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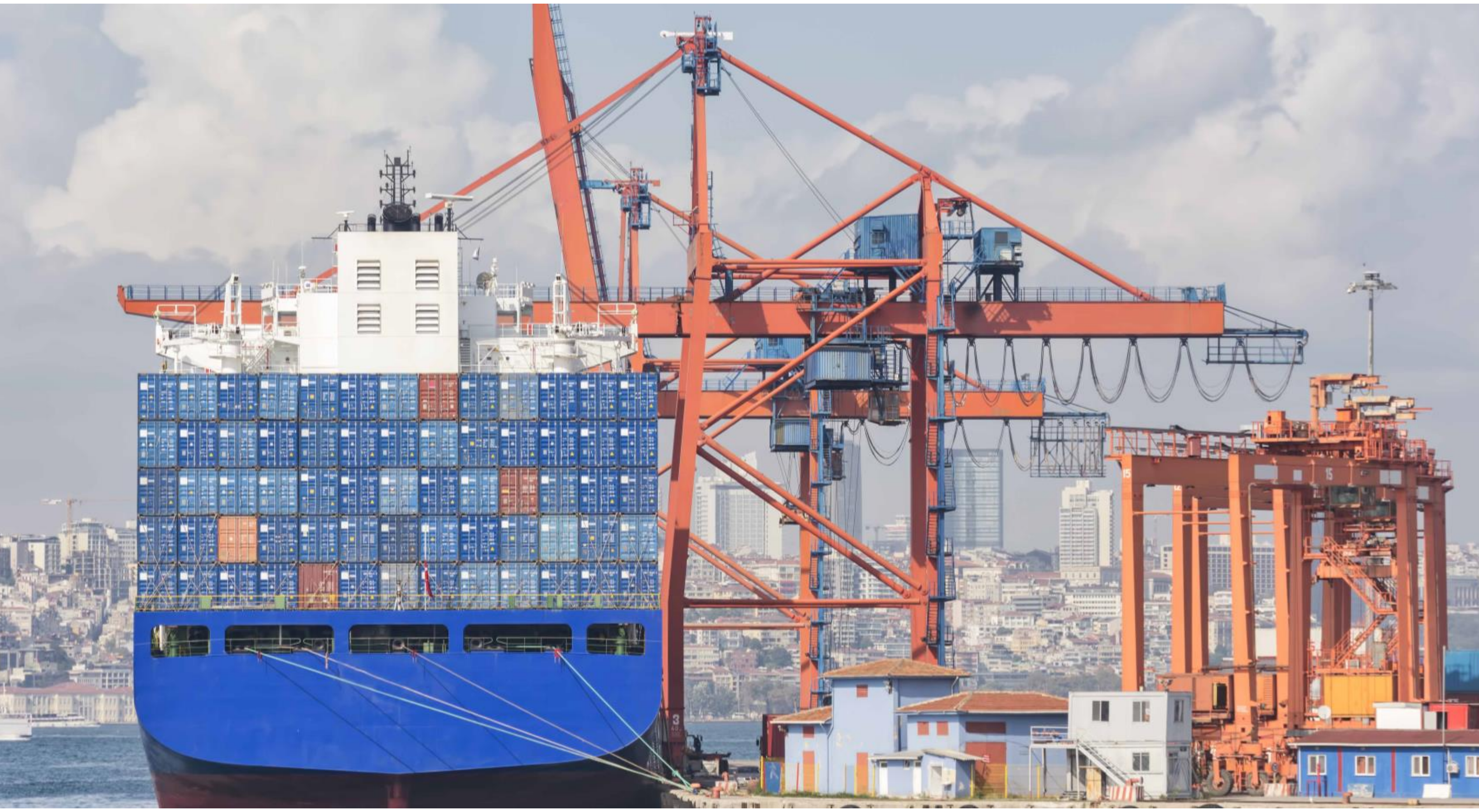
2016 Global Maritime Trade Lane Emissions Factors

Clean Cargo Working Group (CCWG)



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About Clean Cargo Working Group (CCWG)

CCWG is a leadership initiative involving major brands, cargo carriers, and freight forwarders dedicated to reducing the environmental impacts of global goods transportation and promoting responsible shipping.

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

CCWG members share a vision of a container shipping industry that is a responsible part of sustainable supply chains, supporting clean oceans, healthy port communities, and global climate goals. CCWG pursues this vision through delivering on its mission to measure, report, and evaluate performance in marine container transport; share best practices between members; support responsible corporate engagement with stakeholders; and catalyze and partner on projects that drive sustainability performance improvement.

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 CCWG carriers report on vessel-specific environmental performance data to BSR (the secretariat of CCWG), using a standard reporting template and guidance methodologies, including the CCWG CO_2 Carbon Emissions Accounting Methodology. Each carrier also undertakes third-party verification of their reporting system using the CCWG Procedure and guidance for verifying CO_2 and SOx data.[1] BSR provides the aggregated data to shipping customers that are members of CCWG, via individualized carrier scorecards.

