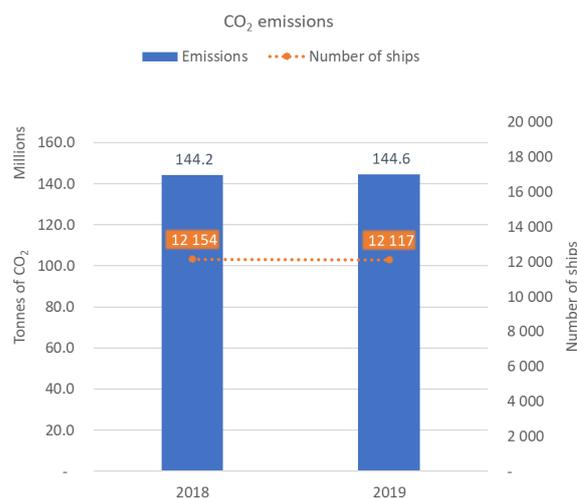
### 5.2 CO<sub>2</sub> emissions per type of voyage

In view of the ensuring accuracy of data for this section, clear outliers have been discarded from the analysis.

The distribution of CO<sub>2</sub> emissions per type of voyage follows similar trend in 2019 than in 2018. Above 60% of the CO<sub>2</sub> emissions in both reporting periods are stemming from voyages to or from a port outside the EEA, including both incoming and outgoing voyages. This reflects the importance of trade with countries outside the EEA in maritime transport. 71% of the goods shipped by EU seaborne transport were transported to or from ports outside the EU in 2019 (international extra EU-27 transport).<sup>13</sup>

When comparing to 2018, there are slightly more CO<sub>2</sub> emissions stemming from incoming extra-EEA voyages than from outgoing extra-EEA voyages. This is in line with the pattern of the movement of goods in EU ports. In 2019, all of the EU's top 10 maritime flows of goods were inward flows, with the exception from outward flows to the UK.<sup>14</sup>

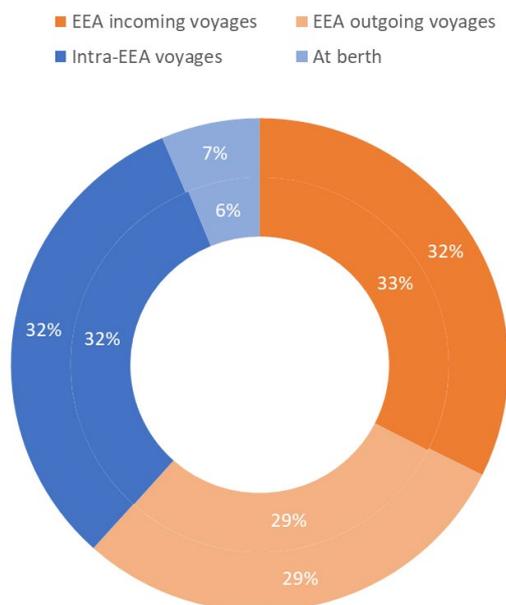
Figure 25: Total CO<sub>2</sub> emissions



Voyages between ports in the EEA (intra-EEA voyages) are responsible for around a third of the reported CO<sub>2</sub> emissions (32%), namely 46 million tonnes of CO<sub>2</sub>. This 32% is broadly consistent with the most recent port statistics for 2019 where cross-border transport between EU ports made up 19% of all maritime transport of goods activities, while 8% of the total EU maritime transport were voyages between national ports,<sup>15</sup> and 7% at berth emissions.

Ships are also emitting CO<sub>2</sub> emissions when they are securely moored in port, as most ships produce their own electricity on-board to provide services for passengers and crew such as air conditioning, to refrigerate perishable goods, or to operate machinery to load or unload cargo. These emissions at berth represented 7% of all reported CO<sub>2</sub> emissions, around 10 million tonnes of CO<sub>2</sub> in absolute terms, in 2019 (similar as in 2018).

**Figure 26: CO<sub>2</sub> emissions from different types of voyages**  
(Inner-circle 2018, Outer-circle 2019)



### 5.3 Analysis of emissions comparing deep-sea and short-sea shipping<sup>15</sup>

The following assessment provides an overview of CO<sub>2</sub> emissions per type of voyage, as well as per ship type and size over 5000 GT. It allows better understanding the CO<sub>2</sub> emissions characteristics of deep-sea and short-sea shipping.

The graph below shows that most of the CO<sub>2</sub> emissions from ro-pax ships (roll-on/roll-off passenger vessels), passenger ships and ro-ro (roll-on/roll-off ferries carrying cars and other wheeled cargo) are predominately associated to intra-EEA voyages due to their regional-based and short-sea coastal trading patterns.

On the contrary, container ships, bulk carriers, oil-tankers, LNG carriers and refrigerated cargo carriers emit predominately in extra-EU scope due to their international-based and deep-sea liner trading patterns. To further compare emissions from deep-sea and short-sea shipping, an additional analysis was performed based on port call information as

there is no sufficient information available on a per voyage basis in THETIS-MRV<sup>16</sup>.

This analysis takes the amount of emissions reported in outcoming and incoming voyages and by comparing with port call information and average distance travelled, an estimation of deep-sea and short-sea voyages is considered. For assessing the following charts, it is paramount to note the methodology and assumptions made for this exercise, available for all ship types in appendix 4.

The outcomes of this analysis show that smaller ships tend to have a larger proportion of their CO<sub>2</sub> emissions coming from intra-EEA voyages. On the contrary, most of the CO<sub>2</sub> emissions coming from large international deep-sea ships are related to their extra-EEA voyages, even when they unload goods in several EEA Ports. The analysis also confirmed that CO<sub>2</sub> emissions from short-sea shipping activities are mainly related to intra-EEA voyages, whereas emissions from deep-sea shipping activities are linked to extra-EEA voyages.

<sup>15</sup> Used as a proxy

<sup>16</sup> MRV can be used to report on a voyage basis but it is on a voluntary basis.

Figure 27: CO<sub>2</sub> Emissions per type of voyages and by ship type (based on 2019 data)

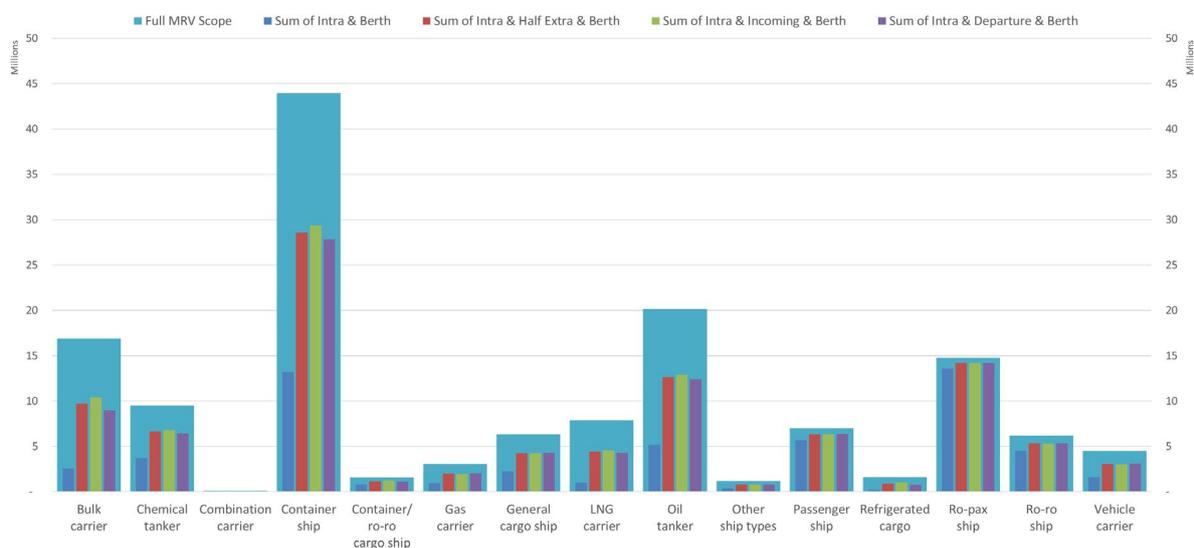


Figure 28: CO<sub>2</sub> Emissions - Bulk Carriers (2019)

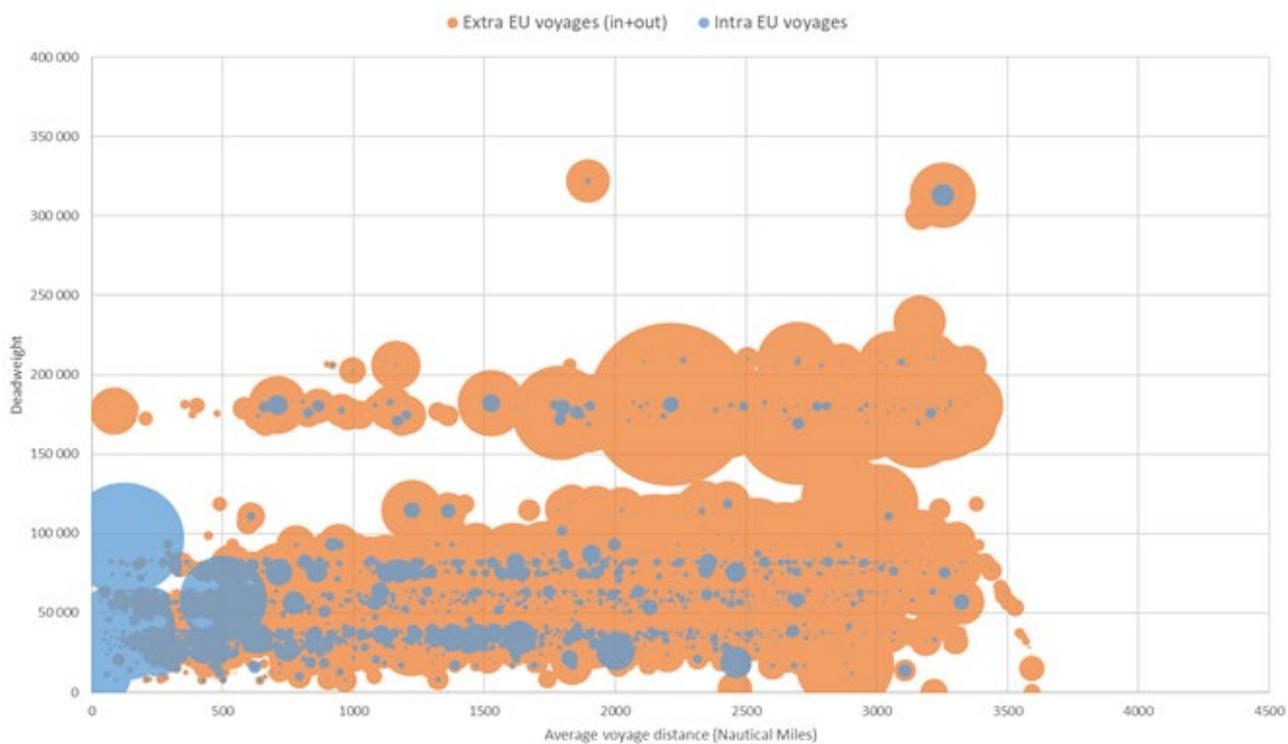


Figure 29: CO<sub>2</sub> Emissions - Container Ship (2019)

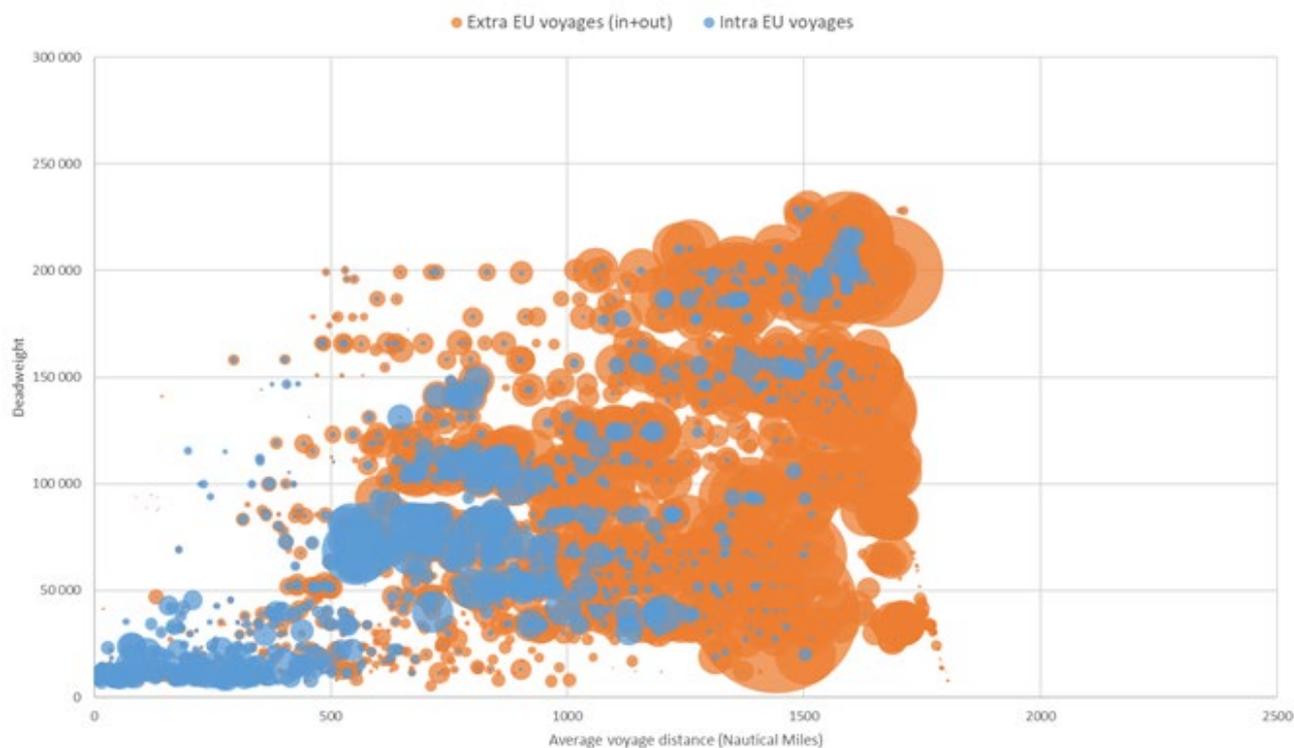


Figure 30: CO<sub>2</sub> Emissions - Oil Tanker (2019)

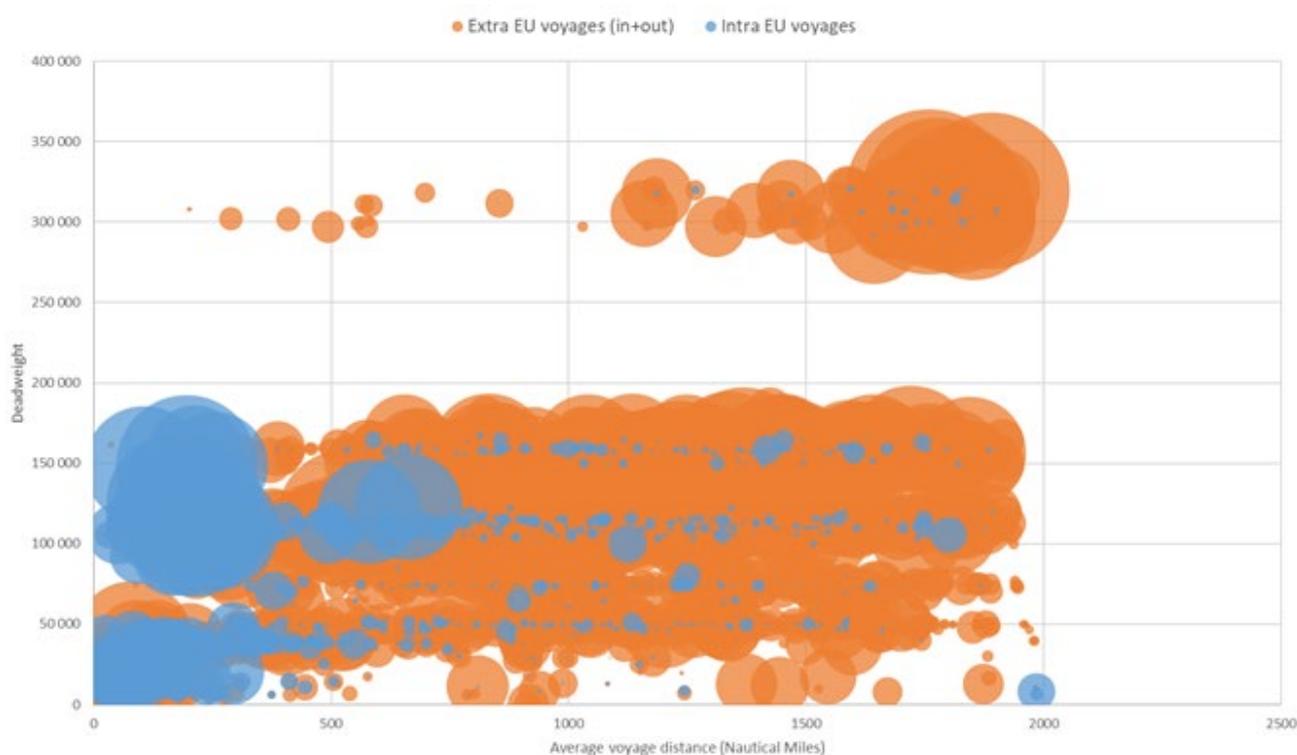
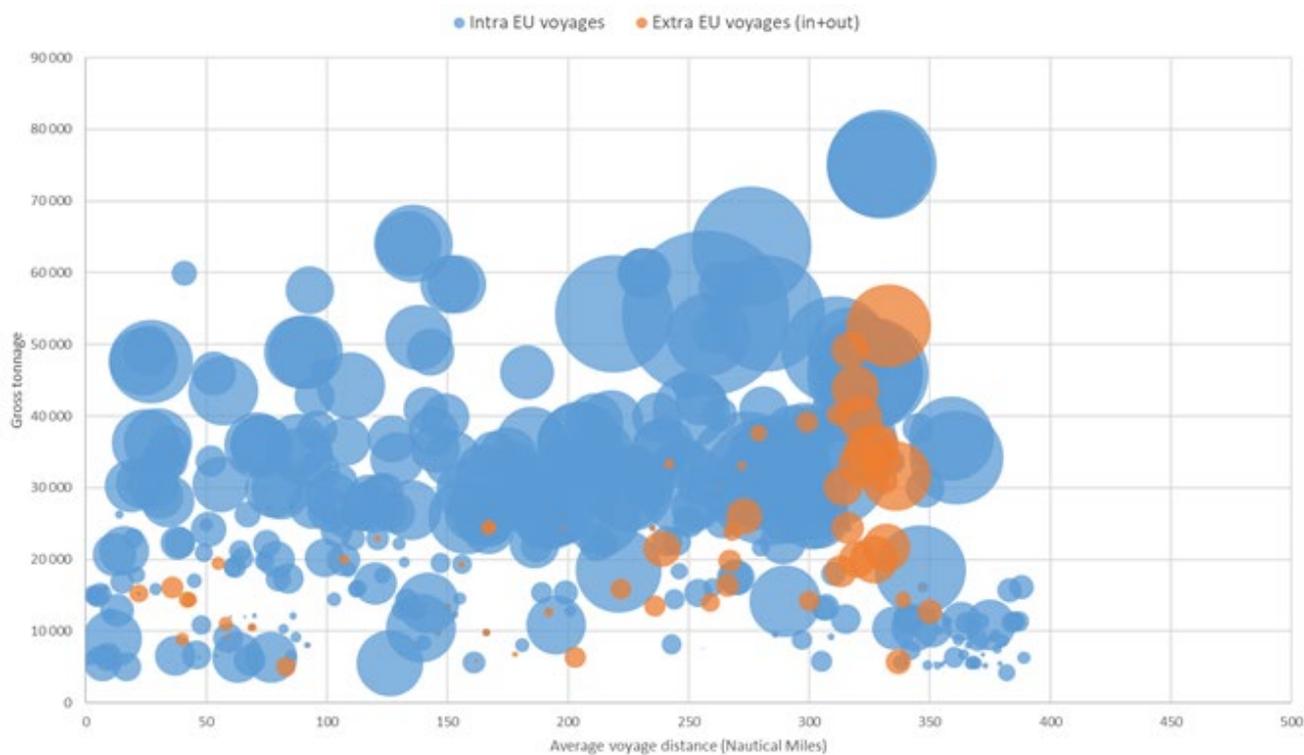


Figure 31: CO<sub>2</sub> Emissions - Ro-pax ships (2019)

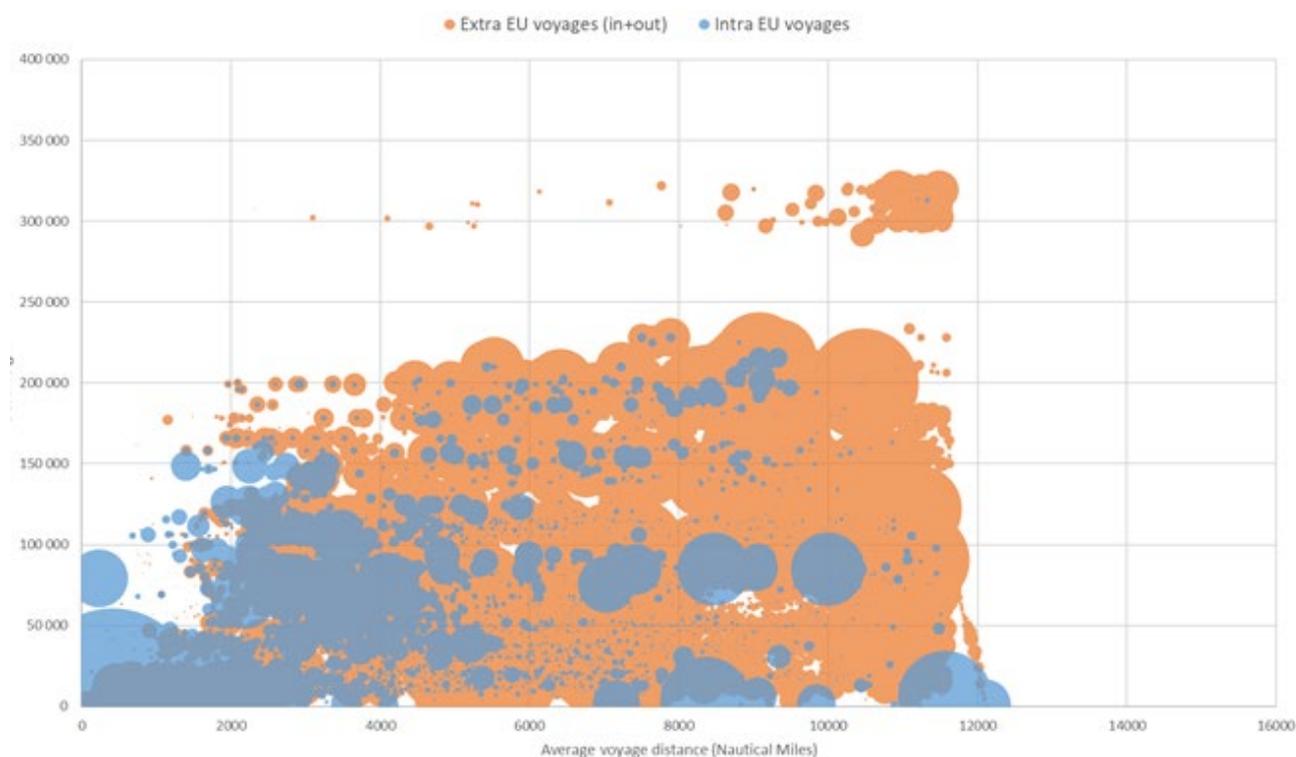


## 5.4 Emission pattern for reported emissions in Intra-EU and Extra EU voyages

The chart below is similar to those provided in the previous section but for all ship types together. It is important to recall that Dead Weight Tonnage (DWT) is not used for categorizing the size of Passengers ships, Ro-Pax and Ro-Ro Cargo ships. In chapter 4.2 each graph is built according to the correct size unit. However, for this exercise which combines all the

ships, all types use DWT as the size unit. This should be taken in due consideration when assessing this chart. The same assumptions and methodology explained in chapter 4.2 and Appendix 4 are to be taken in consideration

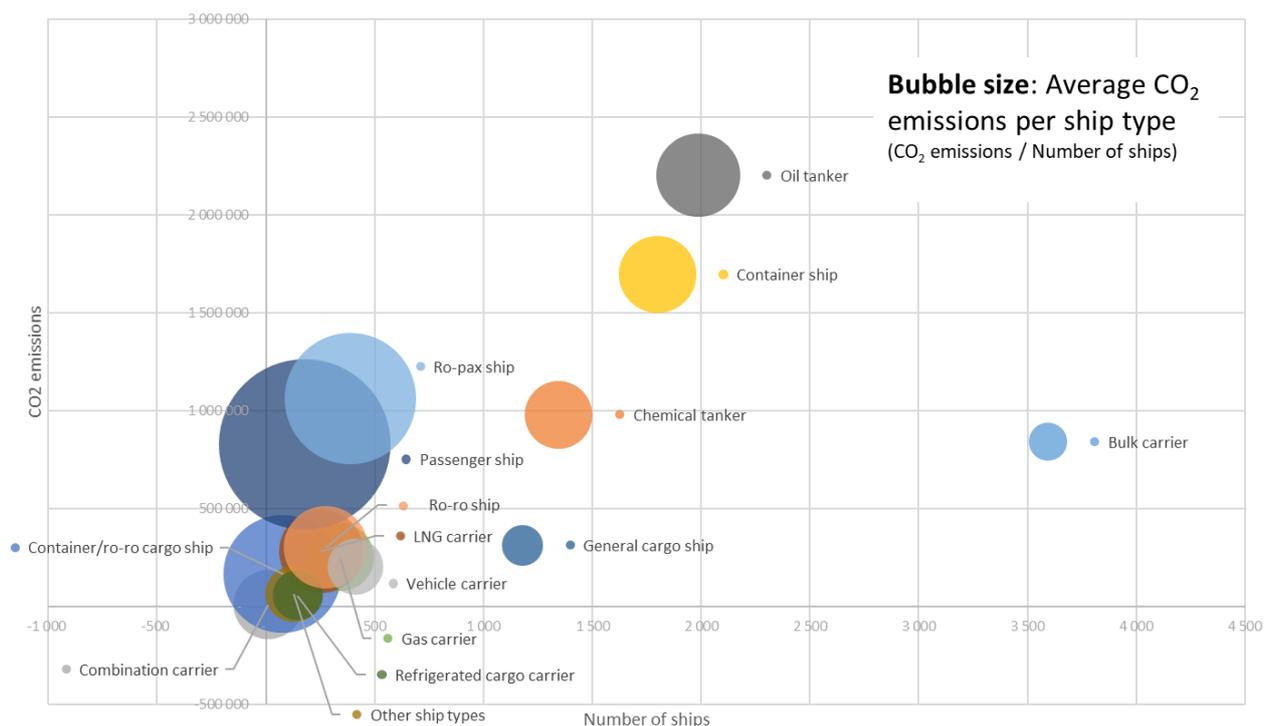
Figure 32: Total CO<sub>2</sub> Emissions for all ship types (2019)



## 5.5 Emission pattern for reported emissions at berth

In terms of emissions reported at berth, the ship types, of a size above 5000 gross tonnage, that emit the most at individual ship level are passenger ship and Ro-pax ships, mostly due to their hoteling load, followed by combination carriers and LNG

carriers. At fleet level, oil tankers are the ones that emit the most CO<sub>2</sub> emissions at berth, followed by containerships.

