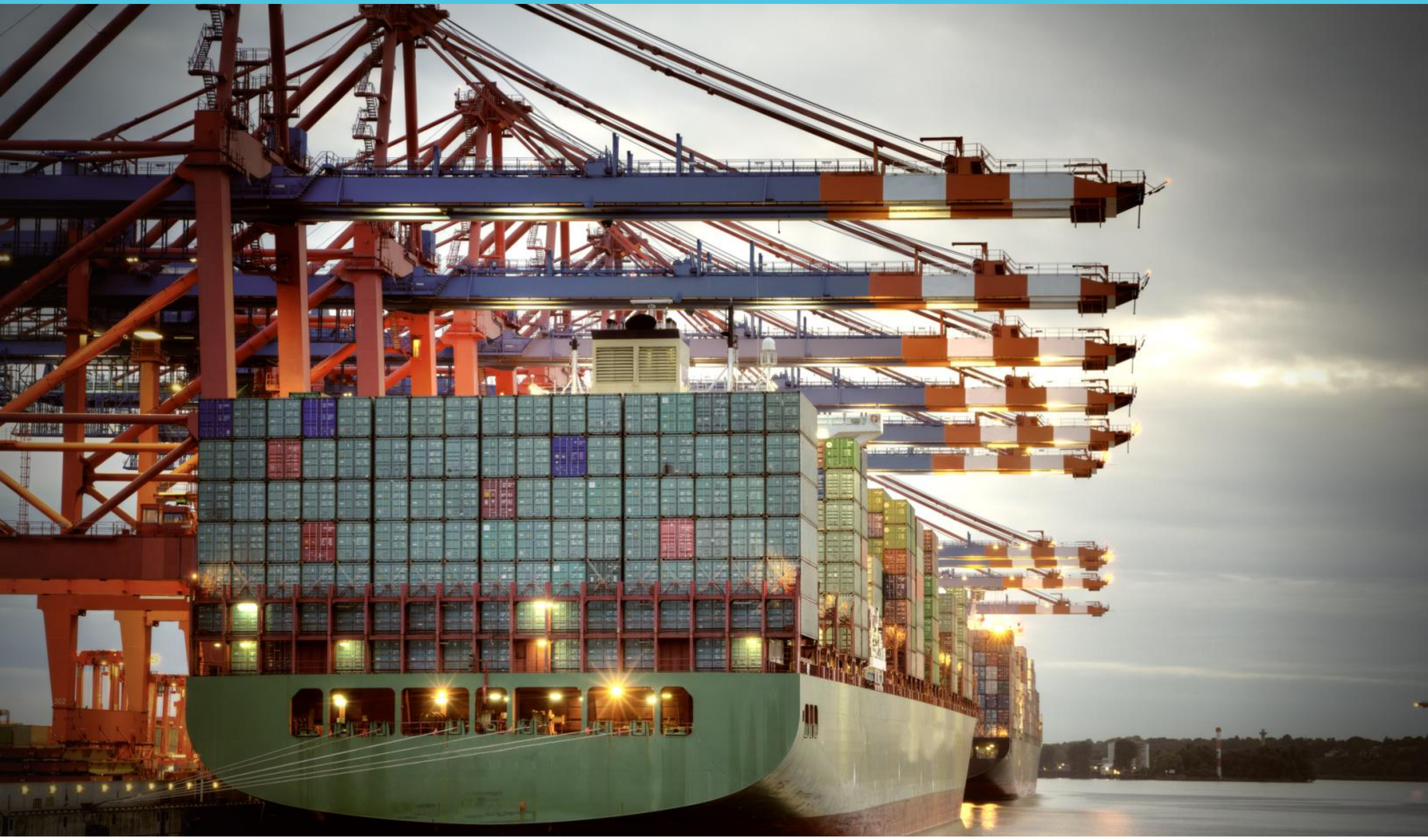
AUGUST 2018

2017 Global Maritime Trade Lane Emissions Factors

Clean Cargo Working Group (Clean Cargo)



Clean Cargo Sustainable Transportation

BSR The Business of a Better World

About Clean Cargo Working Group™ (Clean Cargo)

Clean Cargo is the leading buyer-supplier forum for sustainability in the cargo shipping industry. Members are major brands, cargo carriers, and freight forwarders that share a vision of a shipping industry that is a responsible part of sustainable supply chains, which supports clean oceans, healthy port communities, and global climate goals.