The following index is derived from **emissions reported by over 3,200 ships, calculated from 22 of the world's leading ocean container carriers, who collectively represent around 87 percent of ocean container capacity worldwide**. A complete list of CCWG members can be found on our web page.These results are based on primary data from vessels operating during the calendar year.

Our 2017 annual reporting indicates that **average CO_2 emissions per container per kilometer for global ocean transportation routes were reduced by 2.4 percent from 2015 to 2016**. While changes in carrier representation or global trade conditions likely explain a portion of these results, the continued performance improvement is also attributed to carrier fleet efficiency and data quality, both of which have direct benefits for shipping customers. The following results are from 2016 and the previous three years.[2]

[1] Available on request.

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

CCWG Aggregate average trade lane emission factors 2013-2016								
CO_2 Emissions by Trade Lane (grams of CO_2 per TEU kilometer)	**2016**		**2015**		**2014**		**2013**	
	3233 vessels		**3351 vessels**		**2989 vessels**		**2918 vessels**	
Trade Lane	Dry	Reefer	Dry	Reefer	Dry	Reefer	Dry	Reefer
Asia to-from Africa	51.9	88.0	45.8	80.4	56.1	93.3	61.8	96.0
Asia to-from Mediterranean/Black Sea	40.2	74.0	38.4	71.8	45.0	79.5	54.9	89.6
Asia to-from Middle East/India	46.4	80.9	46.5	80.4	51.6	85.9	54.6	87.8
Asia to-from North America EC/Gulf	48.7	77.3	53.8	84.1	56.0	85.4	62.9	92.7
Asia to-from North America WC	46.6	77.4	48.8	82.1	50.9	82.3	56.2	87.1
Asia to-from North Europe	31.7	62.6	33.7	64.6	37.9	69.6	43.8	76.6
Asia to-from Oceania	59.3	92.5	59.5	91.7	62.7	97.3	61.7	94.8
Asia to-from South America (incl. Central America)	41.9	73.0	43.6	76.3	46.6	78.5	53.5	83.6
Europe (North and Med) to-from Africa	56.8	94.3	59.0	98.3	69.0	119.4	69.5	113.7
Europe (North and Med) to-from South America (incl. Central America)	51.2	84.7	54.8	88.7	52.9	88.0	63.7	94.8
Europe (North and Med) to-from Middle East/India	38.4	71.7	42.6	74.9	57.2	96.8	54.0	87.6
Europe (North and Med) to-from Oceania (via Suez / via Panama)	55.9	86.8	54.2	88.0	78.2	105.8	78.4	109.7
Mediterranean/Black Sea to-from North America EC/Gulf	58.0	92.5	52.1	89.6	64.5	102.1	70.3	100.7
Mediterranean/Black Sea to-from North America WC	50.0	82.2	58.8	94.8	59.7	95.6	60.8	90.4
North America EC/Gulf/WC to-from Africa	55.7	83.9	66.4	100.1	73.5	113.2	84.0	118.1
North America EC/Gulf/WC to-from Oceania	76.3	103.8	74.2	102.9	75.2	104.6	74.7	101.6
North America EC/Gulf/WC to-from South America (incl. Central America)	59.7	94.4	57.2	91.0	66.5	104.3	67.4	100.1
North America EC/Gulf/WC to-from Middle East/India	55.3	86.1	52.9	83.2	61.8	93.7	65.2	90.9
North Europe to-from North America EC/Gulf	59.8	91.1	60.1	91.7	70.3	105.6	75.0	101.7
North Europe to-from North America WC	39.9	72.9	60.7	91.4	65.1	102.1	69.4	97.9
South America (incl. Central America) to-from Africa	45.1	77.6	42.3	77.4	47.4	79.7	58.8	92.3
Intra Africa **[New]**	77.0	122.4						
Intra North America EC/Gulf/WC **[Part of former "Intra Americas"]**	85.5	119.3	69.6	106.7	80.9	123.8	86.5	122.8
Intra South America (incl. Central America) **[Part of former "Intra Americas"]**	71.2	113.8						
SE Asia to-from NE Asia **[Part of former "Intra Asia"]**	69.2	103.6	60.0	97.4	65.6	104.0	87.5	129.8
Intra NE Asia **[Part of former "Intra Asia"]**	71.1	114.8						
Intra SE Asia **[Part of former "Intra Asia"]**	75.0	112.2						
North Europe to-from Mediterranean/Black Sea **[Part of former "Intra Europe"]**	60.6	95.6	75.3	118.9	84.0	130.1	93.6	143.1
Intra Mediterranean/Black Sea **[Part of former "Intra Europe"]**	85.2	140.2						
Intra North Europe **[Part of former "Intra Europe"]**	80.9	122.9						
Intra Middle East/India **[New]**	58.8	103.7						
Other	59.5	97.1	64.6	102.3	83.6	143.6	57.7	103.3
Fleet-Wide Average CO_2 Performance	**47.7**	**80.6**	**48.9**	**82.6**	**53.4**	**87.6**	**58.3**	**91.8**