Figure 33: Total CO<sub>2</sub> Emissions in EEA at Berth in 2019Table 1: Total CO<sub>2</sub> Emissions in EEA at Berth in 2019

|                            | Number of Ships | Total CO <sub>2</sub> Emissions | Emissions per ship |
|----------------------------|-----------------|---------------------------------|--------------------|
| Bulk carrier               | 3 594           | 841 404                         | 234                |
| Chemical tanker            | 1 345           | 979 515                         | 728                |
| Combination carrier        | 11              | 8 419                           | 765                |
| Container ship             | 1 801           | 1 696 453                       | 942                |
| Container/ro-ro cargo ship | 76              | 167 434                         | 2 203              |
| Gas carrier                | 341             | 251 485                         | 737                |
| General cargo ship         | 1 180           | 313 311                         | 266                |
| LNG carrier                | 255             | 284 143                         | 1 114              |
| Oil tanker                 | 1 985           | 2 201 655                       | 1 109              |
| Other ship types           | 129             | 65 502                          | 508                |
| Passenger ship             | 179             | 828 921                         | 4 631              |
| Refrigerated cargo carrier | 145             | 57 346                          | 395                |
| Ro-pax ship                | 388             | 1 062 844                       | 2 739              |
| Ro-ro ship                 | 275             | 303 094                         | 1 102              |
| Vehicle carrier            | 411             | 204 549                         | 498                |

## 5.6 Emission pattern for reported Total CO<sub>2</sub> emissions

When assessing the total CO<sub>2</sub> emissions for the different type of vessels, one can observe that the average CO<sub>2</sub> emissions of Bulk carriers is relatively low compared with other type of vessels. Therefore, bulk carriers are relatively small emitters when taken individually.

On the contrary, the average CO<sub>2</sub> emissions of individual Passenger ships, Ro/pax and LNG carriers are the highest among the different ship types. When considering all the ships in each ship type, the total CO<sub>2</sub> emissions of the Container ships is preminent.

Figure 34: Total CO<sub>2</sub> Emissions in 2019

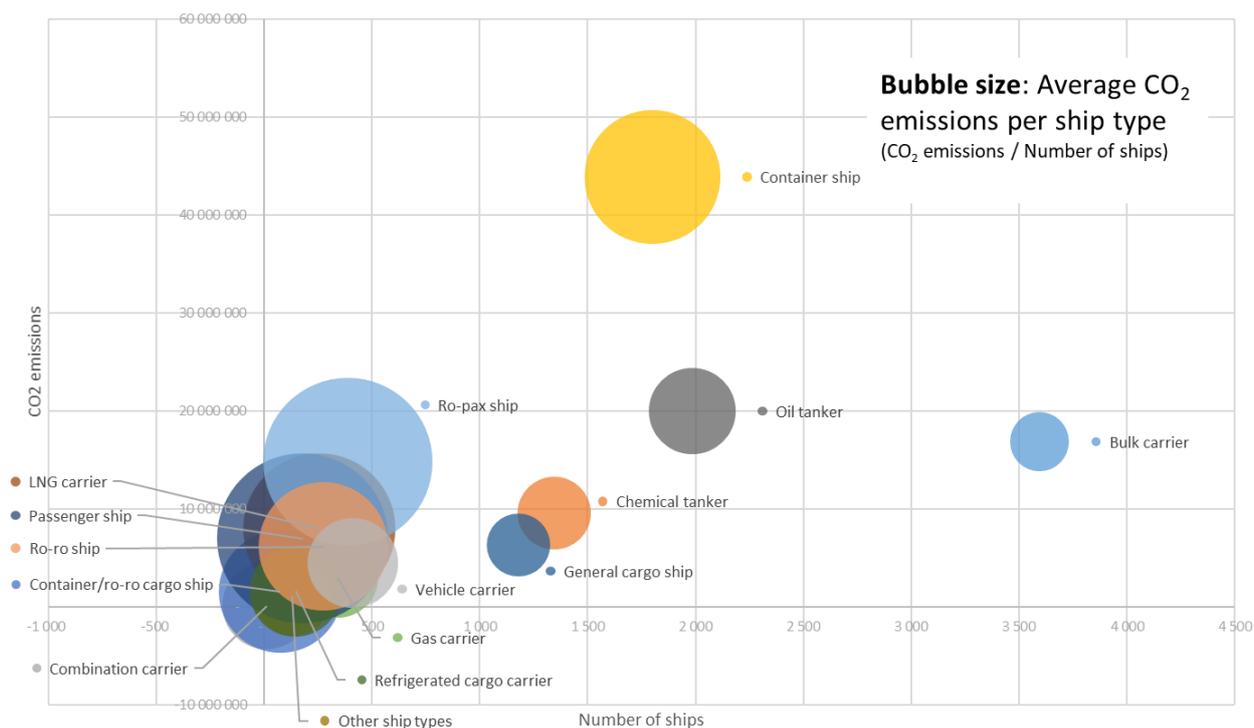


Table 2: Total CO<sub>2</sub> Emissions in 2019

| Ship Type                  | Number of Ships | Total CO <sub>2</sub> Emissions | Emissions per ship |
|----------------------------|-----------------|---------------------------------|--------------------|
| Bulk carrier               | 3 594           | 16 870 584                      | 4 694              |
| Chemical tanker            | 1 345           | 9 617 620                       | 7 151              |
| Combination carrier        | 11              | 113 047                         | 10 277             |
| Container ship             | 1 801           | 43 866 890                      | 24 357             |
| Container/ro-ro cargo ship | 76              | 1 535 326                       | 20 202             |
| Gas carrier                | 341             | 3 037 244                       | 8 907              |
| General cargo ship         | 1 180           | 6 334 615                       | 5 368              |
| LNG carrier                | 256             | 7 978 707                       | 31 167             |
| Oil tanker                 | 1 985           | 19 995 167                      | 10 073             |
| Other ship types           | 129             | 1 100 145                       | 8 528              |
| Passenger ship             | 179             | 6 999 324                       | 39 102             |
| Refrigerated cargo carrier | 145             | 1 613 701                       | 11 129             |
| Ro-pax ship                | 389             | 14 816 053                      | 38 088             |
| Ro-ro ship                 | 275             | 6 186 496                       | 22 496             |
| Vehicle carrier            | 411             | 4 504 030                       | 10 959             |

### 5.7 CO<sub>2</sub> emissions per ship type

The distribution of CO<sub>2</sub> emissions across the different types of ships in 2019 was very similar to 2018. Container ships represented the largest share of total emissions, with 30% in 2019, compared to 31% in 2018. In absolute terms, these ships reported around 44 million tonnes of CO<sub>2</sub> in 2019, one million tonnes less than in 2018. This amount originated from only 1,801 ships that together reported over 6 million hours of time spent at sea. The average CO<sub>2</sub> emissions of containerships in 2019 was around 24.400 tCO<sub>2</sub> per ship.

The total amount of emissions from bulk carriers has decreased by 8.5% between 2018 and 2019. This decrease reflects the lower number of Emission Reports received from bulk carriers during 2019, as presented in chapter 3.1.

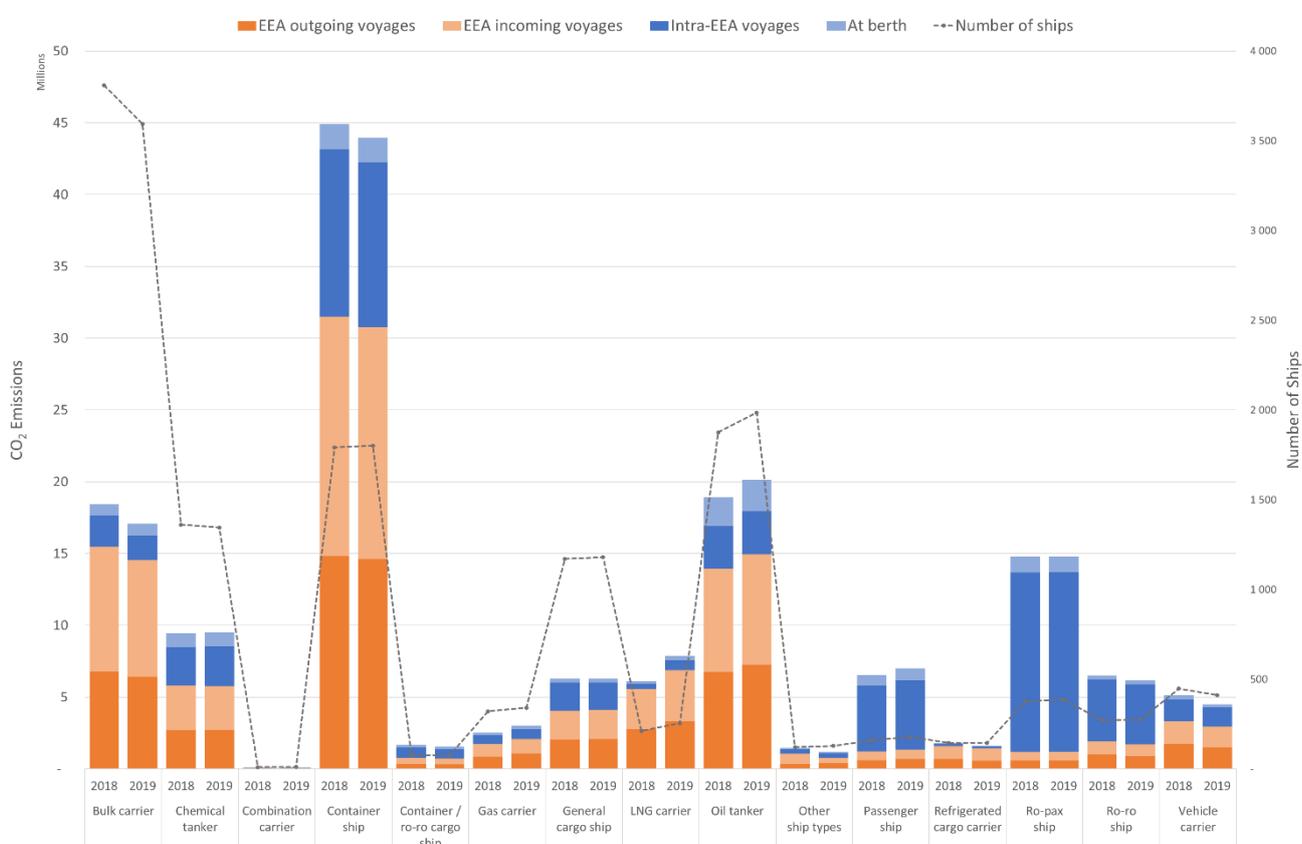
In 2019, bulk carriers, representing almost 30% of the monitored fleet (in terms of numbers of ships), emitted approximately 12% of all reported CO<sub>2</sub> emissions (17 million tonnes). As shown in Figure

36, the average CO<sub>2</sub> emissions reported by bulk carriers is around 4.700 tCO<sub>2</sub> per ship. This is much lower than other ship types as a significant share of their voyages are assumed to fall outside the scope of the EU MRV system.

Like in 2018, the CO<sub>2</sub> emissions from oil tankers and chemical tankers taken together amount to around 20% of all CO<sub>2</sub> emissions, with a slight increase in emissions from both ship types. Oil and chemical tankers transport more than a third of the cargo handled in the main EU ports. CO<sub>2</sub> emissions from LNG carriers increased by 30% from 2019 to 2018, reflecting the rise of European LNG imports.

Ro-ro and Ro-pax ships together reported 21 million tonnes of CO<sub>2</sub> emissions in both reporting years. Unlike bulk carriers, the average CO<sub>2</sub> emissions of Ro-pax was around 38.000 tonnes CO<sub>2</sub> in 2019 as most of their voyages are captured in the scope of the EU MRV regulation.

Figure 35: CO<sub>2</sub> emissions and number of ships per ship type and type of voyage

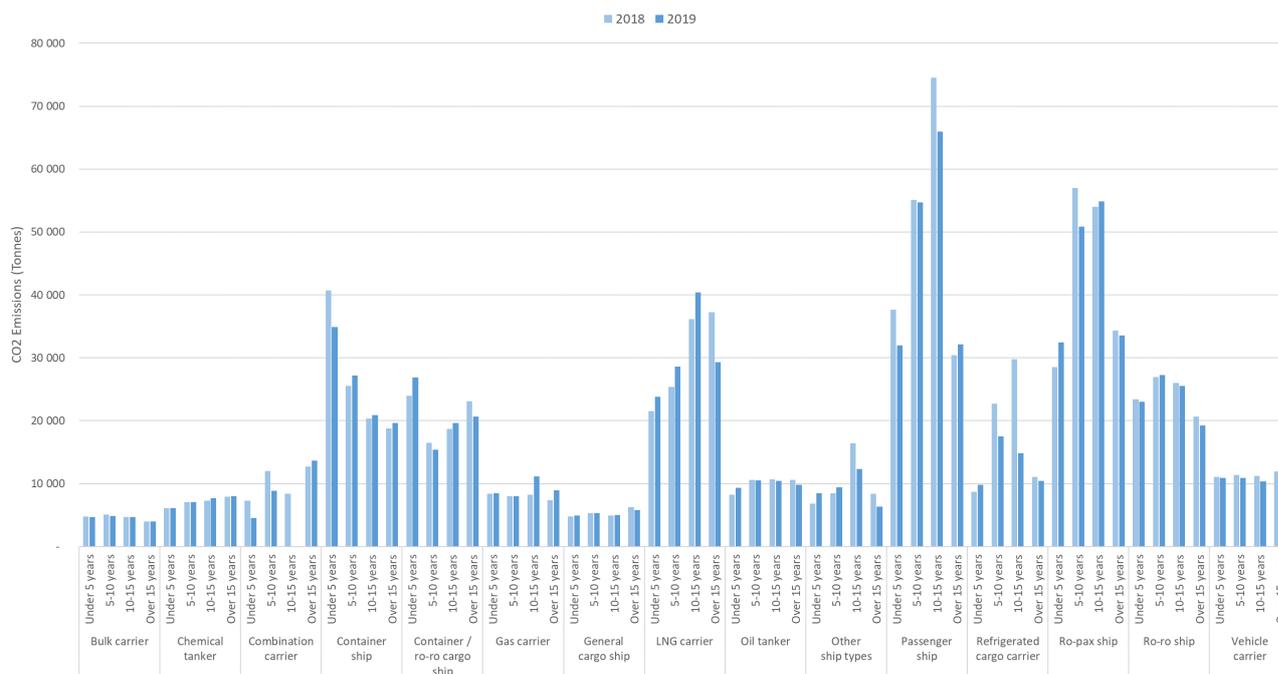


### 5.8 CO<sub>2</sub> emissions per ship age

In both reporting cycles, 21-22% of total emissions stem from ships of under 5 years. These ships represent 22-23% of the monitored fleet. Depending on their lifetime, which depends on the type of ship,

those ships might still be in use in 2040/2050. Therefore, policy instruments to reduce emissions from maritime transport should focus on all ages as there is an age spreading for all types of ships.

**Figure 36: Average CO<sub>2</sub> emissions per ship type and age**  
(Age calculated on 16 November 2019 from Built date)

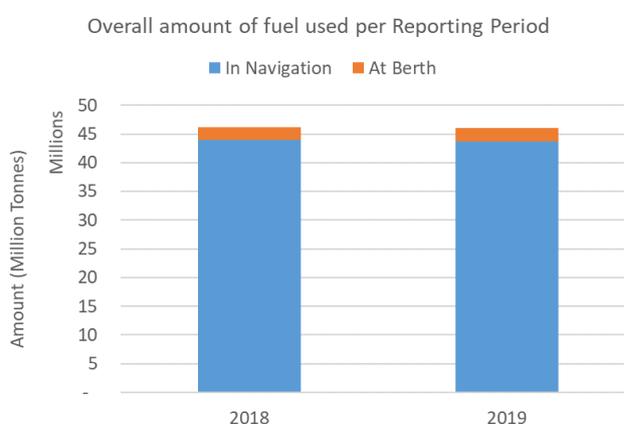


### 5.9 Overall fuel consumption

Fuel consumption is directly linked to CO<sub>2</sub> emissions and is one of the key indicators reported under the EU MRV regulation.

The overall fuel consumption has been 46 million tonnes in both years, 2018 and 2019 data. 44 million tonnes of fuel were consumed during navigation and 2 million tonnes at berth.

**Figure 37: Overall amount of fuel used per reporting period**

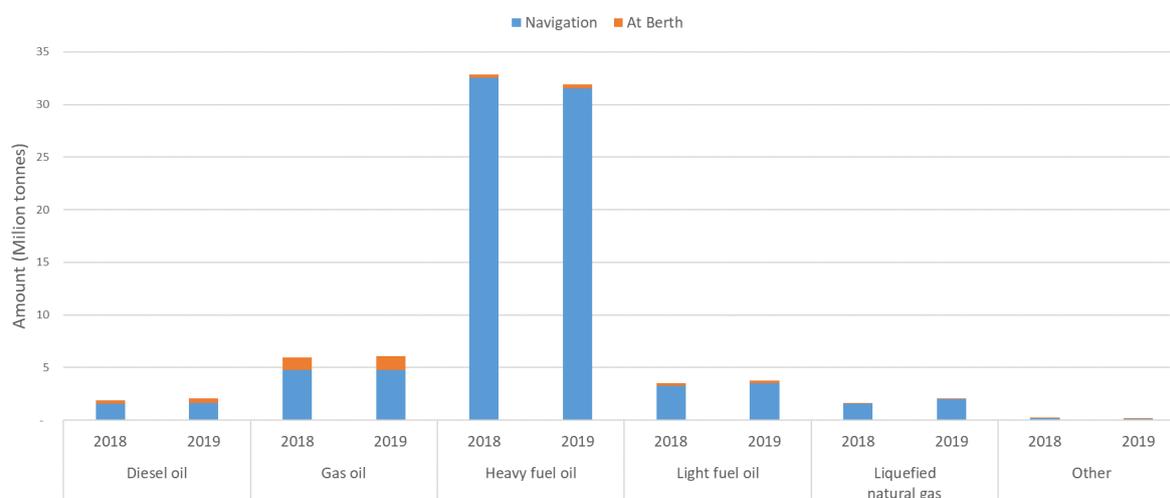


## 5.10 Analysis per fuel use

The distribution of fuel types used has not changed significantly between 2018 and 2019 (Figure 39). 69% of the fuel consumed by the monitored fleet in 2019 was heavy fuel oil (HFO), compared to 71% in 2018. The consumption of liquefied natural gas (LNG) and diesel oil increased by one percentage point each, from 4% to 5%.

LNG is mostly used by LNG carriers. No significant changes occurred in the reported fuel consumption per ship type (Figure 27). The very small fraction of HFO at berth could be explained by its combined usage with an exhaust-gas cleaning system i.e. scrubber.

Figure 38: Reported fuel consumption per fuel type and operation<sup>17</sup>

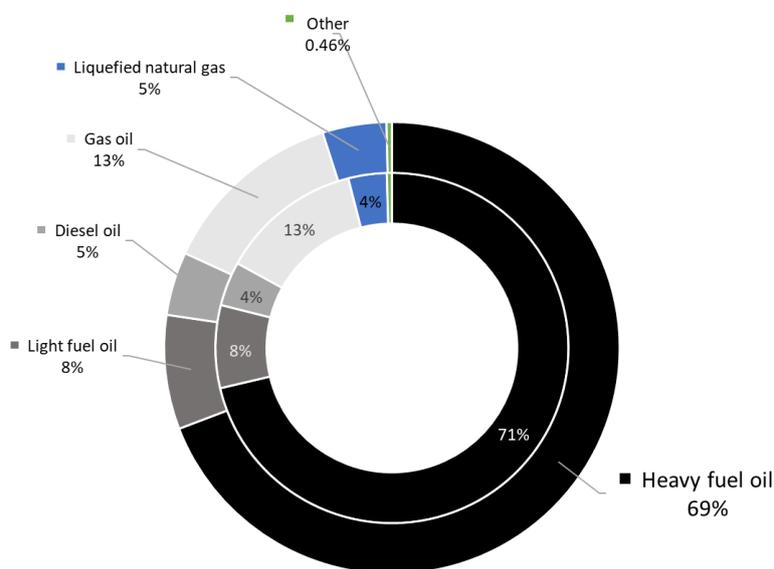


<sup>17</sup> For the purpose of graphic representation, in figures 40, 41 and 42, the category "Other" includes Methanol on top of the "other" category as per reporting requirements

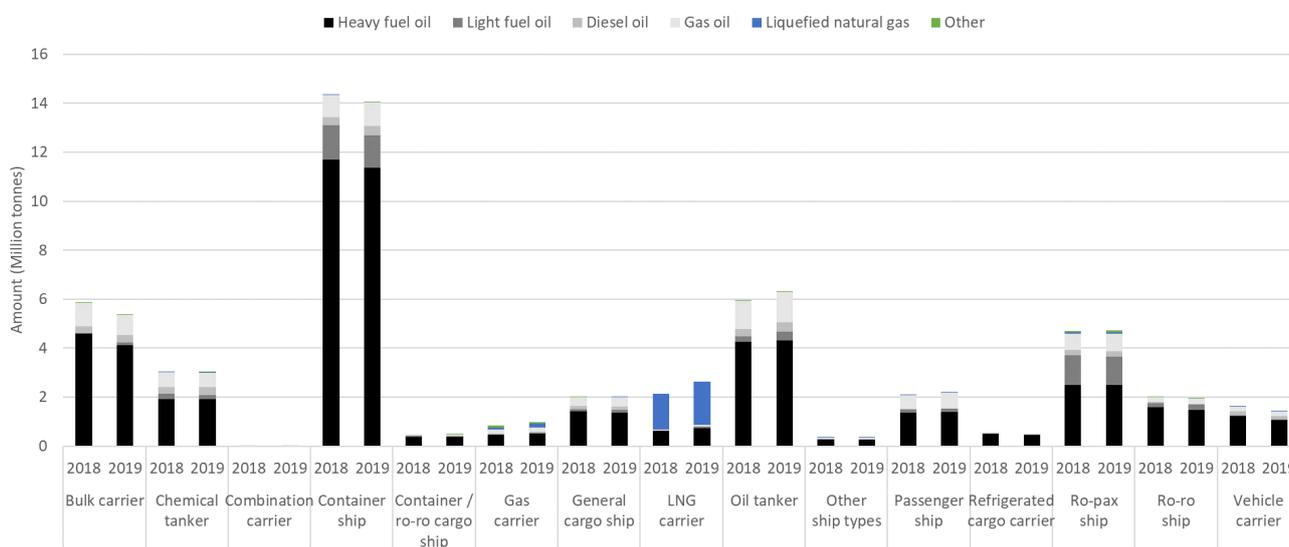
The above chart shows that at berth, the fuel type mostly consumed is gas oil.

Only LNG carriers consume LNG for the most part also at berth.

**Figure 39: Shares of fuel types reported<sup>18</sup>**  
(Inner-circle 2018, Outer-circle 2019)



**Figure 40: Reported fuel consumption per ship type and type of fuel<sup>19</sup>**



<sup>18</sup> For the purpose of graphic representation, the category “other” includes methanol (0.01%), liquefied petroleum gas (butane, 0%) on top of the “other” category (0,46%) as per reporting requirements

<sup>19</sup>For the purpose of graphic representation, the category “other” includes as well methanol, liquefied petroleum gas (butane) on top of the “other” category as per reporting requirements

## 6. The technical and operational energy efficiency of the monitored fleet

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### 6.1 Technical energy efficiency of the monitored fleet

The analysis of the 2019 MRV data shows that there is little change observed in the reported technical energy efficiency of containerships, bulk carriers, oil and gas tankers compared to 2018 (both in terms of attained Energy Efficiency Design Index values (EEDI)<sup>20</sup> and Estimated Index Values (EIV)<sup>21</sup>. The comparison of these values with the IMO values is therefore not repeated in this report.

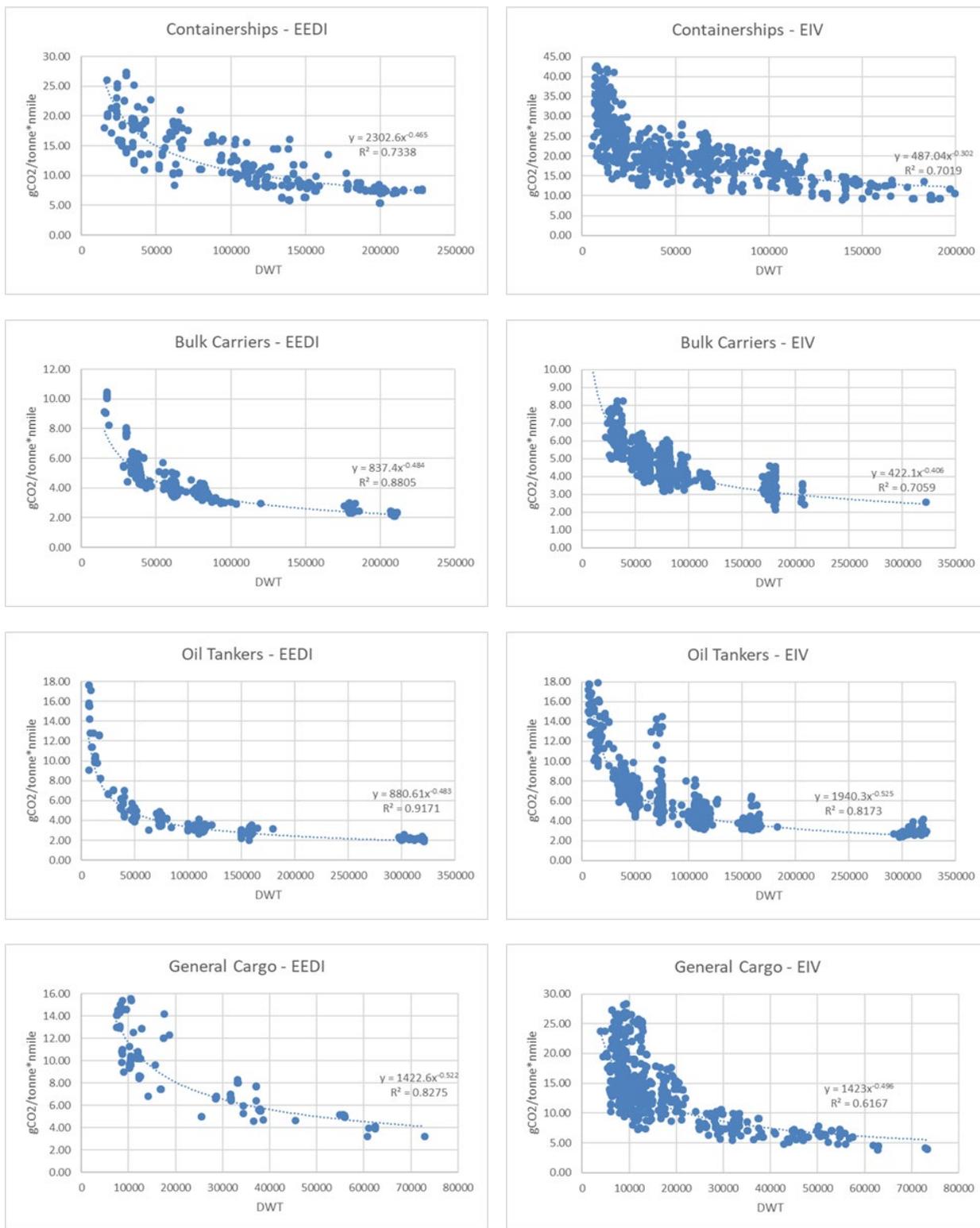
However, the monitored fleet technical efficiency (EEDI or EIV) was plotted against its capacity (DWT or Gross Tonnage (GT) and further extended to all those ship types where sufficient data and statistically robust treatment was possible, including ship types not covered in the previous report.