Today, Clean Cargo tools represent the industry standard for measuring and reporting ocean carriers' environmental performance, including carbon dioxide (CO_2) emissions. Clean Cargo members benefit from these tools while sharing knowledge and best practices for reducing emissions and publicly demonstrating their commitments to sustainable shipping.

Clean Cargo helps ocean freight carriers track and benchmark their performance and easily report to customers in a standard format. We enable shipping customers to review and compare carriers' environmental performance when reporting and making informed buying decisions.

You can find more information about the group on our website: https://www.bsr.org/en/collaboration/groups/clean-cargo-working-group.

Annual Trade Lane CO_2 Emissions Factors

Every year, Clean Cargo carriers report vessel-specific environmental performance data to BSR (the secretariat of Clean Cargo) using a standard reporting template and guidance methodologies. BSR provides the aggregated data to shipping customers that are members of Clean Cargo via individualized carrier scorecards.

The Clean Cargo Working Group Carbon Emissions Accounting Methodology has become the global standard for reporting CO_2 emissions in the ocean container shipping sector.[1] Each carrier also undertakes third-party verification of its reporting system using the Clean Cargo Procedure and Guidance for Verifying CO_2 and SO_x Data.[2] As pressure on shippers, logistics providers, and container carriers to monitor, report, and reduce CO_2 emissions continues to increase, all parties aim to show their customers, investors, and other stakeholders their commitment to responsible operations and to reducing their environmental impacts.

The following index is derived from **emissions reported by over 3,200 vessels, calculated from 22 of the world's leading ocean container carriers, who collectively represent around 84 percent of ocean container capacity worldwide**. A complete list of Clean Cargo members can be found on our web page.[3] These results are based on primary data from vessels operating during the calendar year.

Our 2018 annual reporting indicates that **average CO_2 emissions per container per kilometer for global ocean transportation routes were reduced by one percent from 2016 to 2017**. While changes in carrier representation or global trade conditions likely explain a portion of these results, the continued performance improvement is also attributable to carrier fleet efficiency and data quality, both of which have direct benefits for shipping customers.

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[1] https://www.bsr.org/our-insights/report-view/ccwg-methodology-2015.

[2] Available upon request.

[3] https://www.bsr.org/cleancargo.

Since Clean Cargo began publicly reporting data from the industry in 2009, emissions per container per kilometer have dropped 37.1 percent on average. This was the first year that Clean Cargo began tracking use of low-sulphur and lower-carbon fuels. The data show that five percent of fuel used by the global container fleet in 2017 was light fuel oil (LFO), while liquefied natural gas (LNG) was used by some vessels on the Intra-Northern Europe trade lane.

These data show that the container shipping industry continues to make progress that is essential to reaching clean air and climate goals. However, significantly more financing and innovation will be needed for the shipping industry to remain on track to meet the ambitious climate goals recently announced in the International Maritime Organization (IMO) climate strategy**.**[4]

The following results are from 2017 and the previous four years.[5]

[4] http://www.imo.org/en/mediacentre/pressbriefings/pages/06ghginitialstrategy.aspx.

[5] Data from 2009-2013 can be found at https://www.bsr.org/en/our-insights/report-view/global-maritime-trade-lane-emissions-factors.