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

Guidance on Interpreting and Comparing CCWG Data

REFERENCE CCWG METHODOLOGY AND COMMUNICATIONS STANDARDS

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

COMPARISONS OF 2016 TO PREVIOUS YEARS' DATA ARE APPROPRIATE WITH THE FOLLOWING GUIDANCE

Each year members of the CCWG agree to certain changes to the methodology designed to improve environmental performance evaluation.

There are findings worth noting in the use and interpretation of data when comparing this years' results to previous years:

» Data on Intra tradelanes has always been highly variable year to year and a source of reporting confusion among carriers. In 2016, BSR performed additional analysis and members agreed to steps to reduce variability in data and differences in carrier reporting, specifically by adding additional Intra tradelanes and prohibiting simultaneous reporting of a vessel on any Global tradelane and any Intra tradelane. This resulted in a decrease of performance in the Intra Asia regional tradelanes, due to exclusion of several larger, more efficient vessels that previously were reported on these tradelanes. This did not materially impact the other regional tradelanes.[3]

» Members agreed to the following tradelanes changes in 2017 *that are comparable to the tradelanes from which they were derived in all previous years:*

Original Tradelane for Comparison (2009-2015)	**2016 Tradelane** (2016 and after)
Intra Americas	Intra North America EC/Gulf/WC
	Intra South America (incl. Central America)
Intra Asia	SE Asia to-from NE Asia
	Intra NE Asia
	Intra SE Asia
Intra Asia	North Europe to-from Mediterranean/Black Sea
	Intra Mediterranean/Black Sea

» Members also agreed to add the following new tradelanes in 2017 *for which there is no comparable tradelane in any previous year:*

- Intra Africa
- Intra Middle East/India

» We implemented the transition to mandatory verification by carriers in 2017 (2016 data), and therefore it is the first year that 100 percent of carriers and vessels were verified. For the 2015 data, 11 out of 23 carriers and over 70 percent of vessels were verified to the CCWG standard.

[3] BSR recalculated 2015 emission factors using the updated methodology to evaluate the impacts of the methodology changes on the data.

APPLYING AN AVERAGE VESSEL UTILIZATION FACTOR ON A TRADE LANE BASIS

In recent years, it became clear that the CCWG 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 CCWG 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, CCWG 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.

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. CCWG membership is open to any carrier, freight forwarder, or shipping customer in the maritime shipping supply chain. CCWG encourages all companies who operate or purchase ocean transportation services to adopt and use CCWG carrier scorecards.

If you are interested in joining the network and benefiting from CCWG'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 CCWG secretariat: ccwg@bsr.org.

For a list of current members and information on how to join, visit the CCWG website at www.bsr.org/cleancargo.

CCWG Secretariat

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Annex I: CO_2 Calculation Methodology

CCWG has 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 CCWG member carriers to calculate vessel emissions as part of the CCWG Scorecard disclosure. Following is a description of how CO_2 emissions factors (in gCO_2/TEU-km) are calculated for the purposes of the CCWG performance measurement.

CALCULATION OF VESSEL CO_2 EMISSIONS

CCWG carriers report on the following data for each vessel through the annual CCWG 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)

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

*(total kg fuel consumed for containers * 3114.4 gCO_2/kg fuel)*

*(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. CCWG will continue to align with IMO standards as they improve over time, including an update to the fuel-to-CO_2 conversation factors consistent with IMO factors for different fuel types for the 2018 reporting period.

CCWG 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 Formulas

CO2 Formula

(Note: the input sheet is designed to automatically calculate grams CO2/TEU-km based on carrier inputs)

CO2 formula for dry containers:

$$i_{Dry} = \frac{\left(\sum_{a,k} c \cdot m_{fuel,a,k} \right) - m_{RC} \cdot c}{V_{total} \cdot d}$$

CO2 formula that integrates reefer containers:

$$i_{Reefer} = \frac{\left(\sum_{a,k} c \cdot m_{fuel,a,k} \right) - m_{RC} \cdot c}{V_{total} \cdot d} + \frac{m_{RC} \cdot c}{V_{Reefer} \cdot d}$$

With these definitions of variables:

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

$$\dots c \cdot m_{fuel,MDO,ME} + c \cdot m_{fuel,MDO,AE} + c \cdot m_{fuel,MDO,Boiler}$$

a	Different Aggregates running on fuel (ME, AE, Boiler, Incinerator)
k	Different fuel types used on board (HFO, MDO)
$[m_{fuel}] = kg$	Mass of fuel consumed during specified period (incl. Time at berth, river and sea) by all consumers (ME, AE, Boiler, Incinerator)
$[m_{RC} = 1.9TEU \cdot w_{fuel} \cdot x_{Plugs} \cdot z_{time}] = kg$	Mass of fuel used for operating reefers
$[w_{fuel}] = \frac{kg}{TEU}$	Mass of fuel consumed by one reefer TEU within one year
$[V_{cargo}] = TEU$	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")
$V_{Reefer} = 1.9TEU \cdot x_{Plugs}$	
$[x_{Plugs}]$	Number of reefer plugs on the vessel
1.9 TEU	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:

$w_{fuel} = \overline{P}_{Reefer} \cdot t \cdot y_{utility}$	= 3.8kW * .23kg/kWh * 365 days * 24hours/day * 25% = 1914 kg/reefer-year
$\overline{P}_{Reefer}$	Clean Cargo WG average power consumption of reefers = 3.8 kw
$[y_{Utility}] = 91d = 25\%$	Reefer plugs utilization per year (based on Maersk and Hamburg Süd data)
$c = 3114.4 \frac{g}{kg}$	IMO-approved emissions factor, as of 2010

Annex III: CCWG Trade Lane Definitions

Trade Regions	Countries in the Region	Sample Ports in the Region
Africa	Angola, Benin, Cameroon, Cape Verde, Comoros, Congo, Cote d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Mauritania, Mauritius, Mozambique, Namibia, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Tanzania, Togo	Cape Town, Dakar, Dar Es Salaam, Douala, Douala, Durban, Luanda, Mogadishu, Mombasa, Port Elizabeth, Tripola, Walvis Bay
NE Asia	China, Japan, Korea, Russia (Pacific), Taiwan	Busan, Dalian, Hong Kong, Kaohsiung, Kobe, Shanghai, Shekou, Yantian
SE Asia	Brunei, Burma, Cambodia, East Timor, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam	Ho Chi Minh, Laem Chabang, Manila, Port Kelang, Singapore, Surabaya
Mediterranean/Black Sea	Albania, Algeria, Bulgaria, Croatia, Cyprus, Egypt (Mediterranean), France (Mediterranean), Georgia, Gibraltar, Greece, Israel, Italy, Lebanon, Libya, Malta, Montenegro, Morocco, Portugal, Romania, Russia (Black Sea), Slovenia, Spain, Syria, Tunisia, Turkey, Ukraine	Alexandria, Algeciras, Barcelona, Genoa, Gioia Tauro, Istanbul, Latakia, Lisbon, Novorossiysk, Odessa, Tangier, Tunis
Middle East/India	Bahrain, Bangladesh, Djibouti, Egypt (Red Sea), Eritrea, India, Iran, Iraq, Jordon, Kuwait, Maldives, Oman, Pakistan, Qatar, Saudi Arabia, Sri Lanka, Sudan, United Arab Emirates, Yemen	Abu Dhabi, Aqaba, Bandar Abbas, Chennai, Chittagong, Colombo, Hodeidah, Jebel Ali Dubai, Jeddah, Mina Sulman, Nhava Sheva, Port Qasim, Port Said, Salalah, Shuwaikh, Swakin
North America EC/Gulf	Bahamas, Canada (East Coast), Caribbean Island nations, Cuba, Dominican Republic, Haiti, Mexico (East/Gulf Coast), United States (East Coast and Gulf Coast)	Charlestown, Houston, Miami, Montreal, Newark, Savannah, Toronto, Veracruz
North America WC	Canada (West Coast), Mexico (West/Pacific Coast), United States (West Coast)	LA / Long Beach, Lazaro Cardenas, Oakland, Tacoma, Vancouver
North Europe	Belgium, Denmark, Estonia, Finland, France (Atlantic), Germany, Ireland, Latvia, Lithuania, Netherlands, Norway, Poland, Russia (North European), Sweden, United Kingdom	Antwerp, Bremerhaven, Copenhagen, Felixstowe, Gothenburg, Hamburg, Le Havre, Oslo, Rotterdam, Southampton, Vyborg
South America (incl. Central America)	Argentina, Belize, Brazil, Chile, Columbia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Nicaragua, Panama, Peru, Suriname, Uraguay, Venezuela	Antofagasta, Buenaventura, Buenos Aires, Callao, Guayaquil, Iquique, Itaguai, Itajai, Parangua, Rio Grande, Santos, Valparaíso
Oceania	Australia, New Zealand, Pacific Island nations, Papua New Guinea	Adelaide, Auckland, Brisbane, Fremantle, Melbourne, Sydney

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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