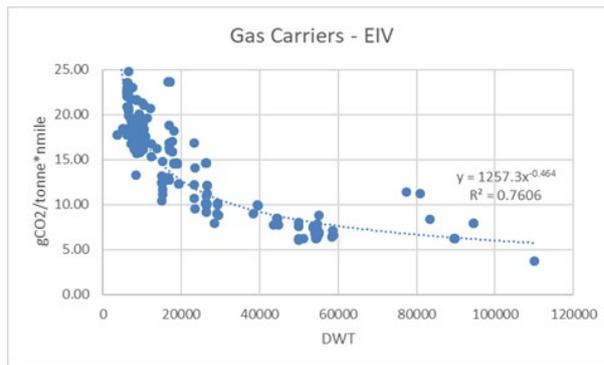
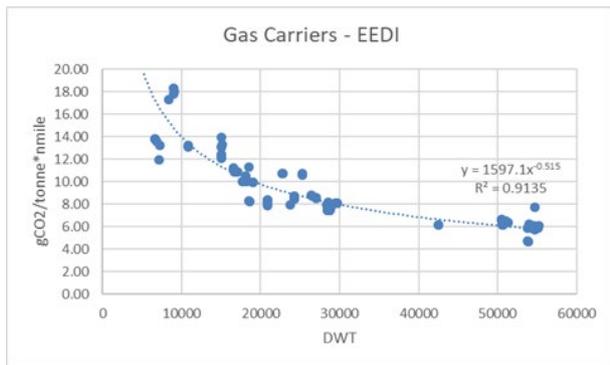
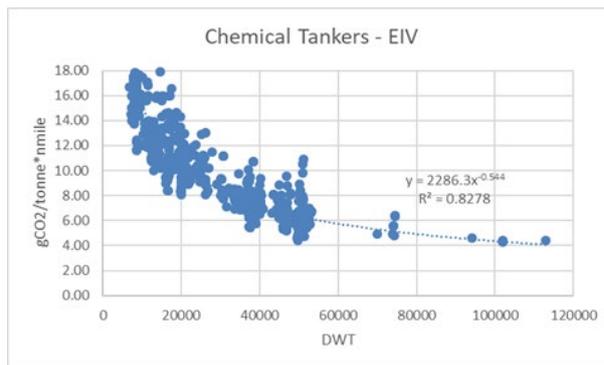
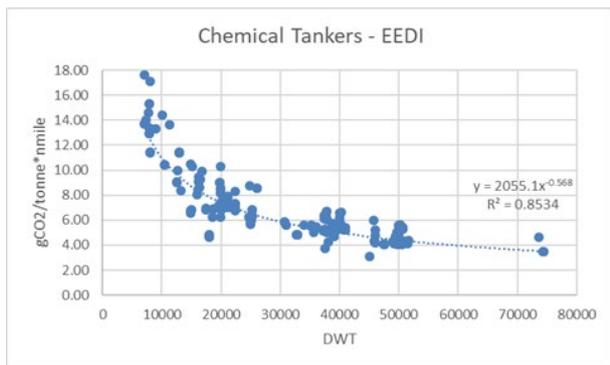
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<sup>20</sup> EEDI: The Energy Efficiency Design Index for new ships is the most important technical measure and aims at promoting the use of more energy efficient (less polluting) equipment and engines. The EEDI requires a minimum energy efficiency level per capacity mile (e.g. tonne mile) for different ship type and size segments.

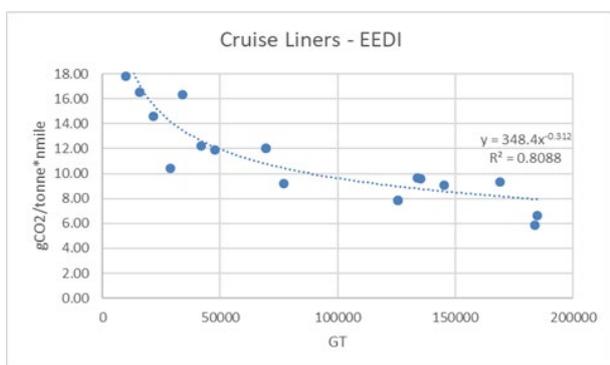
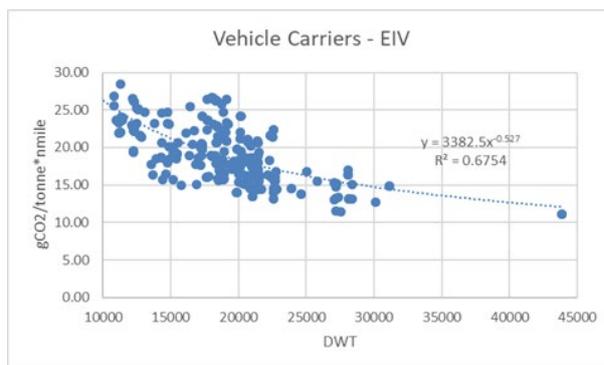
<sup>21</sup> EIV: As of January 1st 2013, all new ships have to meet a minimum value for their Energy Efficiency Design Index (EEDI). The EEDI value ships have to meet is a function of ship type and size of the ship. It is based on an empirical regression line of the efficiency of ships built between 1999 and 2009 which is called the reference line. The reference lines were calculated using publicly available data to construct a simplified version of the EEDI called the Estimated Index Value (EIV).

Figure 41: EEDI and EIV for each ship type





*Insufficient data / statistically robust treatment not possible (Vehicle Carriers EEDI)*



*Insufficient data/ statistically robust treatment not possible (Cruise Liners EIV)*

## 6.2 Operational energy efficiency of the monitored fleet

In the EU MRV system, companies have to use several indicators to monitor their operational energy efficiency:

- CO<sub>2</sub> emissions / fuel consumption per distance
- CO<sub>2</sub> emissions / fuel consumption per transport work

Transport work represents the actual maritime transport service determined by multiplying the distance travelled with the amount of cargo carried. Depending on ship type, cargo carried may be expressed in several units, e.g.: metric tonnes of cargo, number of passengers, volume of cargo, number of cargo units or occupied surface, etc.

Companies report their operational energy efficiency indicators in the form of an annual average.

### *The different indicators*

This report focuses on the following two indicators: the Annual Efficiency Ratio (AER) and the Energy Efficiency Operational Indicator (EEOI). The *Annual Efficiency Ratio* is commonly used by the shipping industry as it serves the primary purpose of evaluating annual progress of a ship. It reflects the ratio between CO<sub>2</sub> emissions and the maximum transport work, based on the cargo carrying capacity in DWT or GT, not the actual cargo carried. This indicator relies on a proxy for transport work, which does not differentiate between the different loading of a ship for each of its voyage.

The *Energy Efficiency Operational Indicator* is defined, in its most simple form, as the ratio of mass of CO<sub>2</sub> 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 and its primarily used for voyage level monitoring of

a ship as part of its Ship Energy Efficiency Management Plan.

Thus, this indicator is highly influenced by the actual loading of vessels (including ballast voyages). Keeping everything else equal, ships with higher payload utilisation tend to have a lower EEOI, which makes them appear more energy efficient.

### *Analysis of the different indicators*

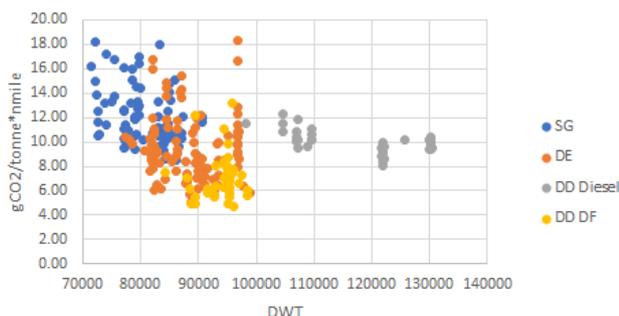
For analysis, the AER and EEOI per ship type have been plotted against the cargo carrying capacity (in DWT, GT or both). Regression curves with R<sup>2</sup>-values have then been calculated using the same methodology as followed by the IMO. The present report includes more ship types than the 2019 report that focused on the three most representative ship types, namely bulkers, container ships and oil tankers. The scatter plots for 2018 and 2019 are attached in both Appendixes 5 & 6 of this report. Note that only graphs with robust R<sup>2</sup>-indicator (>0.6) have been included in this report.

Having considered the obtained results, one could conclude that AER seems suitable for all ship types (R<sup>2</sup> correlation values ranging from 0.7 to 0.9) except Cruise Liners (GT) and LNG Carriers. For the last, a further analysis was made in an attempt to explain such high variability/scatter (reference to footnote 22 and figure 42). Therefore, one could conclude that differences in their age, fuel usage (LNG vs Diesel vs Dual-Fuel) and cargo carrying capacity (DWT) of the different groups could explain the significant variability in the LNG Carriers AERs as a whole and which does not seem to happen in any of the remaining ship types.

On the other hand, EEOI also seems to be provide acceptable results for Containerships, Gas Carriers and Cruise Liners (R2 correlation values ranging

from 0.7 to 0.8); for the remaining ship types, R2 values obtained were lower than 0.6 therefore being left out of this analysis.

**Figure 42: LNG Carriers – AER per propulsion system<sup>22</sup>**



### 6.3 Analysis of the variation of the Annual Efficiency Ratio (AER) and the Energy Efficiency Operational Indicator (EEOI) values in 2019 compared to 2018

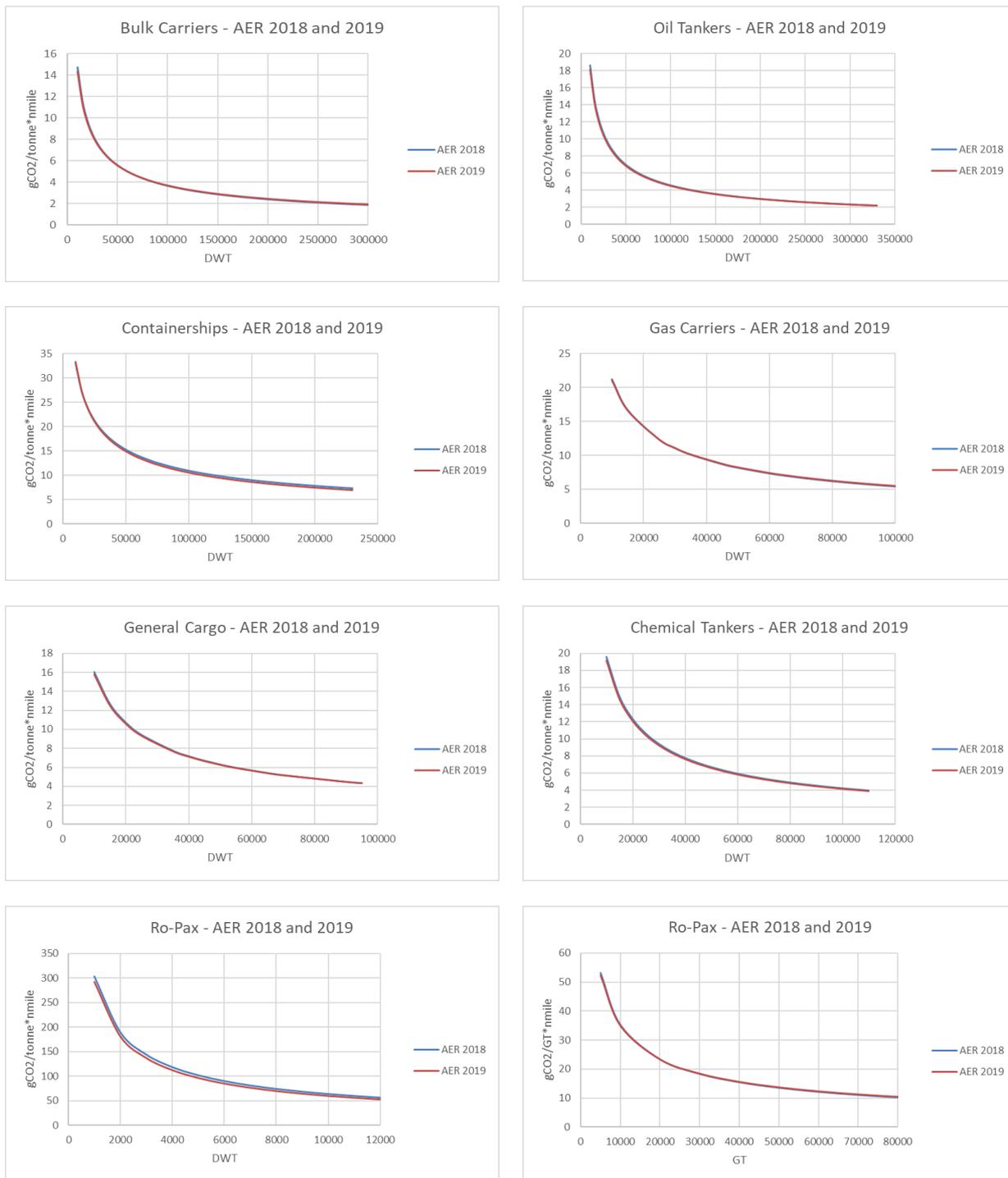
#### AER

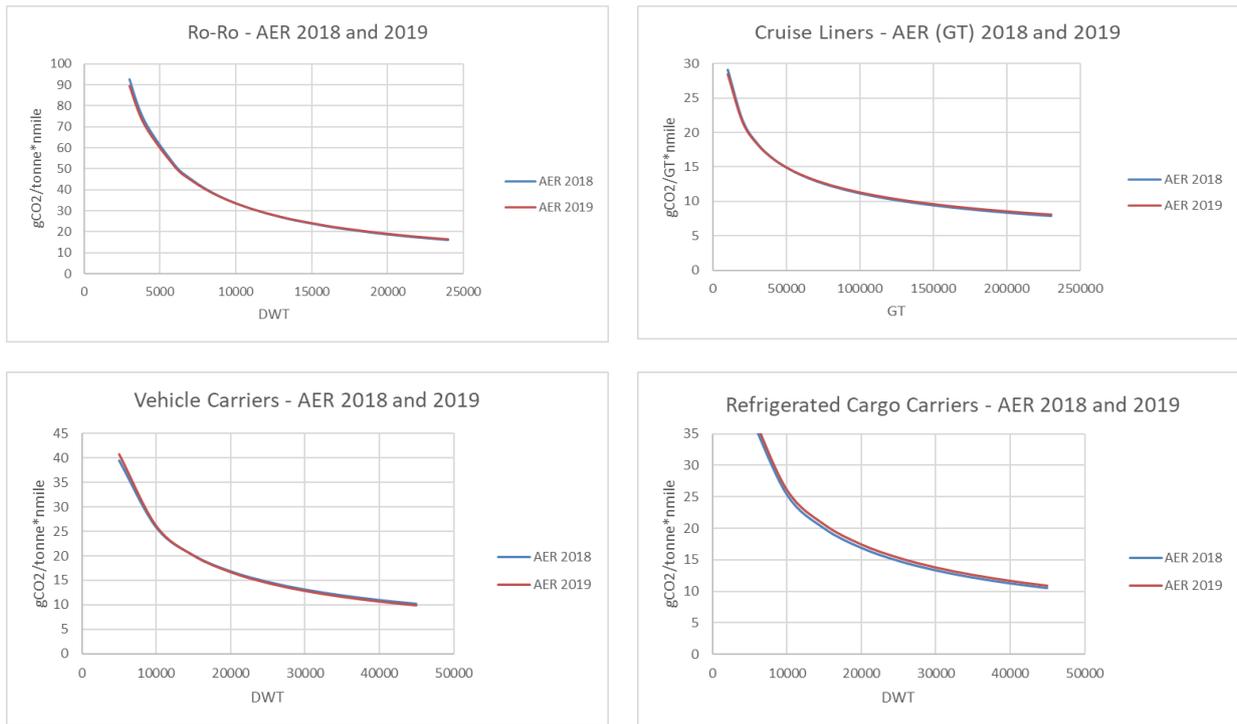
The following graphs show the *AER regression curves* for 2019 for each ship type. The curves follow exactly the same pattern as for 2018 and no significant changes are observed.

<sup>22</sup> SG: Steam Turbine (Diesel only), DE Diesel Electric (LNG primary fuel and Diesel secondary), DD Direct drive (Diesel only), DD Direct drive (Dual fuel)

Having aggregated these ships according to their specific propulsion systems and respective fuel types usage, the following results were obtained: **81 ships SG** - Steam Turbine (Diesel only), **111 ships DE** - Diesel-Electric (LNG primary fuel and Diesel secondary), **45 ships DD** - Direct-drive (Diesel only) and **41 ships DD** - Direct-drive (Dual-Fuel). Also relevant is their respective average age parameter: **SG** > 10 years, **DE** < 10 years but large majority < 5, **DD (Diesel)** > 10 years and **DD (Dual-Fuel)** < 10 years but large majority < 5

Figure 43: AER 2018 and AER 2019 for each ship type



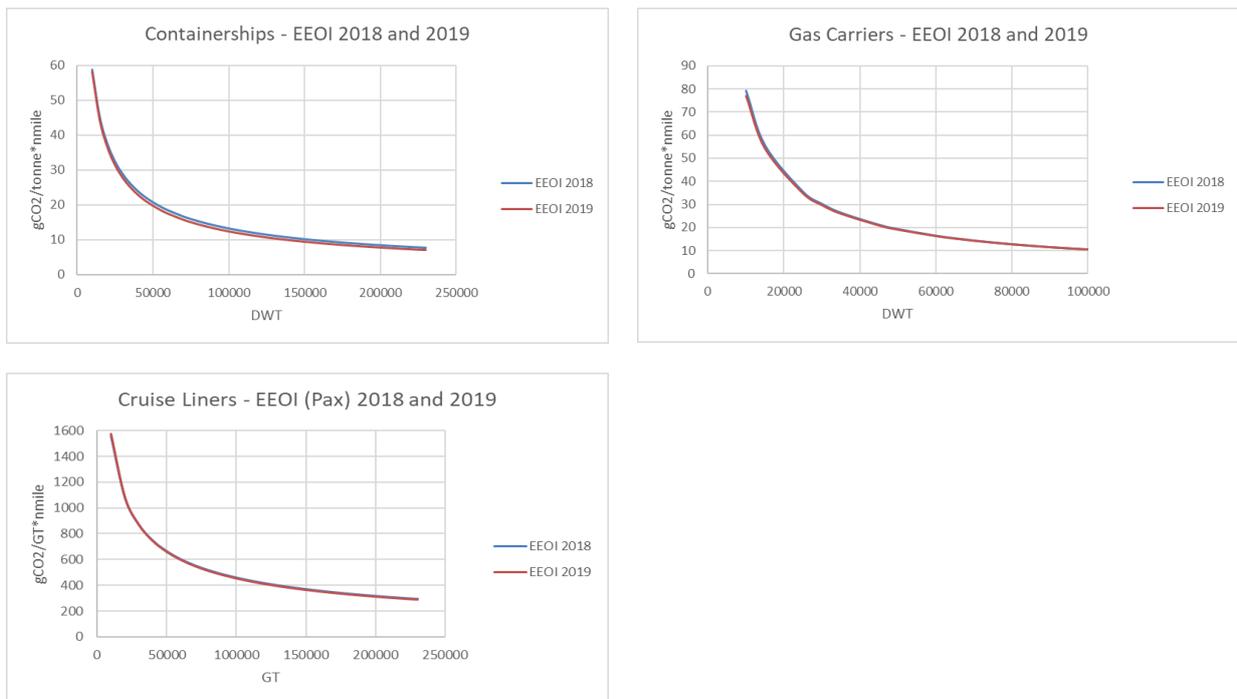


EEOI

Figures below show the EEOI plotted against the carrying capacity for container ships, gas carriers,

and cruise liners. Like in the case of AER, the EEOI has not changed for any of the analysed ship types.

Figure 44: EEOI 2018 and 2019



One could conclude on the wide-ranging consistency of both reporting periods operational performance figures, either in AER or EEOI terms.

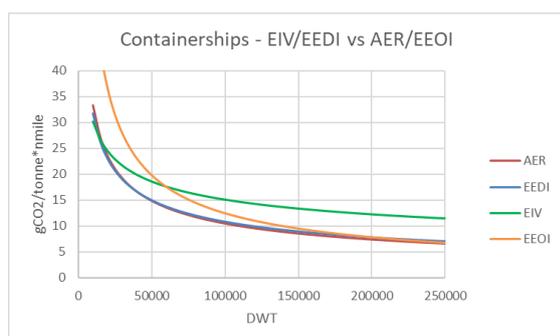
Reference is made to the influential role of speed over operational performance indicators. Since a fleet wise average speed consistency has been observed between 2018 and 2019 (chapter 4), combined with a very similar economic/market period, naturally the ships' operational performances follow a very similar trend.

Further statistical analysis was performed in terms of the Variation (%) between AER 2018 and AER 2019. To this end, only ships present in both reporting periods (around 7400) were used. Results in appendix 6, table 3.

As one can observe, both mean and median results show a very low variability of the AER between 2018 and 2019 at individual ship level on all ship types, even if the mean is known to be highly affected by outliers.

## 6.4 Efficiency Indicator Values (EIV) and attained Energy Efficiency Design Index (EEDI) vs Annual Energy Ratio (AER) & Energy Efficiency Operational Index (EEOI)

Considering that both reported technical efficiency (EEDI/EIV) and operational performance (AER/EEOI) figures did not vary between 2018 and 2019, neither these will change the overall observations/conclusions presented in the previous annual MRV report (namely in relation to the comparison between the energy efficiency indexes and indicators of both pre-EEDI and post-EEDI ships), similar comparisons were made this year and further extended to all those ship types where sufficient data and statistically robust treatment was possible.

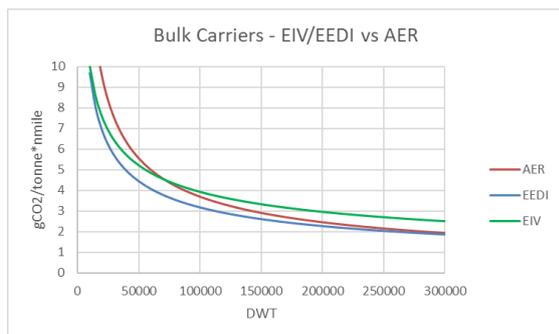


In relation to container ships, the graph shows different trends for ships built before the introduction of EEDI and those built after. For pre-EEDI ships, their observed operational energy efficiency (AER) is much better than their technical energy efficiency at design reference speed. This significant difference is due to the speed reduction within the sector. In 2019, container ships cruised on average at around 60% of their design reference speed. For the newer ships (post-EEDI), the

operational energy efficiency is much closer to the reported EEDI values because they are operating closer to their design reference speed.

It is of interest to compare operational efficiency in terms of EEOI, with EIV/EEDI values. This comparison cannot be made for other ship types, as the EEOI is overly influenced by the capacity utilisation of vessels and ballast voyages. It should also be noted that EIV/EEDI values for container ships are calculated based on 70% of DWT, which is more comparable to real operational conditions. As shown in the figure above, EEOI values are generally higher than AER values, in particular for small-to medium-size ships. However, for larger ships, these two indicators converge. This difference could be attributed to the variation in capacity utilisation of ships, meaning that larger container ships use more of their available capacity. This also means that EEOI and AER are not easily comparable, considering the different behaviour throughout the size segment.

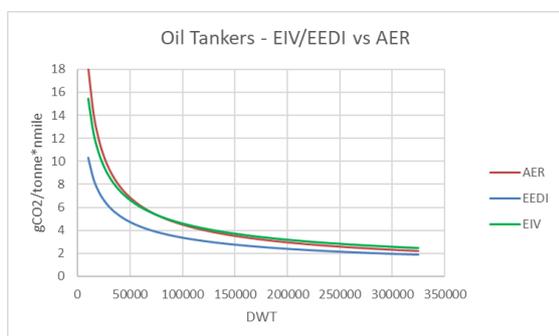
It should also be noted that contrary to AER values, EEOI trends show that the operational energy efficiency of container ships based on real cargo carried is generally worse than their technical efficiency. This is particularly true for small- to medium-size container ships.



For bulk carriers, the figure above show that their technical (EIV or EEDI) and operational energy efficiency level (AER) are relatively comparable. However, for small ship size segments, the operational performance tends to be slightly worse than the technical energy efficiency (up to 20%). The poorer performance of smaller vessels might be explained by their short sea restricted high manoeuvring profile, which negatively affects their average fuel consumption. In addition, it should be noted that operational energy efficiency indicators are influenced by weather conditions, contrary to design performance based on calm water conditions.

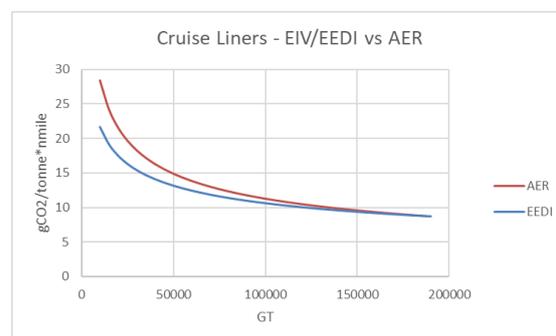
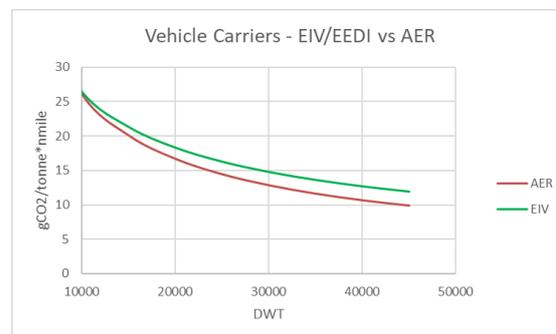
On the contrary, larger bulkers tend to have a better operational performance compared to their technical efficiency (up to around 10%), mostly for pre-EEDI ships.

This difference reflects the fact that bulkers cruise at lower operational speed in comparison to their design reference speed. For the newer ships (post-EEDI), the operational energy efficiency is much closer to the reported EEDI values because they are operating closer to their design reference speed.

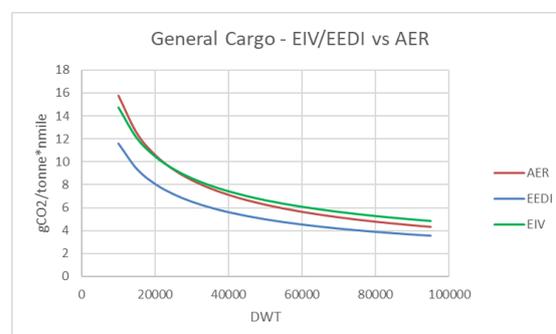


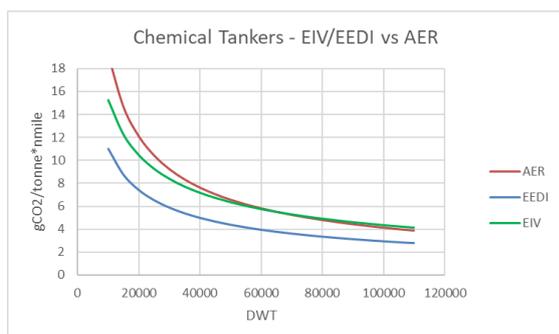
Similar to bulkers, the AER values for small to medium-size oil tankers are generally somewhat higher than corresponding EEDI or EIV values. This difference is particularly notable for small and

medium vessels, whereas it tends to diminish on the largest segments.