Clean Cargo Aggregate Average Trade Lane Emission Factors 2013-2017

CO_2 Emissions by Trade Lane (grams of CO_2 per TEU kilometer)	2017		2016		2015		2014	
	3208 vessels		3233 vessels		3351 vessels		2989 vessels	
Trade Lane	Dry	Reefer	Dry	Reefer	Dry	Reefer	Dry	Reefer
Asia to-from Africa	48.9	83.8	51.9	88.0	45.8	80.4	56.1	93.3
Asia to-from Mediterranean/Black Sea	38.8	71.4	40.2	74.0	38.4	71.8	45.0	79.5
Asia to-from Middle East/India	46.8	79.3	46.4	80.9	46.5	80.4	51.6	85.9
Asia to-from North America EC/Gulf	44.7	74.1	48.7	77.3	53.8	84.1	56.0	85.4
Asia to-from North America WC	46.7	76.8	46.6	77.4	48.8	82.1	50.9	82.3
Asia to-from North Europe	30.5	61.0	31.7	62.6	33.7	64.6	37.9	69.6
Asia to-from Oceania	58.9	91.3	59.4	92.5	59.5	91.8	62.7	97.4
Asia to-from South America (incl. Central America)	41.3	71.6	41.9	73.0	43.6	76.3	46.6	78.5
Europe (North and Med) to-from Africa	61.3	101.5	56.8	94.3	59.0	98.3	69	119.4
Europe (North and Med) to-from South America (incl. Central America)	48.6	83.4	51.2	84.7	54.8	88.7	52.9	88.0
Europe (North and Med) to-from Middle East/India	40.0	72.5	38.4	71.7	42.7	74.9	57.2	96.8
Europe (North and Med) to-from Oceania (via Suez / via Panama)	66.4	99.3	56.0	86.8	54.2	88.0	78.2	105.8
Mediterranean/Black Sea to-from North America EC/Gulf	61.4	96.2	58.0	92.5	52.1	89.6	64.5	102.1
Mediterranean/Black Sea to-from North America WC	51.8	84.2	50.0	82.2	58.8	94.8	59.7	95.6
North America EC/Gulf/WC to-from Africa	71.2	104.7	55.7	83.9	66.4	100.1	73.5	113.2
North America EC/Gulf/WC to-from Oceania	67.2	96.7	76.3	103.8	74.2	102.9	75.2	104.6
North America EC/Gulf/WC to-from South America (incl. Central America)	63.4	99.1	59.7	94.4	57.2	91.0	66.5	104.3
North America EC/Gulf/WC to-from Middle East/India	53.1	84.8	55.3	86.1	52.9	83.2	61.8	93.7
North Europe to-from North America EC/Gulf	60.4	92.6	59.8	91.1	60.1	91.7	70.3	105.6
North Europe to-from North America WC	58.4	88.7	39.9	72.9	60.7	91.4	65.1	102.1
South America (incl. Central America) to-from Africa	45	77.1	45.1	77.6	42.3	77.4	47.4	79.7
Intra Africa [Added 2016]	79.7	130.3	77.0	122.4				
Intra North America EC/Gulf/WC [Added 2016: Part of former "Intra Americas"]	117.2	154.7	85.5	119.3	69.6	106.7	80.9	123.8
Intra South America (incl. Central America) [Added 2016: Part of former "Intra Americas"]	72.4	114.6	71.2	113.8				
SE Asia to-from NE Asia [Added 2016: Part of former "Intra Asia"]	60.2	95.1	69.2	103.6				
Intra NE Asia [Added 2016: Part of former "Intra Asia"]	58.1	102.7	71.1	114.8	60.0	97.5	65.6	104.0
Intra SE Asia [Added 2016: Part of former "Intra Asia"]	74.3	118.5	75.0	112.2				
North Europe to-from Mediterranean/Black Sea [Added 2017: Part of former "Intra Europe"]	63.1	99.7	60.6	95.6	75.3	118.9	84.0	130.1
Intra Mediterranean/Black Sea [Added 2016: Part of former "Intra Europe"]	88.6	148.0	85.2	140.2				
Intra North Europe [Added 2016: Part of former "Intra Europe"]	87.1	133.9	80.9	122.9				
Intra Middle East/India [Added 2016]	59.7	105.3	58.8	103.7				
Other	75.2	114.5	59.5	97.1	64.6	102.3	83.6	143.6
Fleet-Wide Average CO_2 Performance	47.2	80.1	47.7	80.6	48.9	82.6	53.4	87.6

"Dry" = non-refrigerated cargo; "Reefer" = refrigerated cargo; "TEU" = twenty-foot equivalent unit, used to describe capacity of container vessels

Guidance on Using Clean Cargo Data

REFERENCE CLEAN CARGO METHODOLOGY

The Clean Cargo standard for the Clean Cargo methodology is our 2015 report, "Clean Cargo Working Group Carbon Emissions Accounting Methodology."[6] It is the basis for interpreting and using Clean Cargo data.