Vehicle carriers, mostly represented by a pre-EEDI fleet, have a better operational performance compared to their technical efficiency (EIV) throughout the entire size segments, explained by their current reduced cruising speeds. On the contrary, Cruise liners, here plotted solely with the EEDI fleet, tend to have their operational performance closer to their technical efficiency (EEDI reported values) because they are operating closer to their design reference speed, particularly on the largest segments.





Similarly to the pre-EEDI oil tankers and bulk carriers fleets' behaviours, small to medium-size general cargo, chemical tankers and gas carriers have their operational performances (AER) slightly higher than their corresponding reported technical efficiencies (EIV), while an opposite trend is observed on the largest segments. However, in relation to the EEDI fleets, a substantial difference is shown throughout the entire size segments;

this could be explained by the effect of the introduction of specific correction factors for all these ship types within the EEDI Regulatory Framework which have been proven to be in most of the cases overestimated, to a point which led to an advancement of Phase 3 requirements (particularly for general cargo and gas carriers).

## Appendices

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### Appendix 1: Abbreviations & Definitions

AER: Annual Efficiency Ratio

BDN: Bunker Fuel Delivery Note

CH<sub>4</sub>: Methane

CO<sub>2</sub>: Carbon Dioxide

DoC: Document of Compliance

DWT: Dead Weight Tonnage

EEA: European Economic Area

EEDI: Energy Efficiency Design Index

EEOI: Energy Efficiency Operational Indicator

EIV: Efficiency Indicator Values

EMSA: European Maritime Safety Agency

ER: Emissions Report

ESSF: European Sustainable Shipping Forum

ETS: Emissions Trading System

EU: European Union

EUR: Euro (€)

GHG: Greenhouse Gases

GISIS: Global Integrated Shipping Information System

GT: Gross Tonnage

HFO: Heavy Fuel Oil

ICS: International Chamber of Shipping

IMO: International Maritime Organization

IPCC: Intergovernmental Panel on Climate Change

ISPI: Individual Ship Performance Indicator

kW: Kilowatt

LNG: Liquefied Natural Gas

LPG: Liquefied Petroleum Gas

MCR: Maximum Continuous Rating - The maximum output that can be produced by an engine continuously without causing failure to the propulsion machinery.

MRV: Monitoring, Reporting, and Verification

NAB: National Accreditation Body

NM: Nautical Miles

NO<sub>x</sub>: Nitrogen Oxides, air pollutant

N<sub>2</sub>O: Nitrous oxide

PSC: Port State Control Authorities

Ro-pax: Roll-On/Roll-Off Passenger Vessel

Ro-ro: Roll-On/Roll-Off Ship

R<sup>2</sup>: Coefficient of determination

SEEMP: Ship Energy Efficiency Management Plans

SLCFs: Short-lived climate forcers

SO<sub>x</sub>: Sulphur Oxides, air pollutant

PM, BC: Particulate Matter including Black Carbon

TEU: Twenty-Foot Equivalent Unit – a measurement of a ship's carrying capacity, where the dimensions of one TEU corresponds to one standard shipping container (20 ft by 8ft).

T-nm: Thousand nautical miles

UN: United Nations

## Appendix 2: The MRV system - The different steps of the MRV process



### Step 1: Producing a Monitoring Plan

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

Ship owners are required to fill out a monitoring plan before engaging in monitoring and reporting. In this document, ship owners explain how they intend to monitor the relevant parameters required by the EU MRV Regulation. This monitoring plan must provide complete and transparent documentation of the monitoring method that will be applied for each ship. It must follow the pre-defined template provided in the implementing legislation.<sup>16</sup>

Companies can choose between four methods for monitoring CO<sub>2</sub> emissions:

- Bunker Fuel Delivery Note (BDN) and periodic stocktakes of fuel tanks;
- bunker fuel tank monitoring on board;
- flow meters for applicable combustion processes;
- direct CO<sub>2</sub> emissions measurements.<sup>17</sup>

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

All monitoring plans need to be assessed by an accredited verifier. If the verifier identifies any non-conformities, the company must revise its monitoring plan and submit the revised plan for a final assessment.<sup>18</sup> Monitoring plans can be created and assessed in THETIS-MRV on a voluntary basis.

### Step 2: Monitoring and reporting

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

Monitoring and reporting of CO<sub>2</sub> emissions and other mandatory information has to occur while the ship is at sea as well as at berth.

In addition, companies can report voluntary information to ease the interpretation of their CO<sub>2</sub> emissions and energy efficiency indicators. For instance, companies can voluntarily distinguish ballast voyages (without cargo) from laden voyages (with cargo), and, for relevant ship types, single out fuel consumption and CO<sub>2</sub> emissions related to cargo heating, and dynamic positioning.

Shipping companies are ultimately responsible for the accuracy and completeness of the monitored and reported data. Accordingly, they must record, compile, analyse and document monitoring data, including assumptions, references, emission factors and activity data. This must be done in a transparent manner that allows for reproduction of the determination of CO<sub>2</sub> emissions by the verifier.

### Step 3: Providing an Emission Report

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

### Step 4: Verification of Emission Report

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

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

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

### Step 5: Issuing a Document of Compliance

When an emission report has been satisfactorily verified, the verifier drafts the verification report, issues a **document of compliance**, and informs the Commission and the flag State. This document confirms a ship's compliance with the requirements of the Regulation for a specific reporting period. It has to be carried on board no later than 30 June.

The document of compliance is generated using THETIS-MRV, and is valid for a period of 18 months.

### Step 6: Publication of information and Annual Report

According to the legislation, the Commission has to make information on CO<sub>2</sub> emissions and other relevant information publicly available by 30 June each year. The information is available at individual ship level, aggregated on an annual basis.

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

Under specific circumstances, companies can make a request to the Commission to disclose less details of information unrelated to CO<sub>2</sub> emissions. Such requests can only be justified in exceptional cases, where disclosure would undermine the protection of commercial interests, thereby overriding the public interest in granular information.

The Regulation also requires the Commission to publish an annual report in order to inform the public and allow for an assessment of CO<sub>2</sub> emissions and the energy efficiency of maritime transport.

### Continuous enforcement activities throughout the EU MRV process

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

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

## Appendix 3: Average main engine and auxiliary engine power per ship type and size

| Row Labels                        | 2018                                   |                    |                 | 2019                                   |                    |                 |
|-----------------------------------|--|--------------------|-----------------|--|--------------------|-----------------|
|                                   | Average Main propulsion power MCR (kW) | Average Aux Engine | Number of ships | Average Main propulsion power MCR (kW) | Average Aux Engine | Number of ships |
| <b>Bulk carrier</b>               | <b>9 264</b>                           | <b>399</b>         | <b>3 810</b>    | <b>9 118</b>                           | <b>397</b>         | <b>3 594</b>    |
| DWT: 000 000 - 009 999            | 4 285                                  | 272                | 25              | 4 509                                  | 329                | 26              |
| DWT: 010 000 - 034 999            | 6 362                                  | 319                | 764             | 6 371                                  | 323                | 738             |
| DWT: 035 000 - 059 999            | 8 025                                  | 363                | 1 256           | 8 007                                  | 367                | 1 163           |
| DWT: 060 000 - 099 999            | 9 656                                  | 423                | 1 324           | 9 490                                  | 412                | 1 284           |
| DWT: 100 000 - 199 999            | 16 952                                 | 550                | 396             | 16 824                                 | 562                | 340             |
| DWT: 200 000 - 999 999            | 16 665                                 | 805                | 45              | 17 036                                 | 731                | 43              |
| <b>Chemical tanker</b>            | <b>7 374</b>                           | <b>744</b>         | <b>1 361</b>    | <b>7 298</b>                           | <b>755</b>         | <b>1 345</b>    |
| DWT: 000 000 - 004 999            | 5 225                                  | 610                | 2               |  |                    |                 |
| DWT: 005 000 - 009 999            | 3 769                                  | 383                | 116             | 3 773                                  | 385                | 120             |
| DWT: 010 000 - 019 999            | 5 482                                  | 548                | 353             | 5 431                                  | 571                | 357             |
| DWT: 020 000 - 999 999            | 8 600                                  | 869                | 890             | 8 553                                  | 882                | 868             |
| <b>Combination carrier</b>        | <b>10 474</b>                          | <b>626</b>         | <b>10</b>       | <b>9 821</b>                           | <b>581</b>         | <b>11</b>       |
| DWT: 000 000 - 009 999            | 8 190                                  | 611                | 4               | 6 936                                  | 489                | 5               |
| DWT: 010 000 - 034 999            | 12 985                                 | 956                | 1               | 12 985                                 | 956                | 1               |
| DWT: 035 000 - 059 999            | 9 320                                  | 260                | 3               | 9 240                                  | -                  | 2               |
| DWT: 060 000 - 099 999            |  |                    |                 | 10 850                                 | 910                | 1               |
| DWT: 100 000 - 199 999            | 15 519                                 | 1 040              | 2               | 15 519                                 | 1 040              | 2               |
| <b>Container ship</b>             | <b>36 515</b>                          | <b>2 124</b>       | <b>1 792</b>    | <b>36 622</b>                          | <b>2 158</b>       | <b>1 801</b>    |
| DWT: 000 000 - 009 999            | 7 520                                  | 453                | 108             | 7 302                                  | 423                | 104             |
| DWT: 010 000 - 014 999            | 9 463                                  | 751                | 199             | 9 397                                  | 754                | 215             |
| DWT: 015 000 - 039 999            | 17 888                                 | 1 355              | 404             | 17 841                                 | 1 349              | 392             |
| DWT: 040 000 - 079 999            | 40 437                                 | 2 009              | 439             | 39 978                                 | 1 991              | 408             |
| DWT: 080 000 - 119 999            | 56 947                                 | 2 918              | 312             | 56 704                                 | 2 867              | 305             |
| DWT: 120 000 - 199 999            | 60 653                                 | 3 823              | 310             | 59 570                                 | 3 855              | 350             |
| DWT: 200 000 - 999 999            | 59 504                                 | 4 179              | 20              | 63 970                                 | 4 236              | 27              |
| <b>Container/ro-ro cargo ship</b> | <b>16 851</b>                          | <b>955</b>         | <b>79</b>       | <b>17 662</b>                          | <b>946</b>         | <b>76</b>       |
| (blank)                           | 16 851                                 | 955                | 79              | 17 662                                 | 946                | 76              |
| <b>Gas carrier</b>                | <b>8 805</b>                           | <b>939</b>         | <b>321</b>      | <b>9 294</b>                           | <b>970</b>         | <b>341</b>      |
| DWT: 000 000 - 009 999            | 4 788                                  | 501                | 91              | 4 653                                  | 491                | 83              |
| DWT: 010 000 - 019 999            | 7 108                                  | 988                | 83              | 7 147                                  | 1 023              | 86              |
| DWT: 020 000 - 039 999            | 8 859                                  | 1 134              | 66              | 8 789                                  | 1 105              | 74              |
| DWT: 040 000 - 059 999            | 12 745                                 | 1 163              | 70              | 12 722                                 | 1 228              | 81              |
| DWT: 060 000 - 999 999            | 29 459                                 | 1 596              | 11              | 28 664                                 | 1 220              | 17              |
| <b>General cargo ship</b>         | <b>5 963</b>                           | <b>460</b>         | <b>1 171</b>    | <b>5 964</b>                           | <b>457</b>         | <b>1 180</b>    |
| DWT: 000 000 - 004 999            | 3 897                                  | 49                 | 7               | 3 907                                  | 221                | 9               |
| DWT: 005 000 - 009 999            | 3 772                                  | 288                | 441             | 3 763                                  | 289                | 440             |
| DWT: 010 000 - 999 999            | 7 319                                  | 569                | 723             | 7 315                                  | 561                | 731             |
| <b>LNG carrier</b>                | <b>32 668</b>                          | <b>2 228</b>       | <b>212</b>      | <b>34 186</b>                          | <b>2 281</b>       | <b>256</b>      |

|                                   |               |            |               |               |            |               |
|-----------------------------------|---------------|------------|---------------|---------------|------------|---------------|
| DWT: 000 000 - 069 999            | 13 479        | 1 166      | 7             | 8 393         | 188        | 4             |
| DWT: 070 000 - 079 999            | 27 063        | 2 951      | 42            | 28 308        | 2 996      | 39            |
| DWT: 080 000 - 089 999            | 32 326        | 1 557      | 80            | 33 274        | 1 501      | 92            |
| DWT: 090 000 - 099 999            | 38 784        | 1 660      | 46            | 38 385        | 1 942      | 74            |
| DWT: 100 000 - 999 999            | 35 798        | 3 765      | 37            | 36 429        | 3 924      | 47            |
| <b>Oil tanker</b>                 | <b>13 116</b> | <b>928</b> | <b>1 876</b>  | <b>12 933</b> | <b>930</b> | <b>1 985</b>  |
| DWT: 000 000 - 004 999            | 9 040         | 753        | 2             | 13 350        | 970        | 2             |
| DWT: 005 000 - 009 999            | 3 051         | 362        | 54            | 3 262         | 384        | 46            |
| DWT: 010 000 - 019 999            | 5 935         | 768        | 78            | 5 906         | 782        | 85            |
| DWT: 020 000 - 059 999            | 8 851         | 823        | 510           | 8 863         | 831        | 528           |
| DWT: 060 000 - 079 999            | 12 051        | 860        | 205           | 11 921        | 871        | 203           |
| DWT: 080 000 - 119 999            | 13 281        | 941        | 521           | 13 281        | 934        | 625           |
| DWT: 120 000 - 199 999            | 17 598        | 1 072      | 385           | 17 383        | 1 087      | 392           |
| DWT: 200 000 - 999 999            | 27 112        | 1 326      | 121           | 26 730        | 1 286      | 104           |
| <b>Other ship types</b>           | <b>10 139</b> | <b>429</b> | <b>122</b>    | <b>9 912</b>  | <b>399</b> | <b>129</b>    |
| (blank)                           | 10 139        | 429        | 122           | 9 912         | 399        | 129           |
| <b>Passenger ship</b>             | <b>38 757</b> | <b>896</b> | <b>159</b>    | <b>39 388</b> | <b>882</b> | <b>179</b>    |
| GT: 002 000 - 009 999             | 4 523         | 610        | 9             | 4 252         | 448        | 15            |
| GT: 010 000 - 059 999             | 18 864        | 922        | 64            | 19 273        | 807        | 64            |
| GT: 060 000 - 099 999             | 49 567        | 1 269      | 52            | 50 714        | 1 401      | 58            |
| GT: 100 000 - 150 000             | 68 093        | 458        | 26            | 65 933        | 588        | 31            |
| GT: 150 000 - 999 999             | 70 798        | -          | 8             | 69 797        | -          | 11            |
| <b>Refrigerated cargo carrier</b> | <b>10 824</b> | <b>806</b> | <b>145</b>    | <b>10 608</b> | <b>770</b> | <b>145</b>    |
| DWT: 000 000 - 009 999            | 6 887         | 508        | 34            | 5 999         | 457        | 45            |
| DWT: 010 000 - 014 999            | 11 568        | 894        | 85            | 12 030        | 858        | 71            |
| DWT: 015 000 - 039 999            | 12 152        | 867        | 23            | 13 135        | 1 019      | 26            |
| DWT: 040 000 - 999 999            | 24 180        | 1 223      | 3             | 24 180        | 1 223      | 3             |
| <b>Ro-pax ship</b>                | <b>24 872</b> | <b>973</b> | <b>376</b>    | <b>24 604</b> | <b>952</b> | <b>389</b>    |
| GT: 000 000 - 009 999             | 16 237        | 306        | 54            | 16 488        | 287        | 61            |
| GT: 010 000 - 014 999             | 15 743        | 632        | 57            | 15 354        | 632        | 55            |
| GT: 015 000 - 039 999             | 26 524        | 1 100      | 220           | 26 443        | 1 080      | 229           |
| GT: 040 000 - 074 999             | 38 257        | 1 586      | 41            | 38 108        | 1 584      | 42            |
| GT: 075 000 - 999 999             | 43 450        | 1 628      | 4             | 32 400        | 2 040      | 2             |
| <b>Ro-ro ship</b>                 | <b>13 867</b> | <b>909</b> | <b>272</b>    | <b>13 865</b> | <b>953</b> | <b>275</b>    |
| GT: 000 000 - 009 999             | 5 312         | 424        | 30            | 5 152         | 416        | 31            |
| GT: 010 000 - 014 999             | 12 155        | 594        | 26            | 12 488        | 607        | 24            |
| GT: 015 000 - 039 999             | 15 492        | 1 000      | 157           | 15 359        | 1 011      | 159           |
| GT: 040 000 - 074 999             | 14 646        | 1 055      | 59            | 14 940        | 1 211      | 61            |
| <b>Vehicle carrier</b>            | <b>13 846</b> | <b>766</b> | <b>448</b>    | <b>13 787</b> | <b>762</b> | <b>411</b>    |
| DWT: 000 000 - 009 999            | 9 008         | 366        | 32            | 8 193         | 397        | 27            |
| DWT: 010 000 - 014 999            | 11 926        | 945        | 62            | 12 361        | 999        | 54            |
| DWT: 015 000 - 039 999            | 14 527        | 749        | 349           | 14 429        | 742        | 326           |
| DWT: 040 000 - 999 999            | 21 080        | 2 268      | 5             | 18 520        | 1 635      | 4             |
| <b>Grand Total</b>                | <b>14 961</b> | <b>884</b> | <b>12 154</b> | <b>15 147</b> | <b>905</b> | <b>12 117</b> |

## Appendix 4: Analysis of emissions comparing deep-sea and short-sea shipping

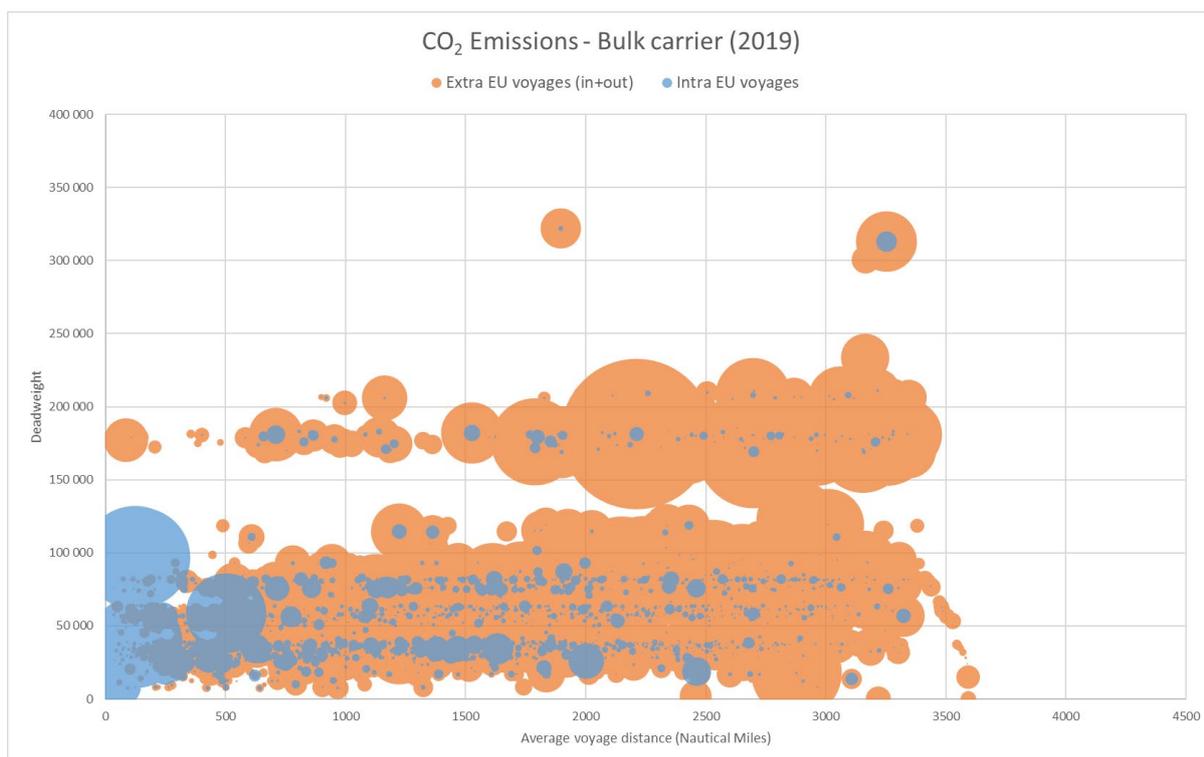
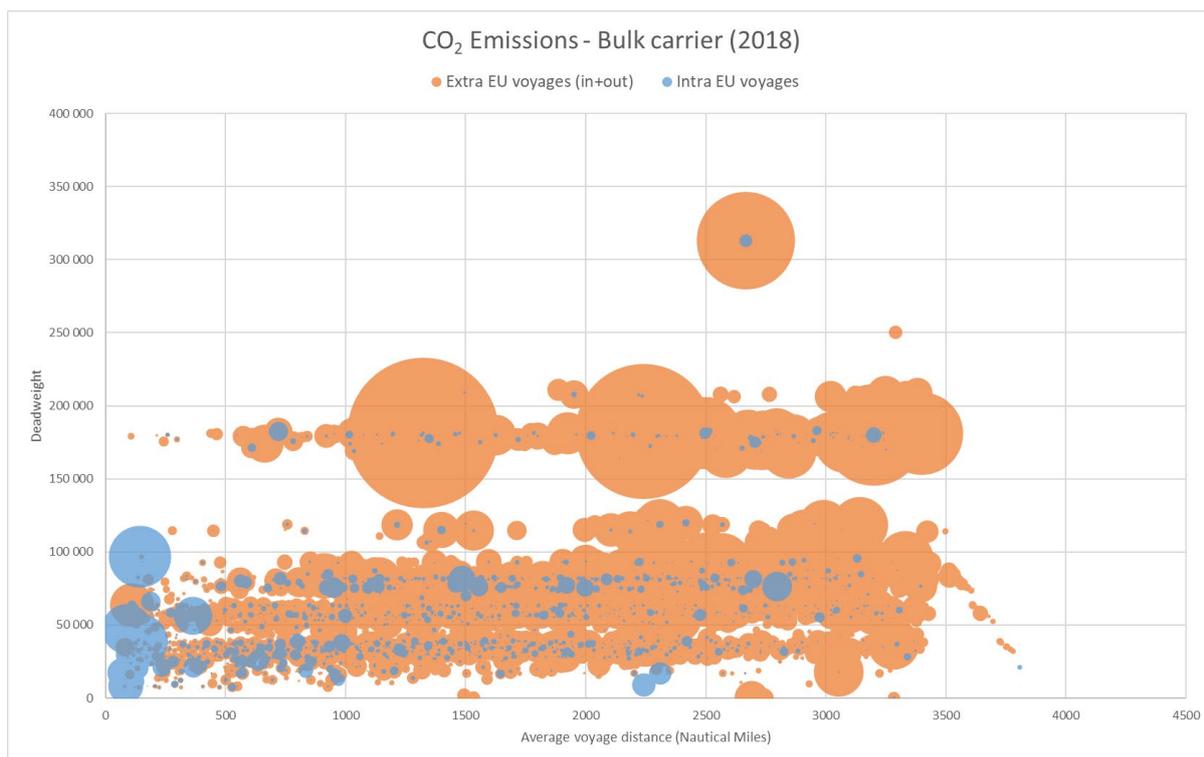
The methodology used for assessing emission on short/deep sea is the following:

- The average distance of a voyage was calculated by dividing the reported distance travelled by the number of PortCalls
- Scattered graphs were plotted for each ship type as follows:
  - Horizontal Aix: Average distance of a voyage
  - Vertical Aix: Ship size (DWT or GT as relevant)
  - Blue bubbles size: reported emission for each ship in intra EU voyages
  - Orange bubbles sizes: reported emissions for each ship for incoming plus outgoing voyages

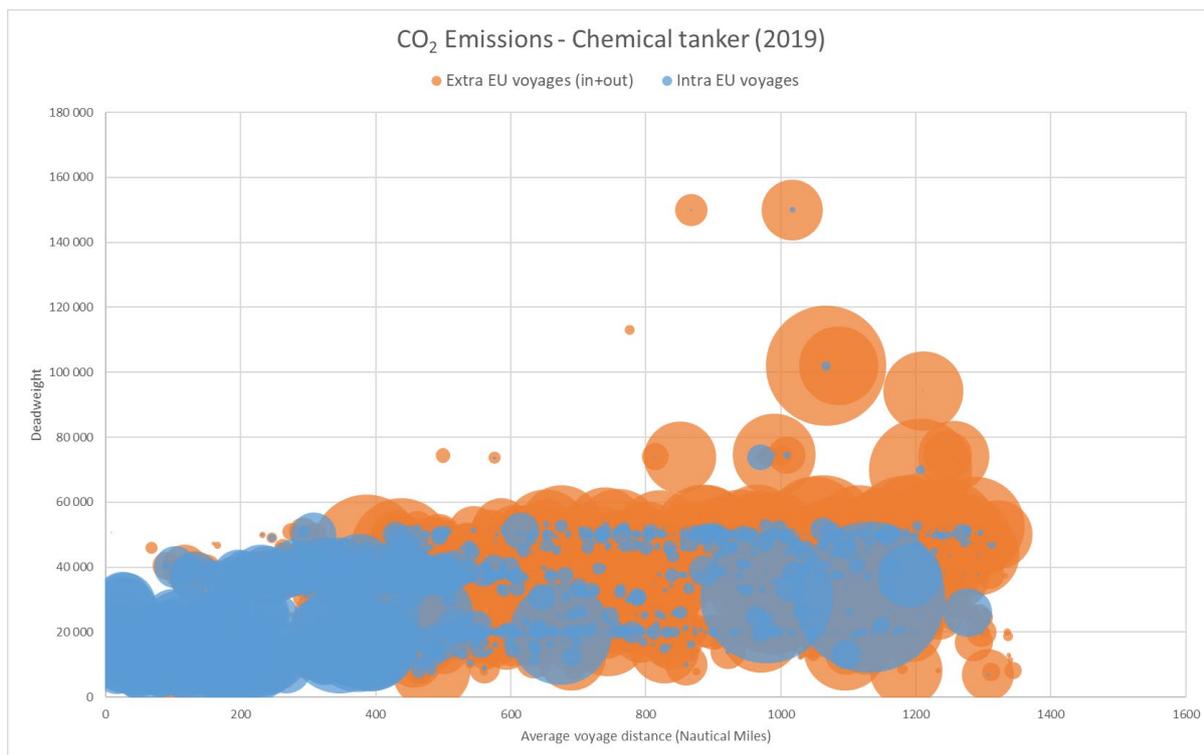
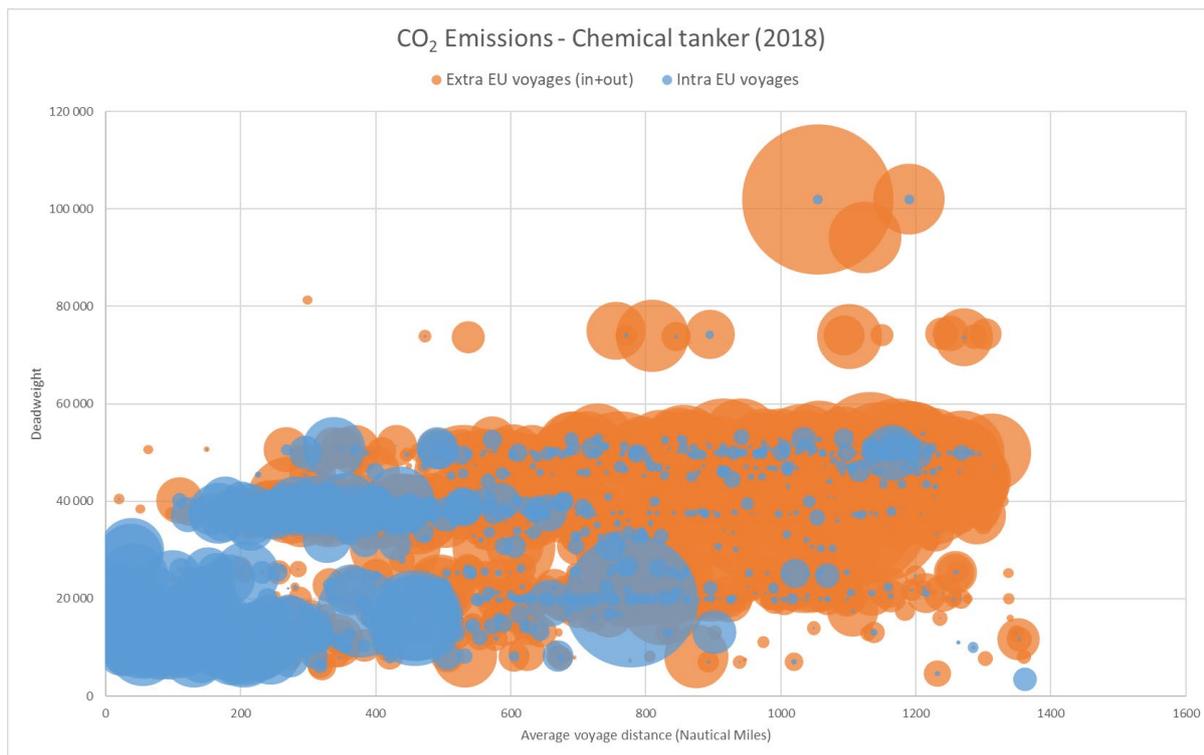
While assessing the graphs below (and those of section 5.3) it is important to take into account that the methodology used is a proxy. Therefore, the following aspects are to be taken into consideration:

- ships operating with different voyage lengths will be wrongly placed in the graphs;
- ships operating with constant voyage lengths will be well placed in the graphs;
- ships placed to the right side of the graphs have higher average voyage length and are closer to be considered as deep-sea trade.
- ships placed to the left side of the graphs have lower average voyage length and are closer to be considered as short-sea trade.
- careful attention should be taken when comparing between graphs of different ship types because not all graphs are presented with the same axis scales.
- each ship is represented by an orange and a blue concentric bubble. If only orange is noted, it means that intra EU voyages are not existent or in a very small number. If only blue is noted, it means that extra EU voyages are not existing or in a very small number.

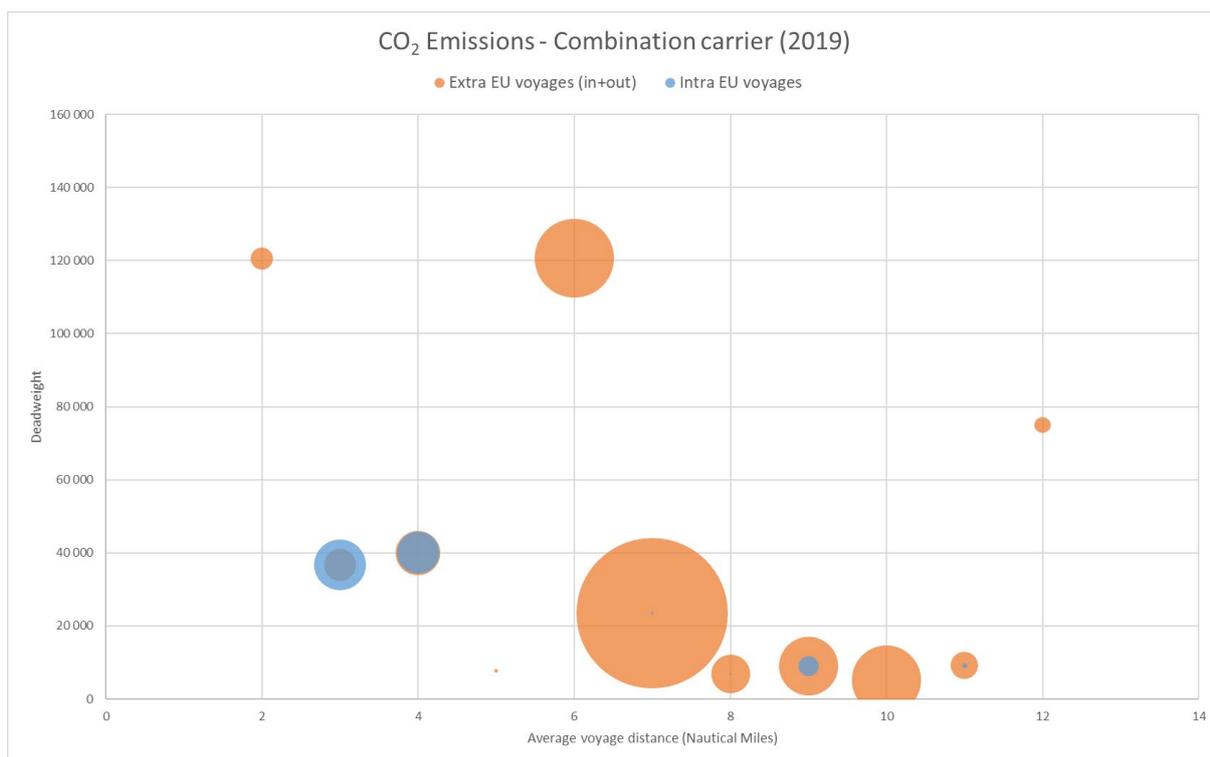
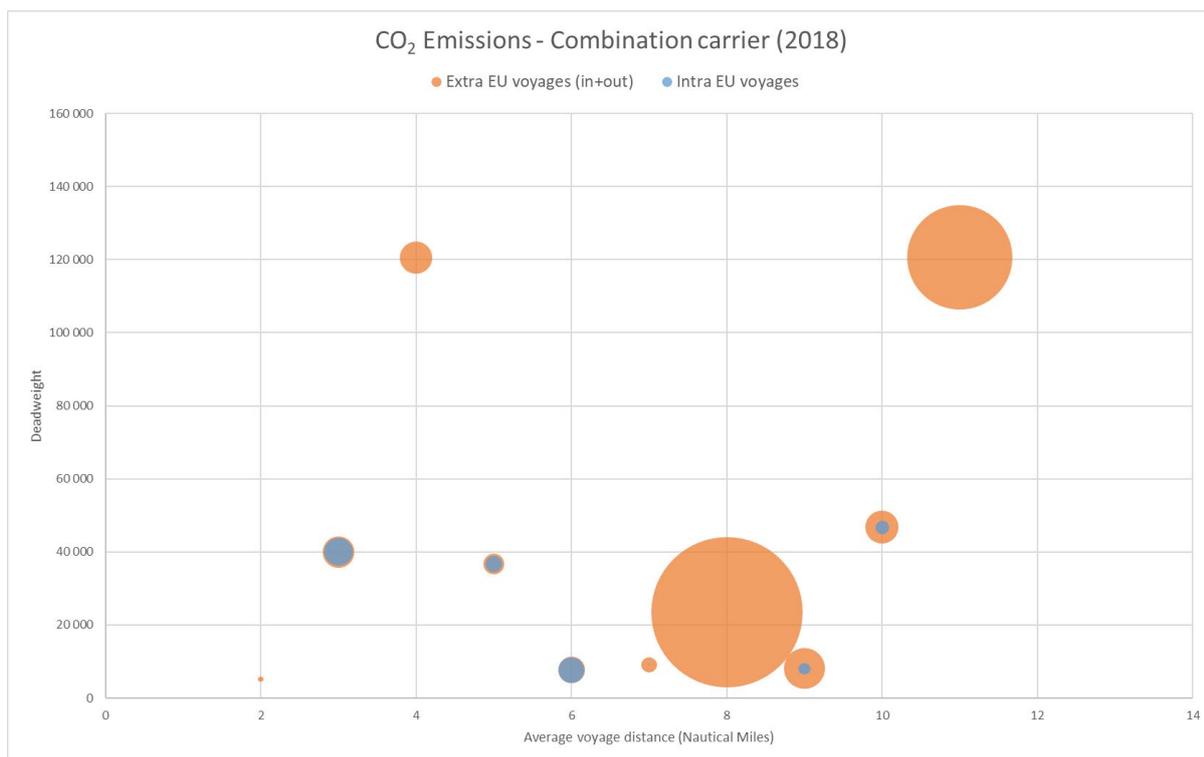
## Bulk Carriers



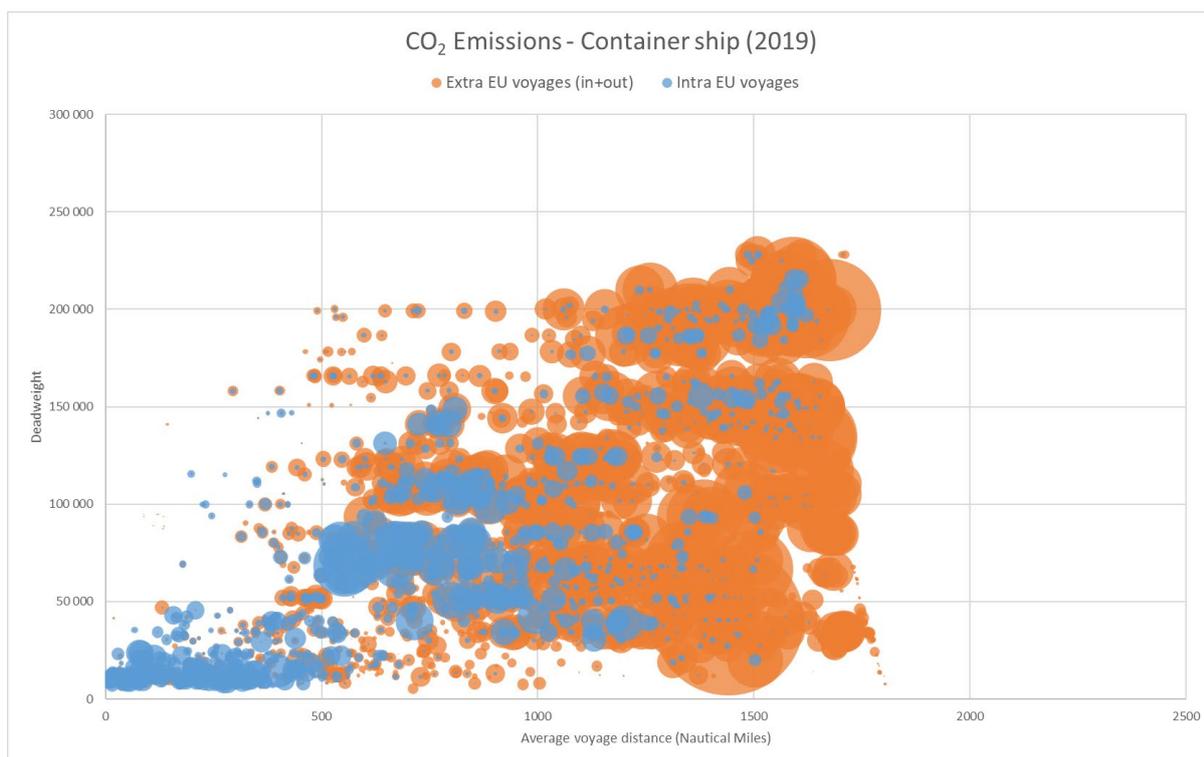
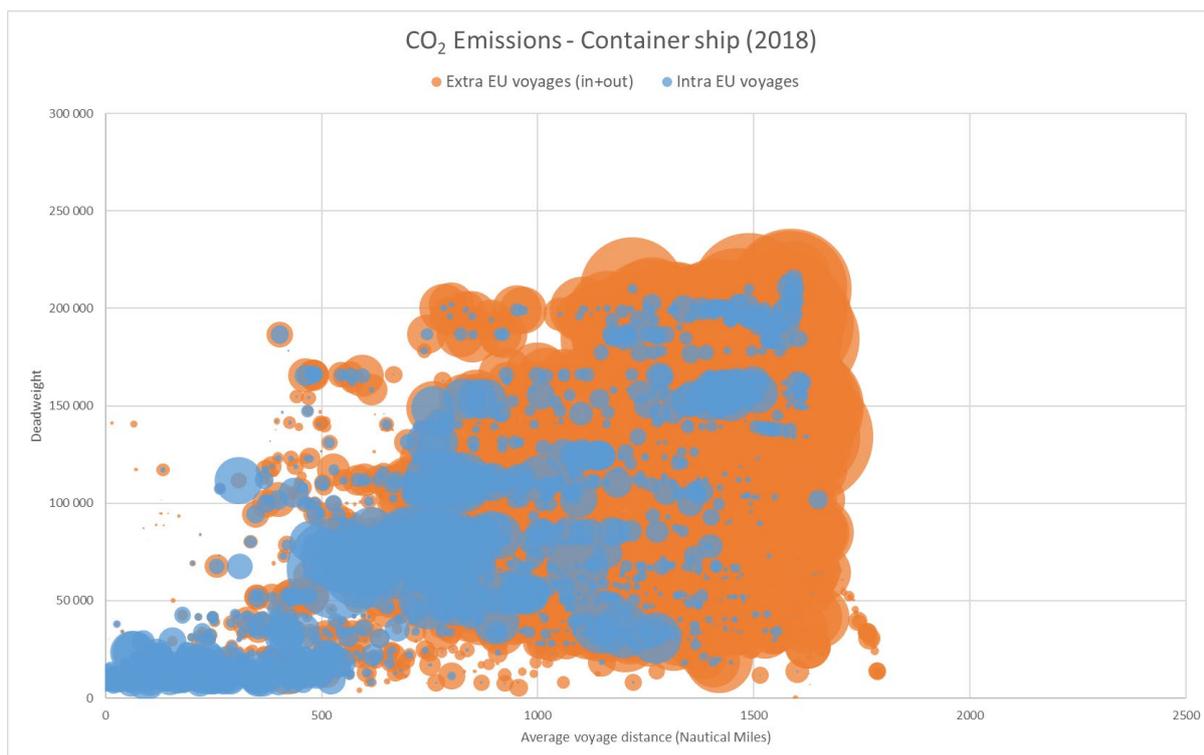
### Chemical tanker



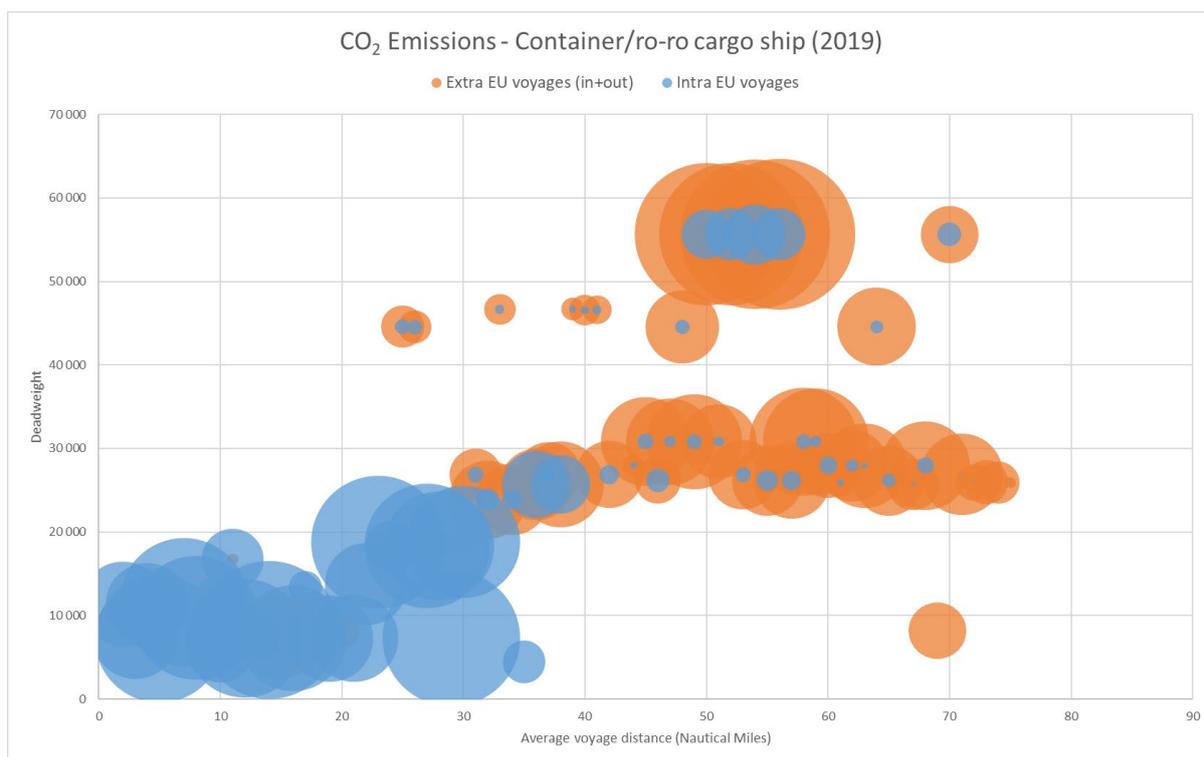
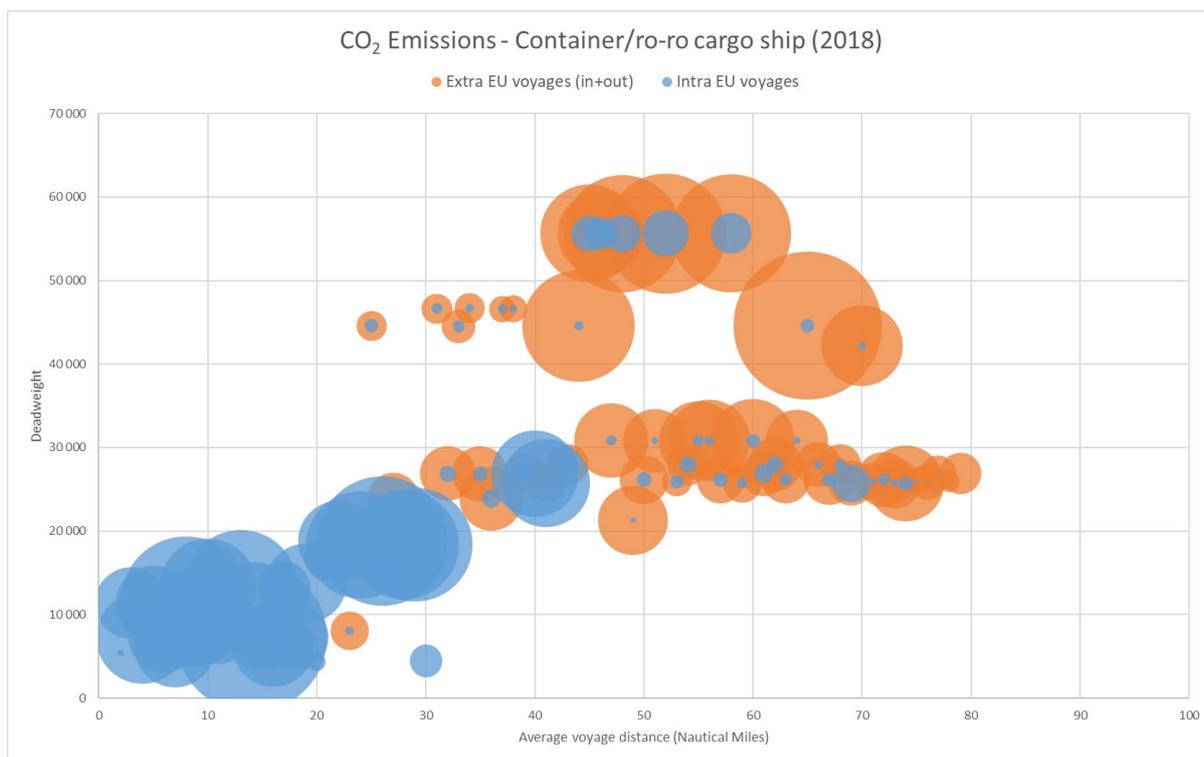
### Combination carrier



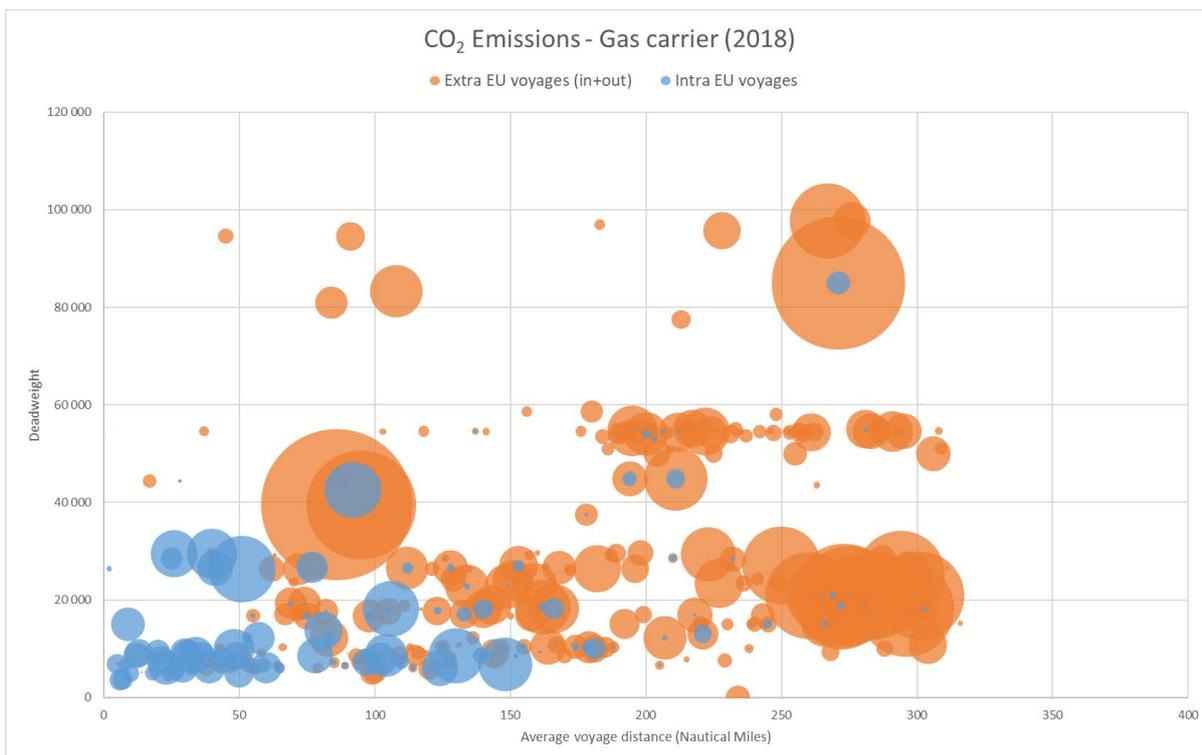
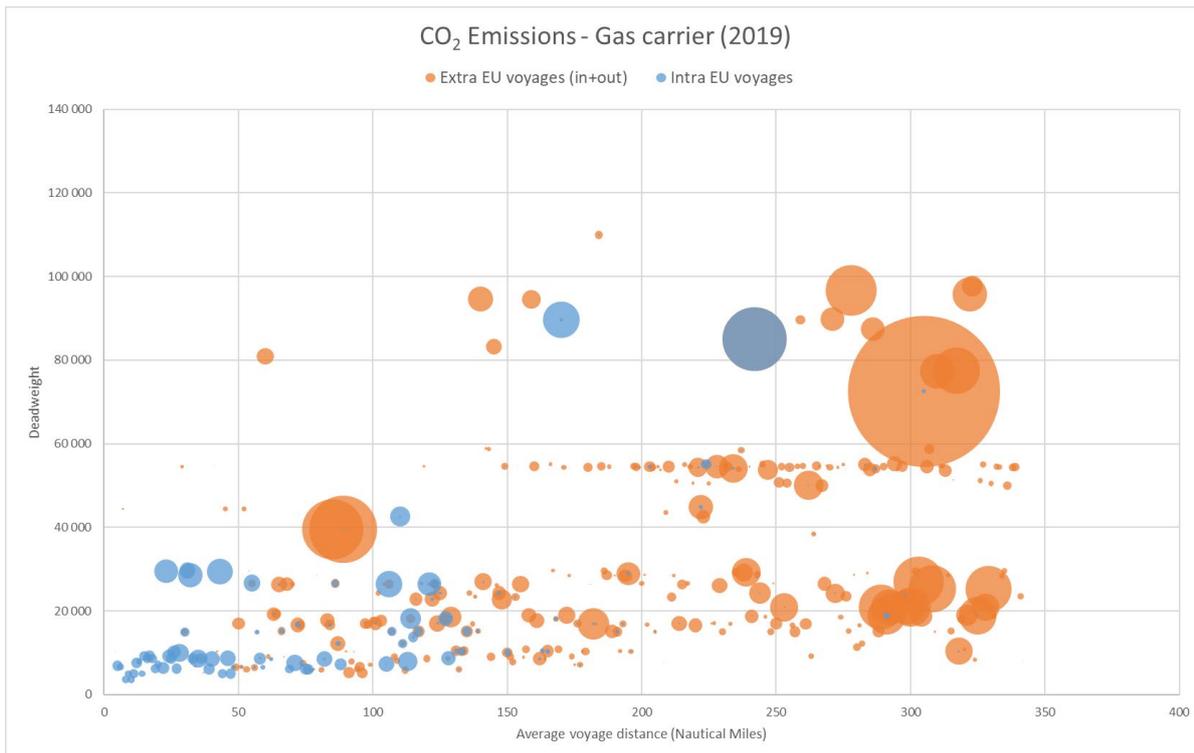
### Container ship