APPLYING AN AVERAGE VESSEL UTILIZATION FACTOR ON A TRADE LANE BASIS

In recent years, it became clear that the Clean Cargo CO_2 methodology, which is based on nominal (maximum) capacity of the vessels, may not fully account for actual emissions. Including utilization data in the CO_2 calculations is a more accurate approach and better aligned with international guidance on how to calculate CO_2 emissions for transportation.

Therefore, Clean Cargo piloted a methodology and process over a three-year period to collect average vessel utilization data from carriers to better understand variance (2013-2015). The analysis of the average utilization data show that the aggregate average utilization across all the largest trade lanes is around 70 percent, with some variation from year to year. As a result, Clean Cargo concluded that 70 percent is a representative average of the global average utilization. These results also align with IMO and WSC estimates. This cannot be used to benchmark performance, but it can be used to make carbon footprint calculations for customer transport services accounting for average utilization on a trade lane.

USING DATA TO CALCULATE AND MANAGE EMISSIONS FROM OCEAN TRANSPORT

The Clean Cargo Working Group methodology was developed to balance technical accuracy with practical application. Transportation procurement managers use these tools as a factor in supplier selection and to quantify and drive improvements for this important category in corporate greenhouse gas reduction targets. Specifically, they can:

» Calculate a CO_2 footprint

» Assess supplier environmental performance

» Select suppliers using sustainability criteria

Currently, more than 95 percent of shipping customers who are members of Clean Cargo use our data and tools in procurement decisions. BSR has produced a guide on approaches to calculate and manage CO_2 emissions from ocean container transport.[7]

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[6] https://www.bsr.org/our-insights/report-view/ccwg-methodology-2015.

[7] https://www.bsr.org/en/our-insights/report-view/how-to-calculate-and-manage-co2-emissions-from-ocean-transport.

For More Information

On behalf of the Clean Cargo Working Group, we hope that these aggregate average trade lane emission factors may be useful for your calculations and reporting needs. Clean Cargo membership is open to any carrier, freight forwarder, or shipping customer in the maritime shipping supply chain. Clean Cargo encourages all companies who operate or purchase ocean transportation services to adopt and use Clean Cargo carrier scorecards.

If you are interested in joining the network and benefiting from Clean Cargo's best-practice sharing, ready-made tools, and access to more detailed carrier-specific data, or if you have questions on the CO_2 emission factors disclosed in this document, we encourage you to contact BSR, the Clean Cargo secretariat, at ccwg@bsr.org.

For a list of current members and information on how to join, visit the Clean Cargo website at https://www.bsr.org/en/collaboration/groups/clean-cargo-working-group.

Clean Cargo Contacts

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Annex I: CO_2 Calculation Methodology

Clean Cargo developed a standardized CO_2 calculation methodology to enable CO_2 benchmarking, drive improvements, and improve data quality over time. The methodology is used exclusively by Clean Cargo member carriers to calculate vessel emissions as part of the Clean Cargo Scorecard disclosure. Following is a description of how CO_2 emissions factors (in gCO_2/TEU-km) are calculated for the purposes of the Clean Cargo performance measurement.

CALCULATION OF VESSEL CO_2 EMISSIONS

Clean Cargo carriers report on the following data for each vessel through the annual Clean Cargo data collection process:

- » Nominal capacity in 20-foot equivalent container units (TEUs)
- » Number of reefer plugs
- » Distance sailed
- » Fuel consumed (HFO and MDO/MGO reported separately)
- » Timeframe of data (days vessel operated)

Clean Cargo uses this information to calculate vessel CO_2 emissions. A general formula for this calculation is:

$$\frac{\left(total\ kg\ fuel\ consumed\ for\ containers\ * IMO\ factor\ \frac{gCO2}{kg}\ fuel\right)}{(maximum\ nominal\ TEU\ capacity\ *\ total\ distance\ sailed)}$$

The calculation methodology for dry containers is based on International Maritime Organization (IMO) guidance for emissions and carbon contents of fuels. Clean Cargo will continue to align with IMO standards as they improve over time, including an update that was made to the fuel-to-CO_2 conversation factors consistent with IMO factors for different fuel types in the 2018 reporting period. These factors are:

Fuel Type	IMO / MRV Factor (gCO_2/kg fuel)
HFO	3,114
LFO	3,151
MDO / MGO	3,206
Propane LPG	3,000
Butane LPG	3,030
LNG	2,750
Methanol	1,375
Ethanol	1,913

Clean Cargo members receive full access to the calculation methodologies and the ability to work with the group to shape future standards. The group continuously improves the methodology to increase the accuracy of data. Improvements are based on factors such as changes to IMO protocols, new GHG standards, availability of better emissions factors, availability of more accurate data, utilization adjustments, and stakeholder expectations.