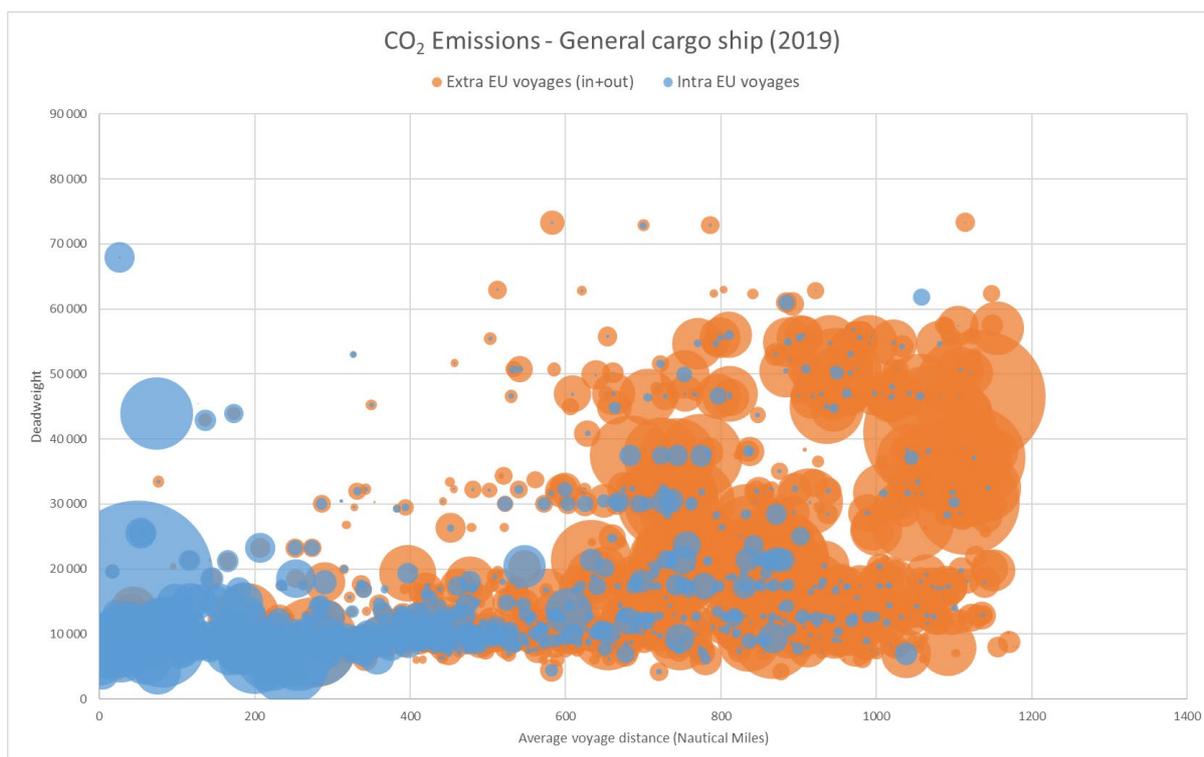
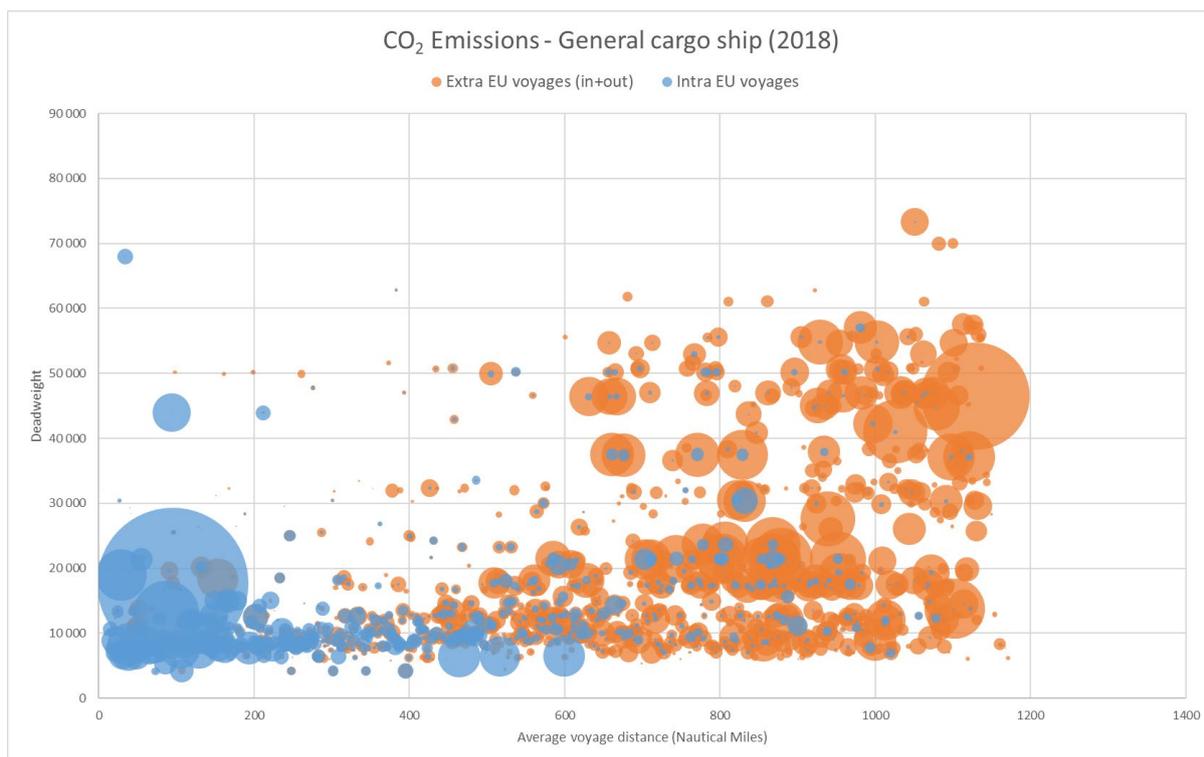
### Container/ro-ro cargo ship



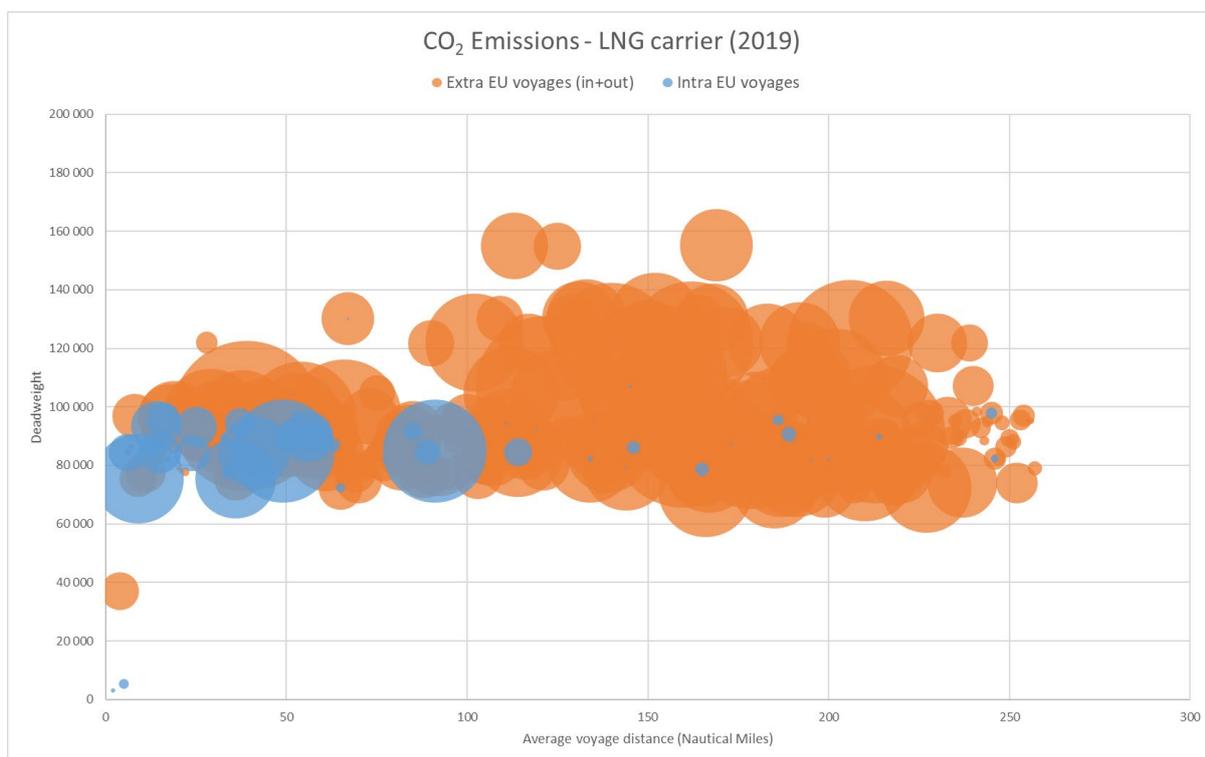
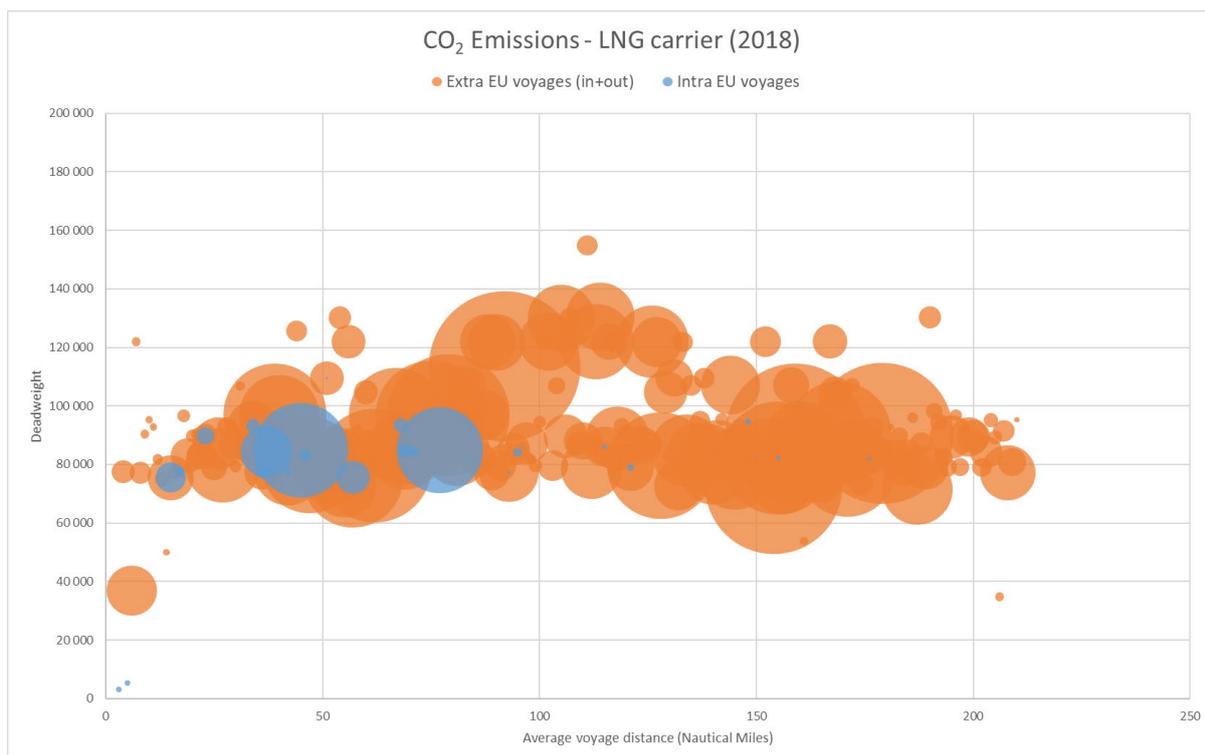
### Gas carrier



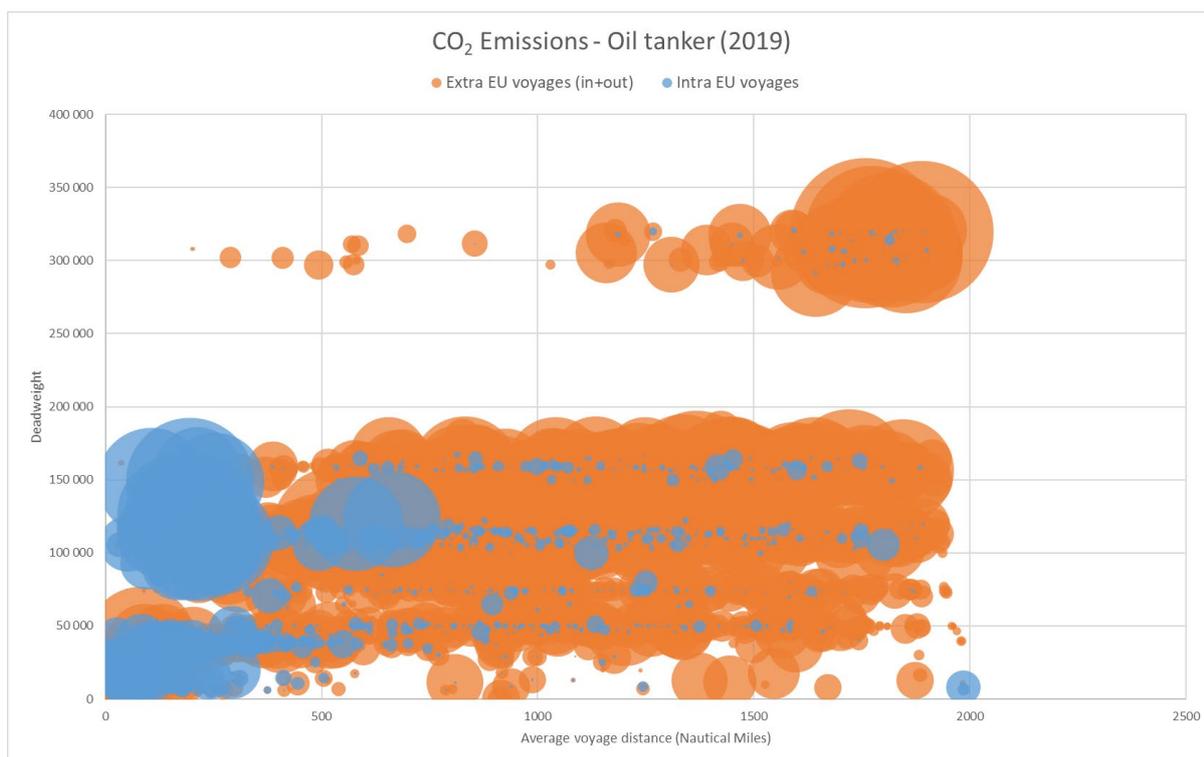
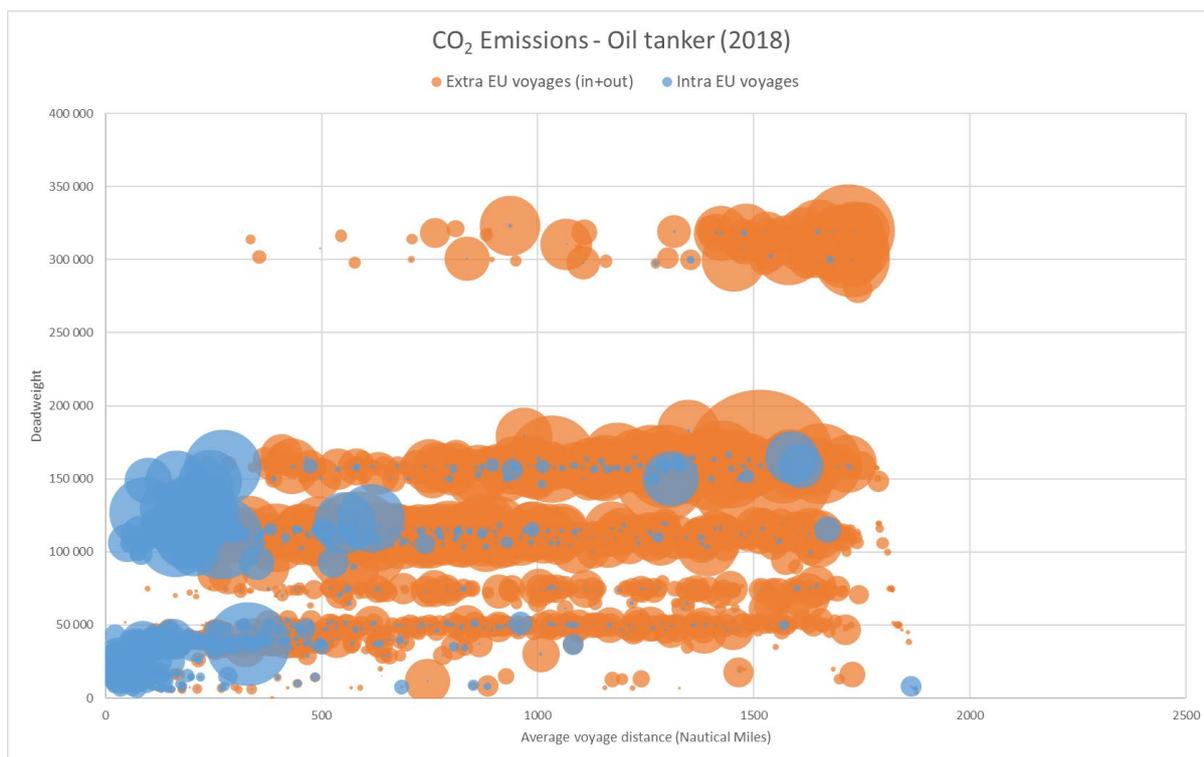
## General cargo ship



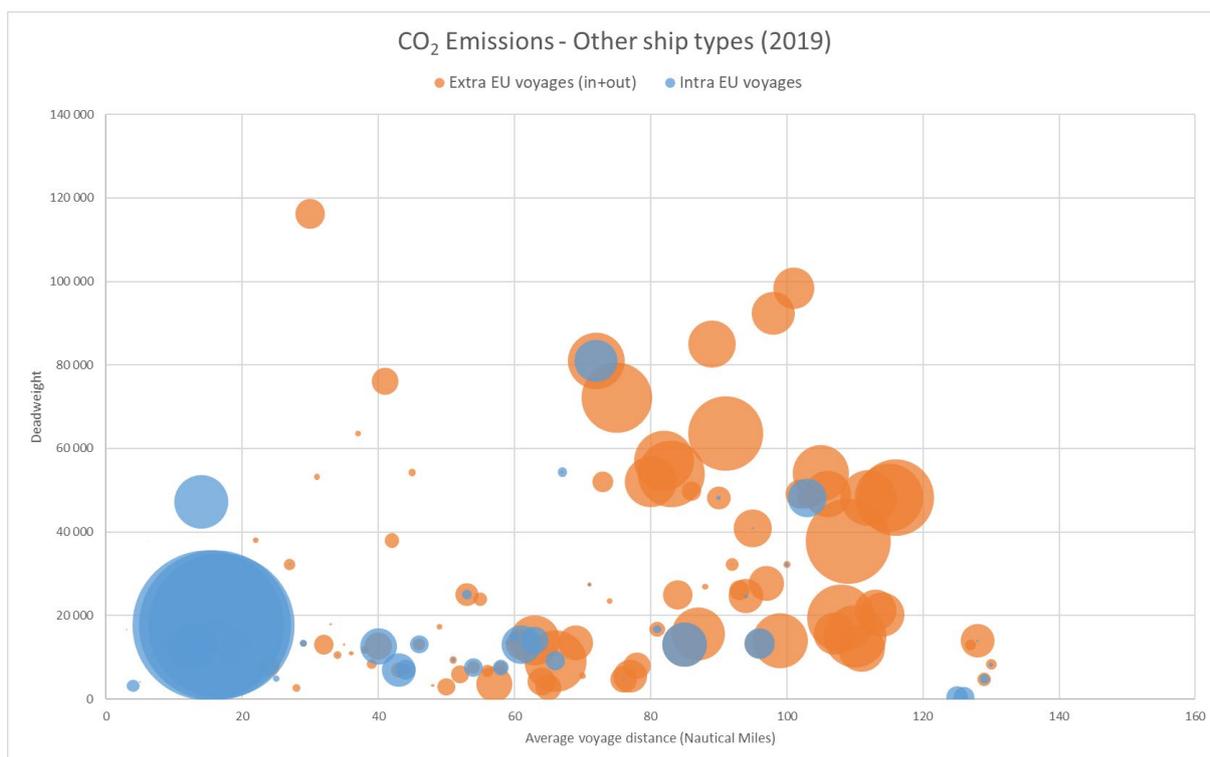
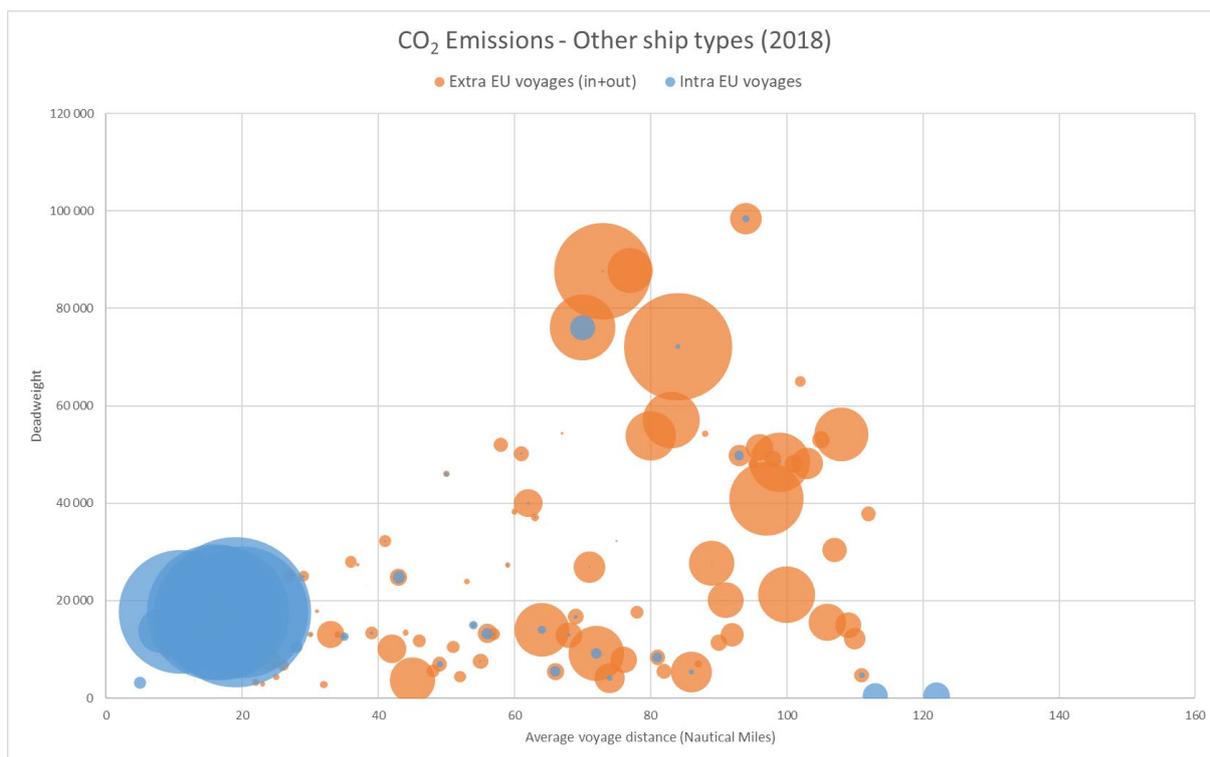
LNG carrier



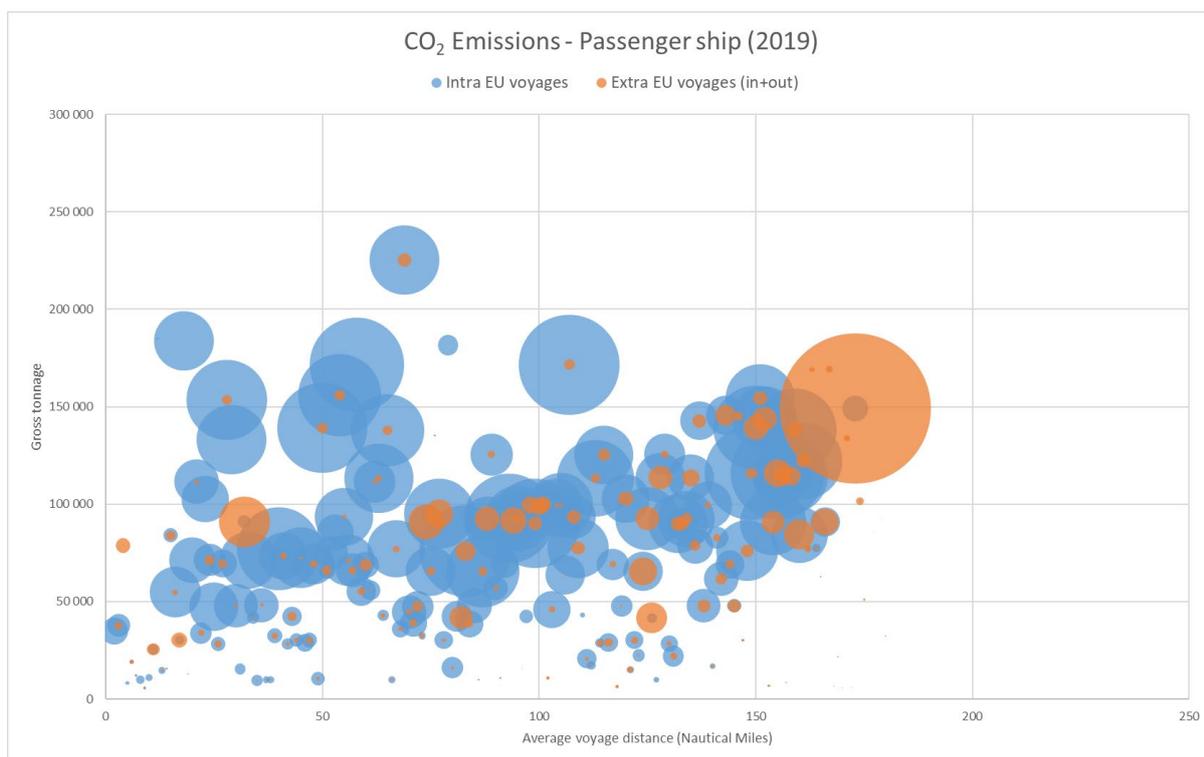
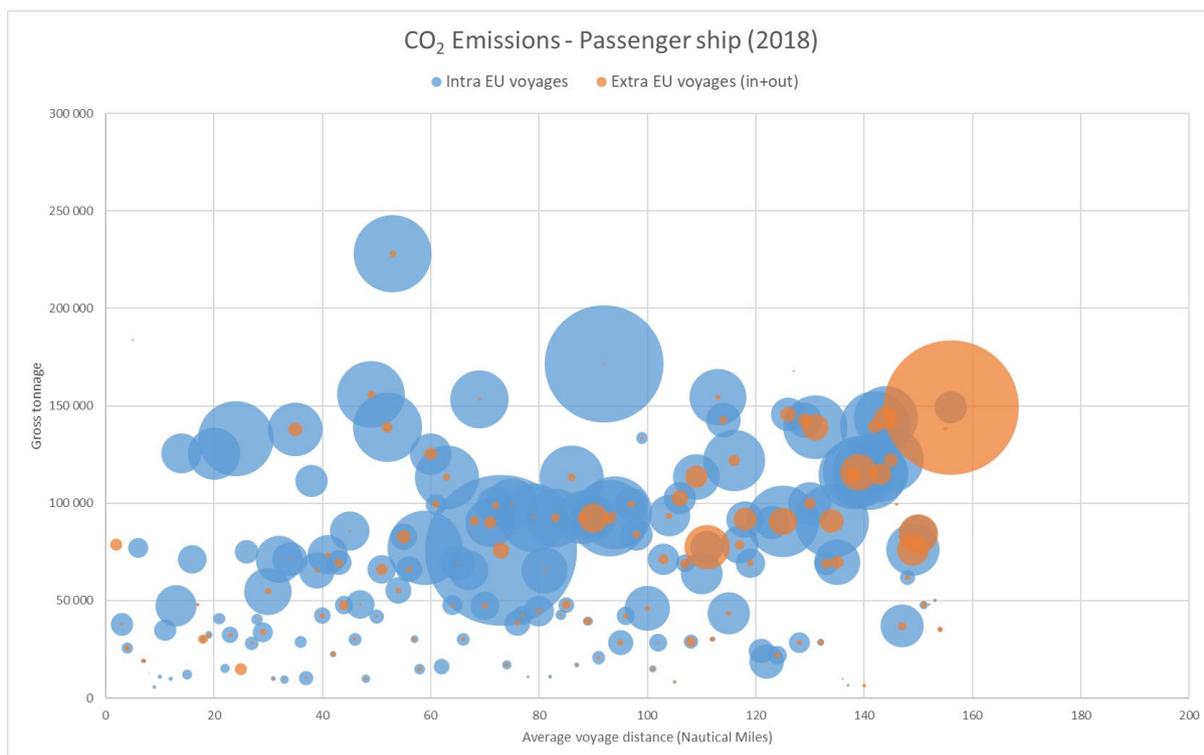
## Oil tanker