Annex II: CO_2 Formulae

<u>CO_2 formula for dry containers</u>: $i_{Dry} = \frac{(\sum_{a,k} c_k \cdot m_{fuel\,a,k}) - m_{RC} \cdot c_{RC}}{V_{total} \cdot d}$

<u>CO_2 formula that integrates reefer containers</u>: $i_{Reefer} = \frac{(\sum_{a,k} c_k \cdot m_{fuel\,a,k}) - m_{RC} \cdot c_{RC}}{V_{total} \cdot d} + \frac{m_{RC} \cdot c_{RC}}{V_{Reefer} \cdot d}$

With these definitions of variables:

$$\sum_{a,k} c \cdot m_{fuel\,a,k} = c \cdot m_{fuel,HFO,ME} + c \cdot m_{fuel,HFO,AE}\ c \cdot m_{fuel,HFO,Boiler} + c \cdot m_{fuel,MDO,ME} + c \cdot m_{fuel,MDO,AE}\ c \cdot m_{fuel,MDO,Boiler}$$

a Different Aggregates running on fuel (ME, AE, Boiler, Incinerator)
k Different fuel types used on board (HFO, LFO, MDO, Propane LPG, Butane LPG, LNG, Methanol, Ethanol)

$\lfloor m_{fuel\,a,k} \rfloor = kg$ Mass of fuel consumed during specified period (incl. time at berth, river, and sea) by all consumers (ME, AE, boiler, incinerator)

$\lfloor \lfloor m_{RC} \rfloor = 1.9\,TEU \cdot w_{fuel} \cdot x_{Plugs} \cdot z_{time} \rfloor = kg$ Mass of fuel used for operating reefers

$$c_{RC} = \frac{\sum_{a,k} c_k \cdot m_{fuel\,a,k}}{\sum_{a,k} m_{fuel\,a,k}}$$

$\lfloor w_{fuel} \rfloor = \frac{kg}{TEU}$ Mass of fuel consumed by one reefer TEU within one year

$\lfloor \boldsymbol{V_{cargo}} \rfloor = \boldsymbol{TEU}$ **Maximum nominal TEU is defined as "The MAXIMUM number of TEU capable of being loaded onto a specific ship while at STATUTORY summer draft, and complying with the SOLAS safe visibility regulation (Chapter V "Safety of navigation", Regulation 22 "Navigation bridge visibility")**

$V_{Reefer} = 1.9TEU \cdot x_{Plugs}$

$\lfloor x_{Plugs} \rfloor$ Number of reefer plugs on the vessel

$1.9TEU$ Number of TEU per plug (We have several sizes of reefers, e.g. 20', 40', and 45'; 1.9 is the average number of 20'reefer per reefer plug)

$[d] = km$ Total distance sailed during specified period (incl. river, ports, and sea distance)

$[z_{time}]$ Percentage of one-year calculation is provided for (if one year $z_{time} = 1$)

And these constants:

$w_{fuel} = \bar{P}_{Reefer} \cdot t \cdot y_{utility}$ = 3.8kW * .23kg/kWh * 365 days * 24hours/day * 25% = 1914 kg/reefer-year

$\bar{P}_{Reefer}$ Clean Cargo WG average power consumption of reefers = 3.8 kw

$\lfloor y_{utility} \rfloor = 91d = 25\%$ Reefer plugs utilization per year (based on Maersk and Hamburg Süd data)

$$c_k = \frac{g}{kg}$$ [8]

[8] http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Documents/245(66).pdf.

About BSR

BSR is a global nonprofit organization that works with its network of more than 250 member companies and other partners to build a just and sustainable world. From its offices in Asia, Europe, and North America, BSR develops sustainable business strategies and solutions through consulting, research, and cross-sector collaboration. Visit www.bsr.org for more information about BSR's 25 years of leadership in sustainability.

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