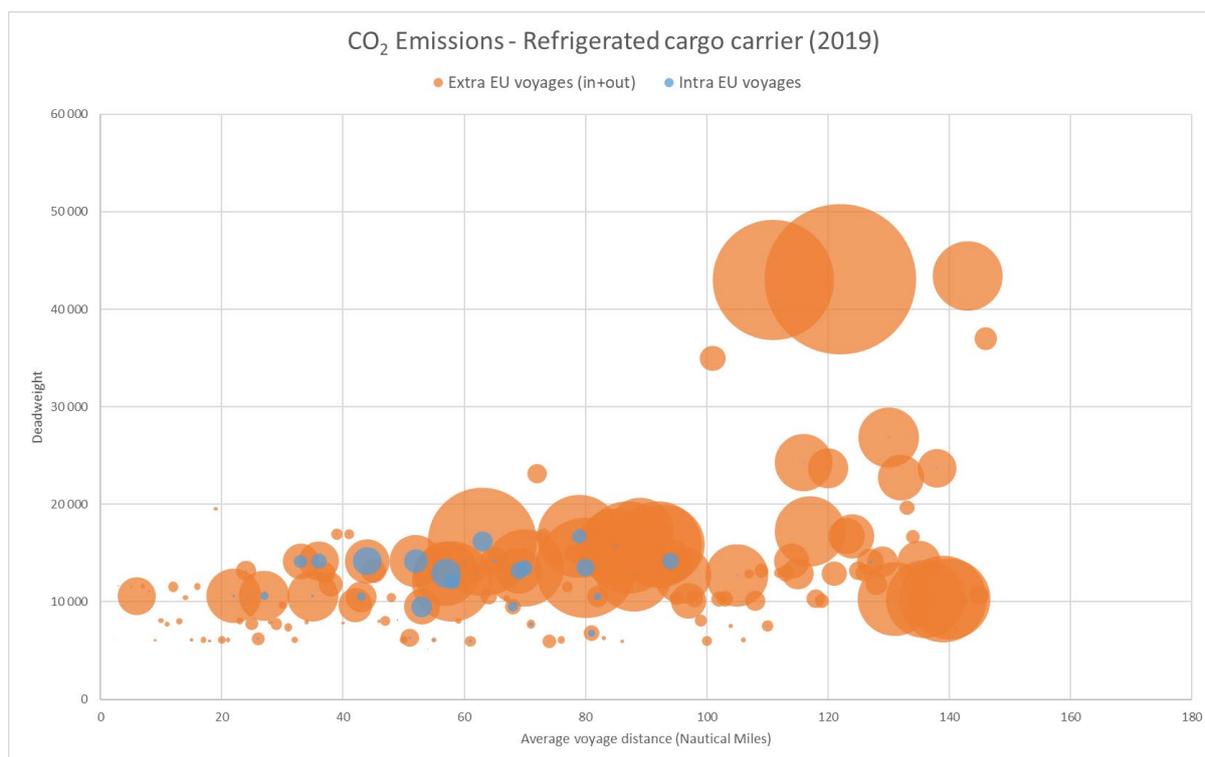
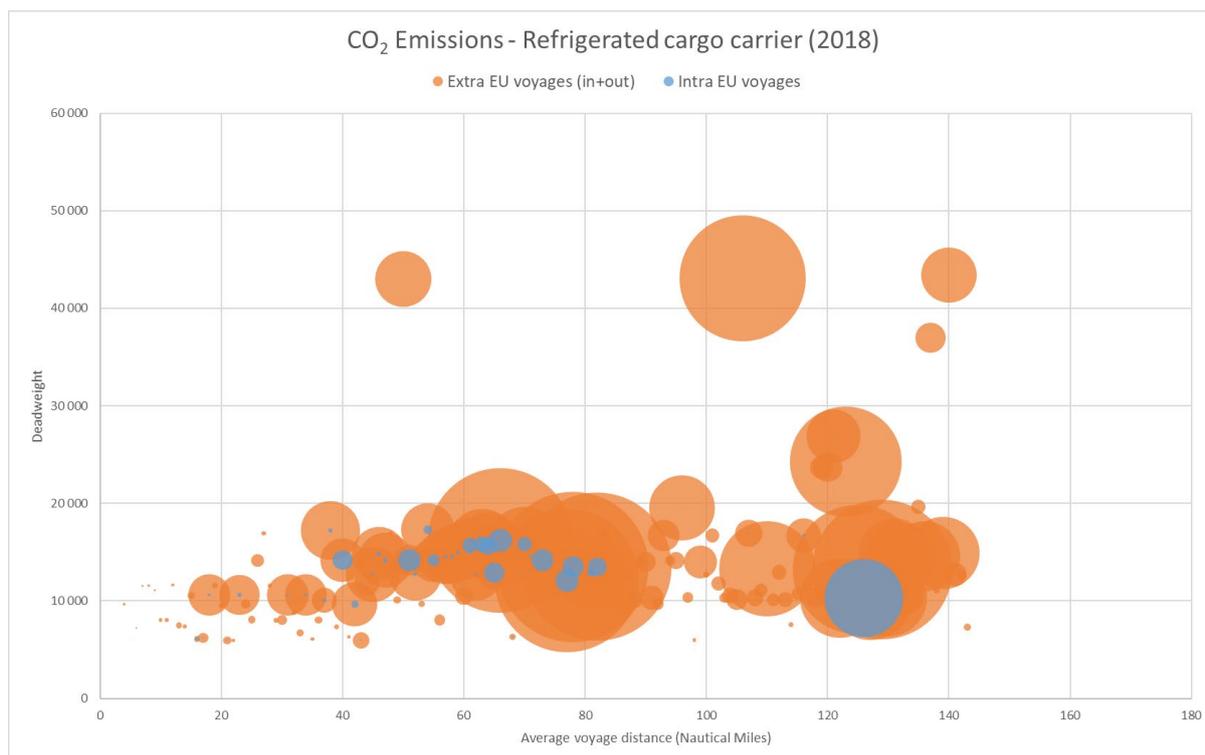
## Other ship types



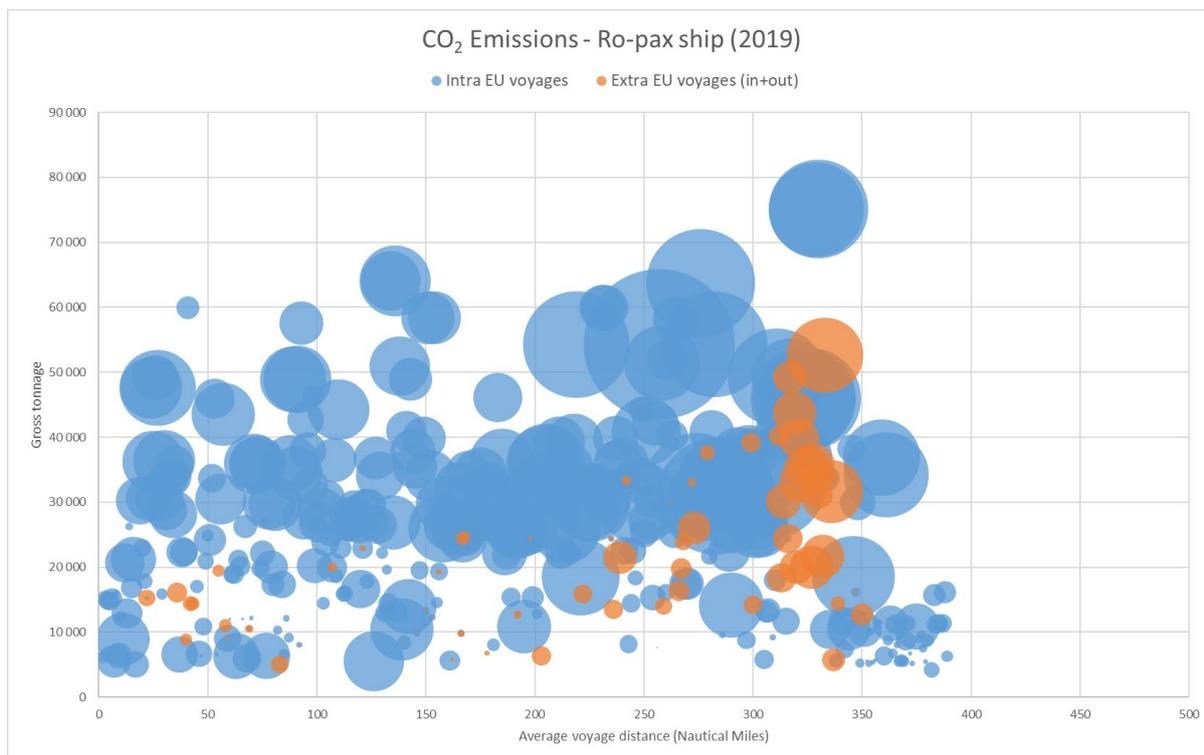
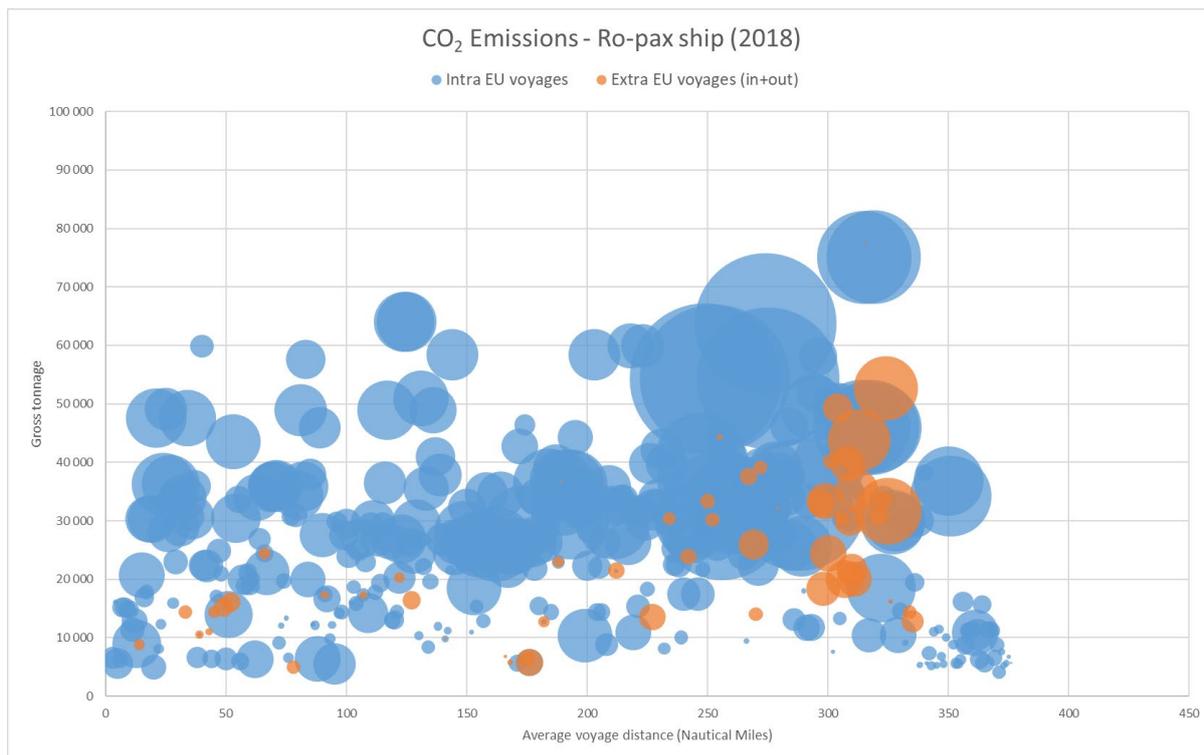
Passenger ship



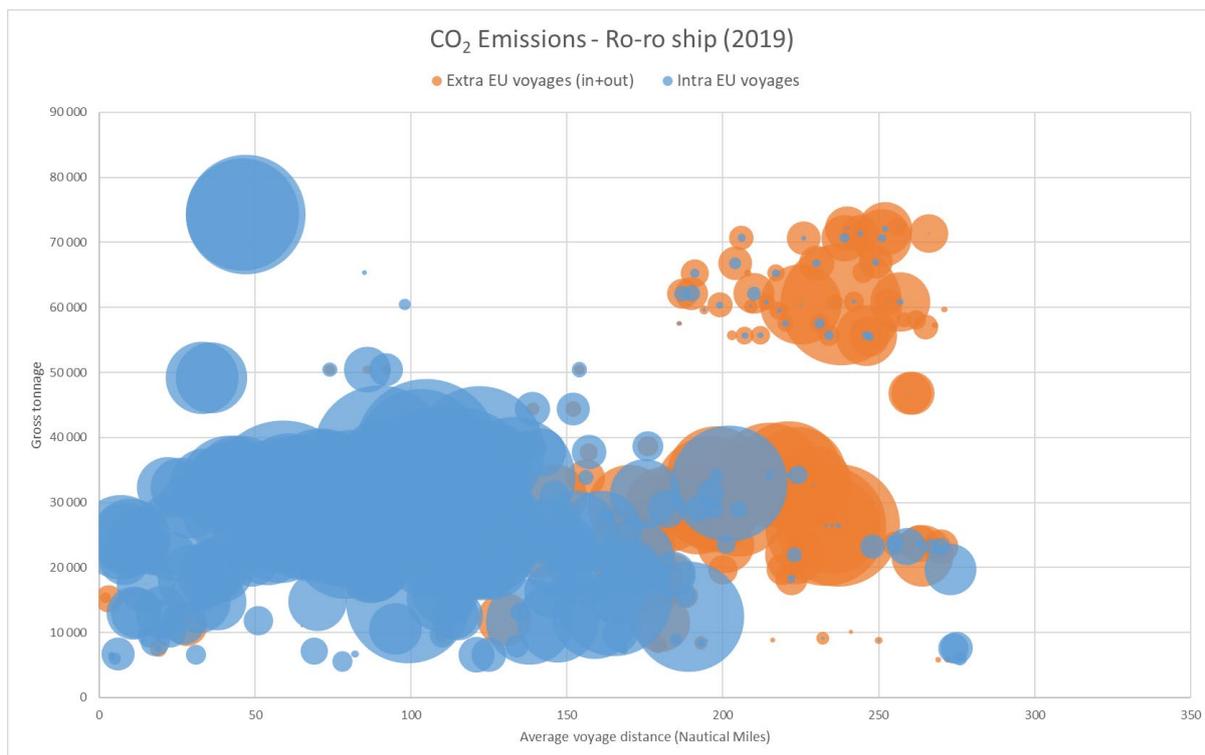
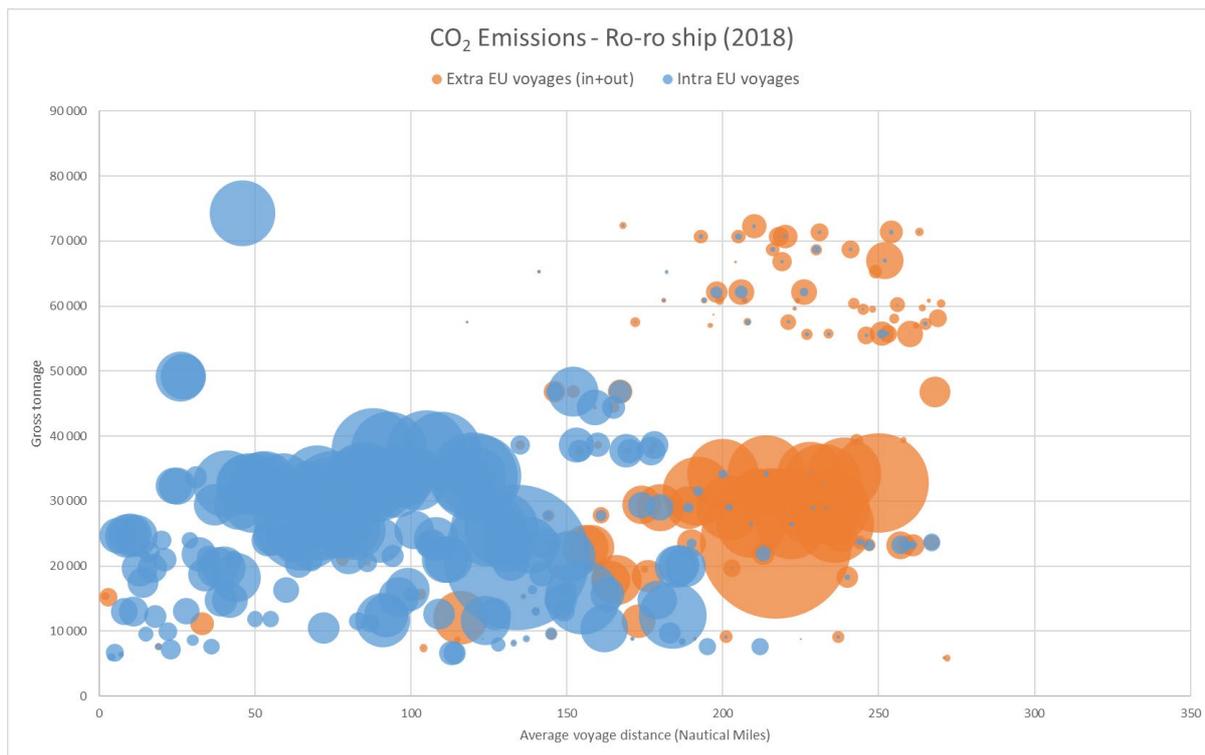
### Refrigerated cargo carrier



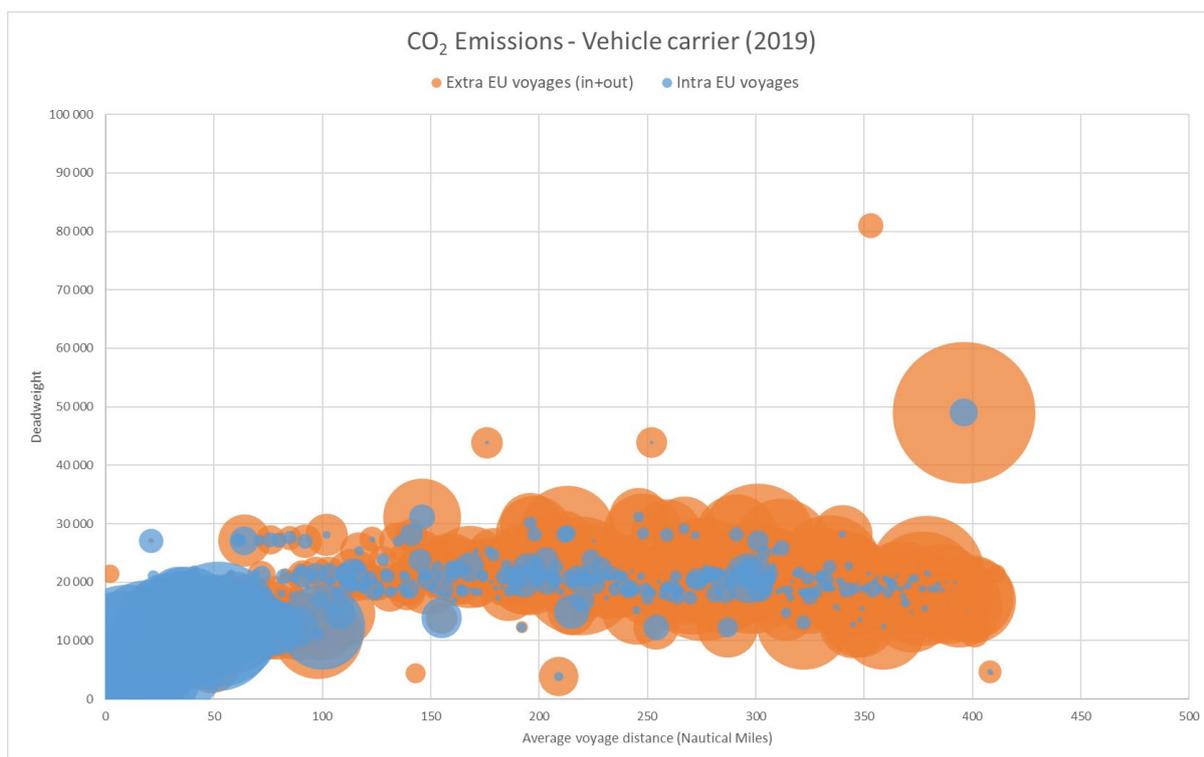
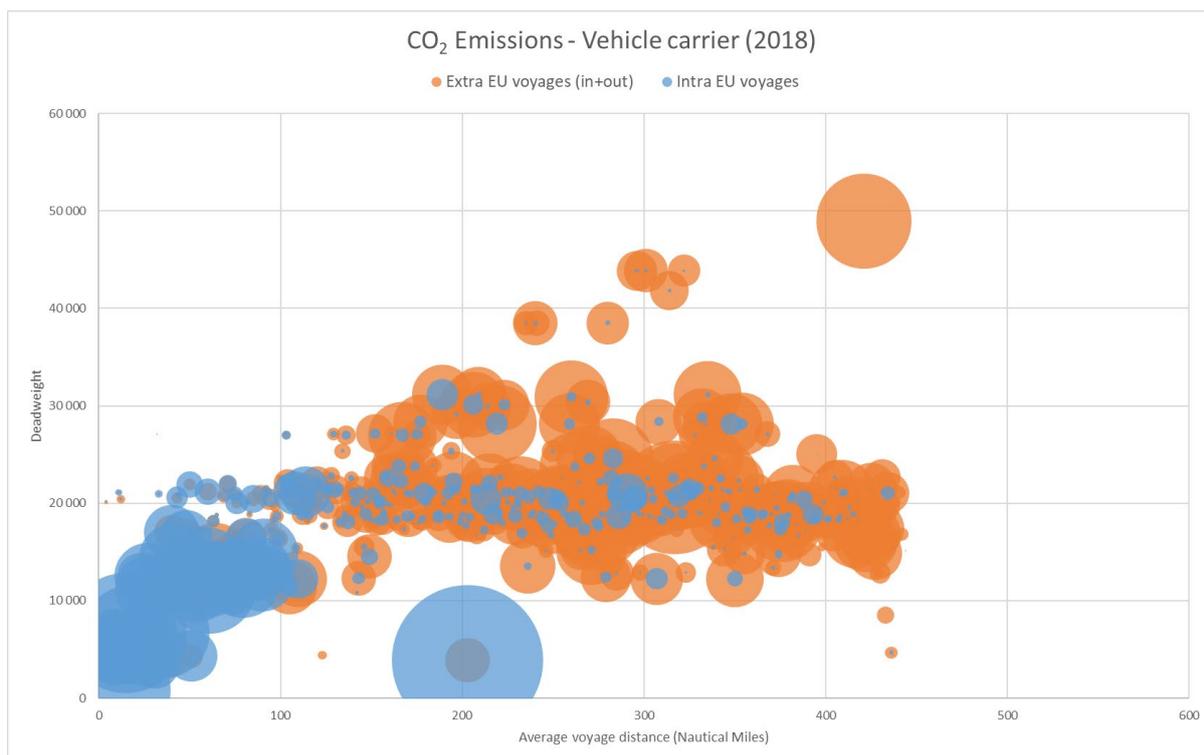
### Ro-pax ship



Ro-ro ship



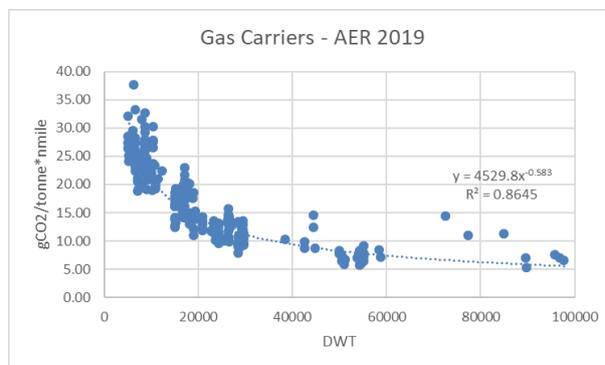
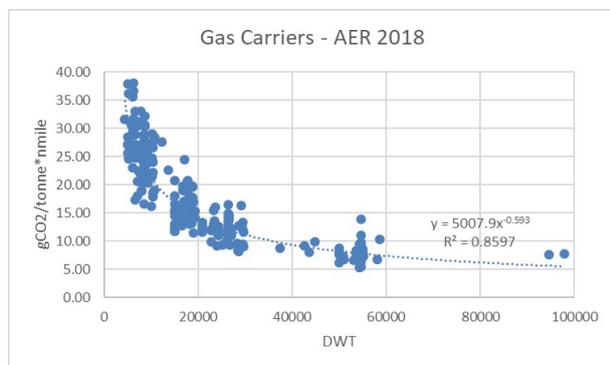
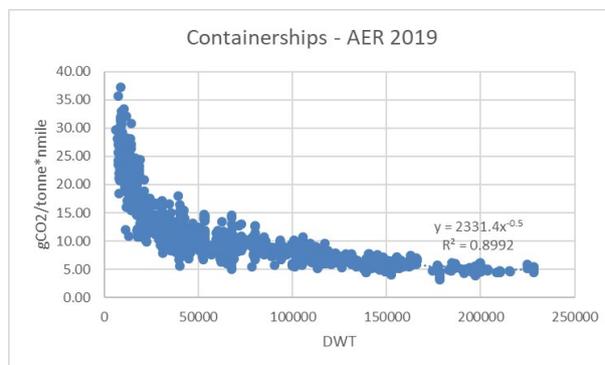
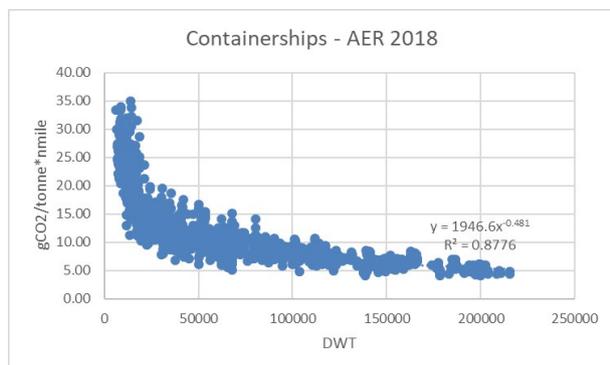
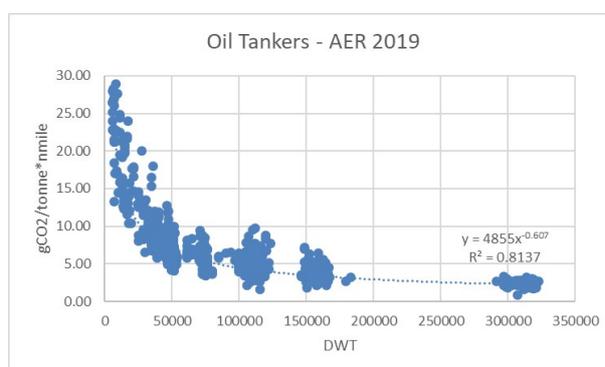
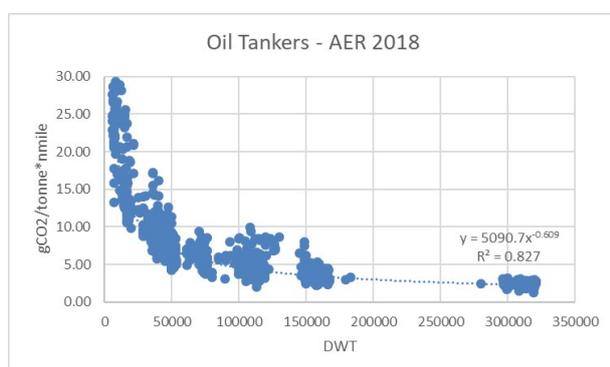
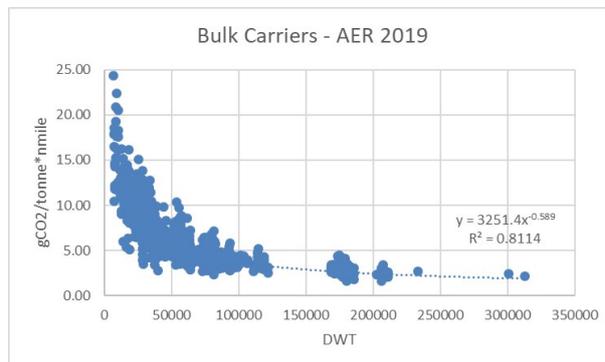
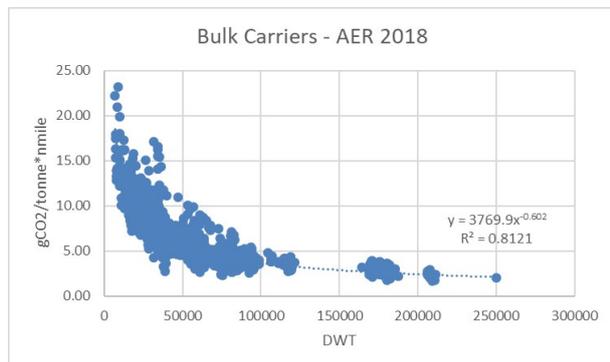
## Vehicle carrier

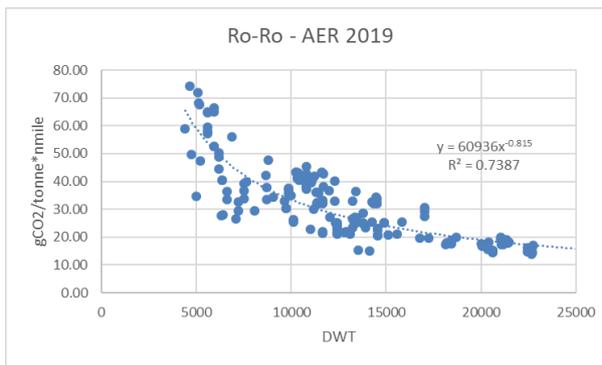
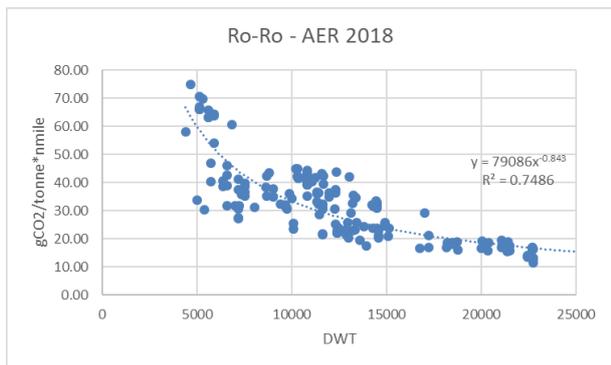
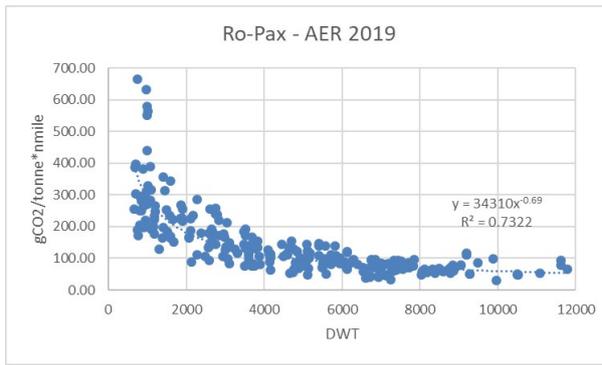
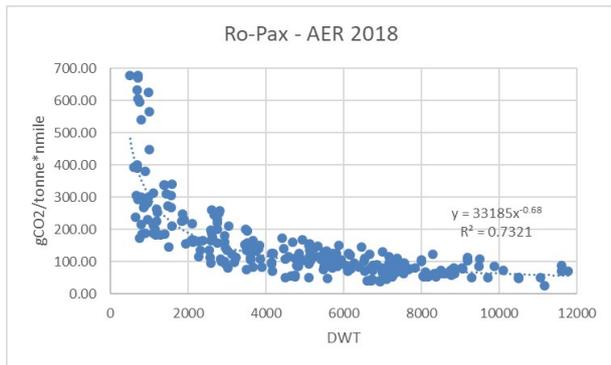
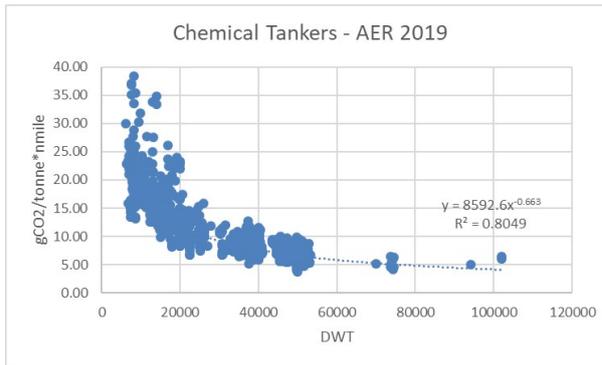
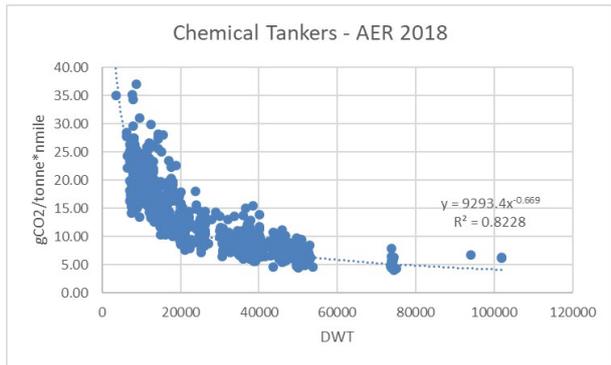
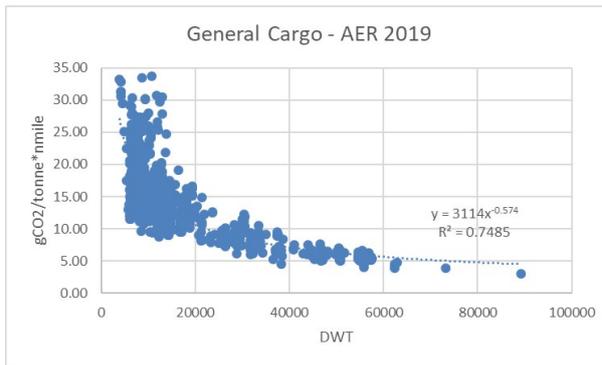
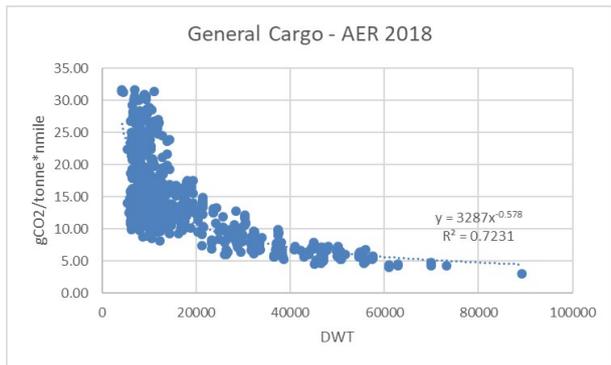


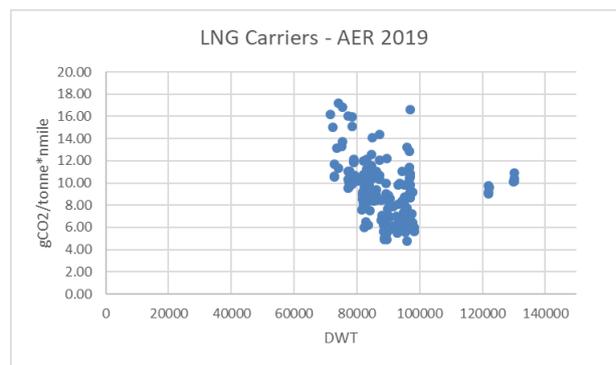
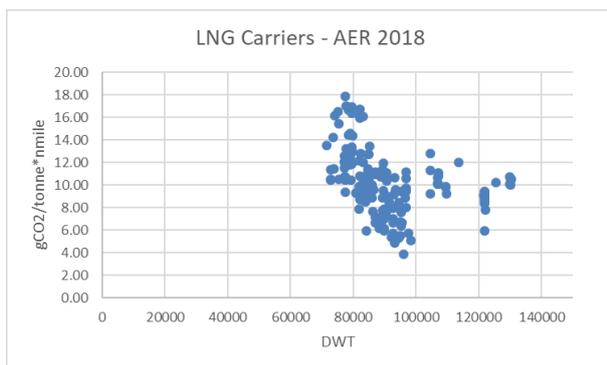
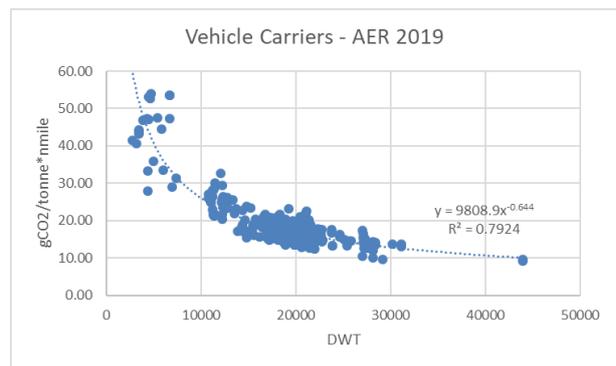
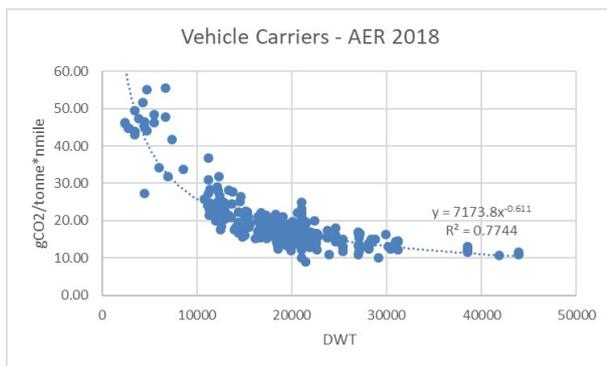
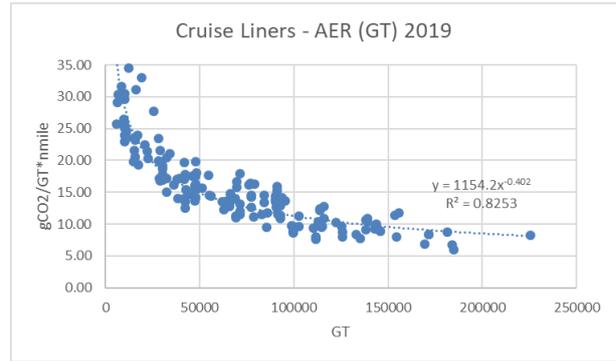
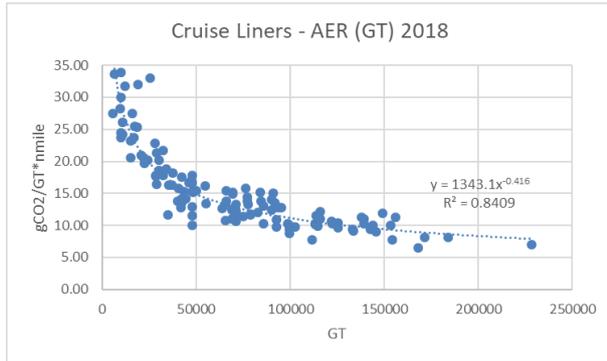
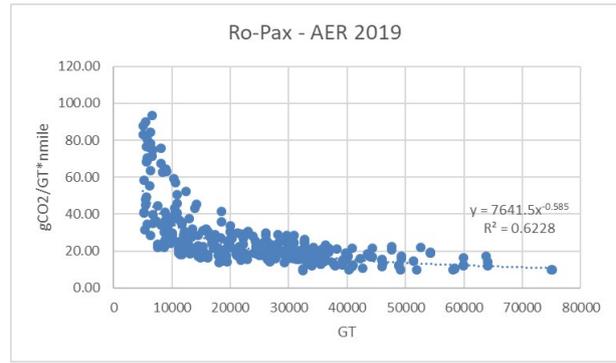
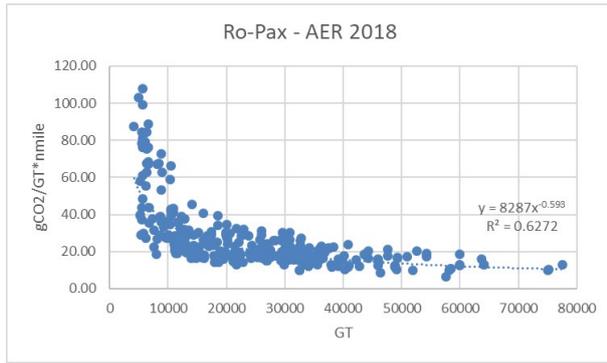
Appendix 5: CO<sub>2</sub> emission per ship type

|                                     | EEA outgoing<br>voyages | EEA incoming<br>voyages | Intra-EEA<br>voyages | At berth  | Number<br>of ships |
|-------------------------------------|-------------------------|-------------------------|----------------------|-----------|--------------------|
| <b>Bulk carrier</b>                 |                         |                         |                      |           |                    |
| 2018                                | 6 781 640               | 8 695 952               | 2 181 321            | 797 536   | 3 809              |
| 2019                                | 6 425 658               | 8 101 323               | 1 714 927            | 841 404   | 3 594              |
| <b>Chemical tanker</b>              |                         |                         |                      |           |                    |
| 2018                                | 2 692 510               | 3 114 935               | 2 684 422            | 943 523   | 1 361              |
| 2019                                | 2 709 479               | 3 069 534               | 2 748 219            | 979 515   | 1 345              |
| <b>Combination carrier</b>          |                         |                         |                      |           |                    |
| 2018                                | 41 973                  | 35 514                  | 16 460               | 11 787    | 10                 |
| 2019                                | 39 568                  | 44 138                  | 19 056               | 8 419     | 11                 |
| <b>Container ship</b>               |                         |                         |                      |           |                    |
| 2018                                | 14 824 436              | 16 674 368              | 11 671 511           | 1 753 283 | 1 792              |
| 2019                                | 14 602 613              | 16 156 303              | 11 503 141           | 1 696 453 | 1 801              |
| <b>Container / ro-ro cargo ship</b> |                         |                         |                      |           |                    |
| 2018                                | 348 232                 | 423 627                 | 738 538              | 158 996   | 79                 |
| 2019                                | 322 445                 | 417 443                 | 627 952              | 167 434   | 76                 |
| <b>Gas carrier</b>                  |                         |                         |                      |           |                    |
| 2018                                | 858 506                 | 889 215                 | 593 268              | 191 869   | 321                |
| 2019                                | 1 067 738               | 1 016 967               | 698 292              | 251 485   | 341                |
| <b>General cargo ship</b>           |                         |                         |                      |           |                    |
| 2018                                | 2 036 432               | 2 000 401               | 1 980 336            | 304 452   | 1 171              |
| 2019                                | 2 078 652               | 2 020 078               | 1 908 672            | 313 311   | 1 180              |
| <b>LNG carrier</b>                  |                         |                         |                      |           |                    |
| 2018                                | 2 795 361               | 2 771 550               | 366 919              | 186 708   | 212                |
| 2019                                | 3 299 006               | 3 586 371               | 707 890              | 284 143   | 255                |
| <b>Oil tanker</b>                   |                         |                         |                      |           |                    |
| 2018                                | 6 742 681               | 7 207 385               | 2 966 971            | 1 993 424 | 1 876              |
| 2019                                | 7 250 175               | 7 710 462               | 2 967 247            | 2 201 655 | 1 985              |
| <b>Other ship types</b>             |                         |                         |                      |           |                    |
| 2018                                | 335 415                 | 707 272                 | 351 041              | 68 752    | 122                |
| 2019                                | 380 378                 | 392 466                 | 332 356              | 65 502    | 129                |
| <b>Passenger ship</b>               |                         |                         |                      |           |                    |
| 2018                                | 607 122                 | 615 906                 | 4 611 462            | 711 638   | 159                |
| 2019                                | 690 975                 | 655 632                 | 4 822 748            | 828 921   | 179                |
| <b>Refrigerated cargo carrier</b>   |                         |                         |                      |           |                    |
| 2018                                | 680 498                 | 913 642                 | 159 995              | 55 935    | 145                |
| 2019                                | 569 619                 | 852 188                 | 133 606              | 57 346    | 145                |
| <b>Ro-pax ship</b>                  |                         |                         |                      |           |                    |
| 2018                                | 583 801                 | 589 200                 | 12 510 333           | 1 131 490 | 376                |
| 2019                                | 598 422                 | 597 504                 | 12 510 434           | 1 062 844 | 387                |
| <b>Ro-ro ship</b>                   |                         |                         |                      |           |                    |
| 2018                                | 996 928                 | 901 905                 | 4 311 805            | 303 742   | 272                |
| 2019                                | 869 006                 | 834 531                 | 4 184 599            | 303 094   | 275                |
| <b>Vehicle carrier</b>              |                         |                         |                      |           |                    |
| 2018                                | 1 732 979               | 1 580 332               | 1 537 095            | 288 368   | 448                |
| 2019                                | 1 506 093               | 1 418 083               | 1 375 804            | 204 549   | 411                |

## Appendix 6: AER plots







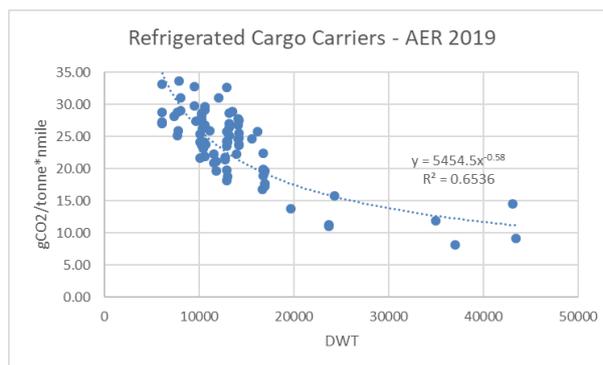
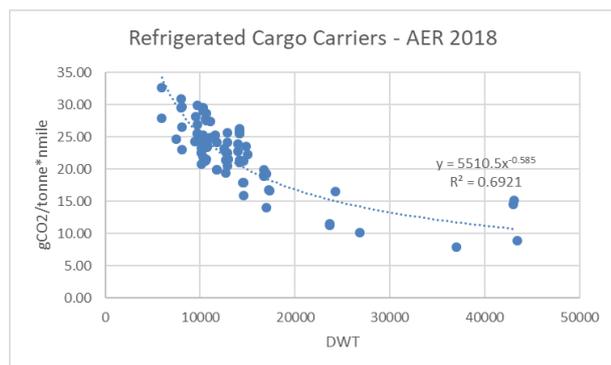
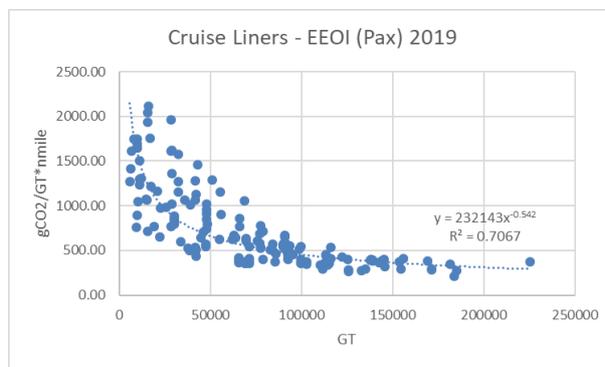
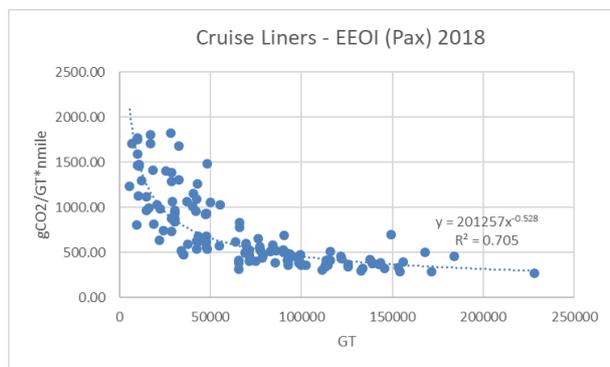
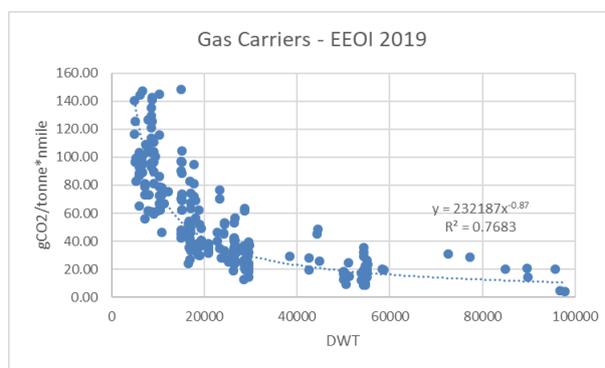
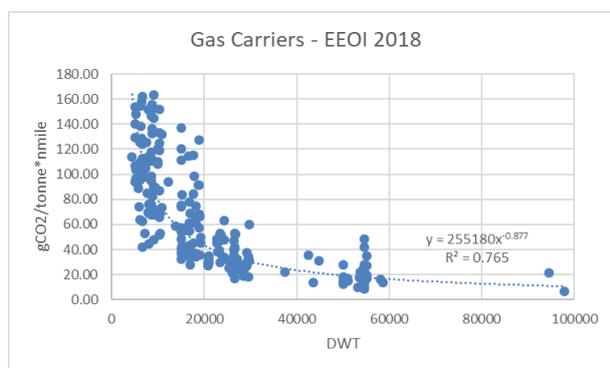
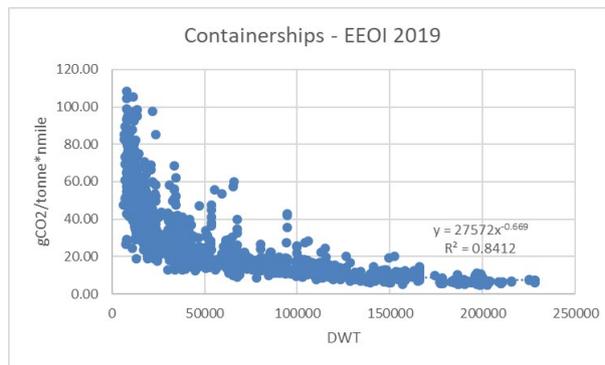
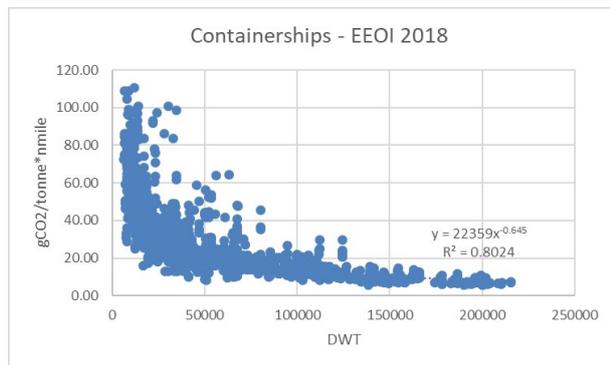


Table 3: Variation between 2018 and 2019 AER

| Ship Type                  | Number of Ships | Average (Mean) | Median (50% Pop) | Q1 (25% Pop) | Q3 (75% Pop) |
|----------------------------|-----------------|----------------|------------------|--------------|--------------|
| Ro-Pax                     | 281             | -1.2%          | -0.7%            | -4.2%        | 2.9%         |
| Ro-Ro                      | 207             | 1.1%           | 0.7%             | -3.4%        | 4.8%         |
| Vehicle Carrier            | 311             | 1.5%           | -2.0%            | -8.3%        | 5.8%         |
| Refrigerated Cargo Carrier | 103             | 1.0%           | -1.1%            | -6.3%        | 5.8%         |
| Passenger Ship             | 106             | 6.4%           | 0.6%             | -5.8%        | 6.7%         |
| LNG Carrier                | 142             | 5.3%           | 2.0%             | -6.5%        | 10.6%        |
| General Cargo              | 777             | 1.5%           | 0.2%             | -6.0%        | 6.1%         |
| Gas Carrier                | 194             | 2.1%           | 1.3%             | -7.3%        | 10.4%        |
| Chemical Tanker            | 960             | 0.3%           | -0.6%            | -8.7%        | 8.1%         |
| Bulk Carrier               | 1895            | 3.0%           | -0.6%            | -7.8%        | 8.4%         |
| Oil Tanker                 | 1268            | 2.5%           | 1.0%             | -9.0%        | 10.2%        |
| Containership              | 1134            | -1.3%          | -2.4%            | -9.2%        | 3.8%         |

## Appendix 6: EEOI Plots



## References

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<sup>1</sup> Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC.

<sup>2</sup> IMO (2020). Fourth IMO GHG Study 2020. Final Report.

<sup>3</sup> European Commission (2019). Communication from the Commission. The European Green Deal, COM(2019) 640 final, 11 December 2019. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1596443911913&uri=CELEX:52019DC0640#document2>.

<sup>4</sup> European Commission (2020). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people, COM(2020) 562 final, 17 September 2020. Available at: [https://ec.europa.eu/clima/sites/clima/files/eu-climate-action/docs/com\\_2030\\_ctp\\_en.pdf](https://ec.europa.eu/clima/sites/clima/files/eu-climate-action/docs/com_2030_ctp_en.pdf).

<sup>5</sup> European Commission (2019). 2030 Climate Target Plan. Available at: [https://ec.europa.eu/clima/policies/eu-climate-action/2030\\_ctp\\_en](https://ec.europa.eu/clima/policies/eu-climate-action/2030_ctp_en).

<sup>6</sup> European Commission (2020). Commission Staff Working Document accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Sustainable and Smart Mobility Strategy – putting European transport on track for the future. SWD(2020) 331 final, 9 December 2020. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0331&from=EN>.

<sup>7</sup> European Commission (2020). State of the Union: Commission raises climate ambition and proposes 55% cut in emissions by 2030. Available at: [https://ec.europa.eu/commission/presscorner/detail/en/ip\\_20\\_1599](https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1599).

<sup>8</sup> Faber, J and Lee, D. S. (2020). Bridging the gap – the role of international shipping and aviation. In: United Nations Environment Programme. *Emissions Gap Report 2020*. Available at: <https://www.unep.org/emissions-gap-report-2020>, 52-61, 55.

<sup>9</sup> Allen, M. R., Dube, O. P., Soleski, W. (2018). Framing and Context. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, 49-91, 66.

<sup>10</sup> Ibid. 64.

<sup>11</sup> Ibid. 67.

<sup>12</sup> Eurostat (2020). Maritime freight and vessels statistics. Available at: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Maritime\\_freight\\_and\\_vessels\\_statistics](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Maritime_freight_and_vessels_statistics).

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<sup>13</sup> Eurostat statistics are not completely comparable with MRV data, as they are EU27 based vs EEA based for the MRV data

<sup>14</sup> Ibid.

<sup>15</sup> Ibid.

<sup>16</sup> Commission Implementing Regulation (EU) 2016/1927.

<sup>17</sup> Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC.

<sup>18</sup> Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC.