Global Maritime Trade Lane Emissions Factors

Clean Cargo Working Group (CCWG)
August 2014

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BSR is a global nonprofit that works with its network of more than 250 member companies 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 more than 20 years of leadership in sustainability.

2014 CCWG Secretariat
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Introduction

For over a decade, we have worked with many of the world's largest companies and their ocean-transport partners as part of the Clean Cargo Working Group (CCWG), one of BSR's longest-running collaborative initiatives.

The group now comprises 40 leading cargo carriers and their customers, representing approximately 85 percent of ocean container cargo. Through the CCWG tools and methodology, these companies are increasing transparency, helping them to understand and to manage their sustainability impacts.

This is the fifth year that CCWG has released its average trade lane emissions data in an effort to improve transparency and understanding of environmental impacts from goods transport. This is also the first year in which we disclose aggregated average utilization factors for each trade lane.

About Clean Cargo Working Group

The Clean Cargo Working Group is a global, business-to-business initiative dedicated to improving the environmental performance of marine container transport. CCWG creates practical tools for measuring, evaluating, and reporting the environmental impacts of global goods transportation.

The work of CCWG enables the ocean container freight industry to credibly measure and report on its environmental performance to its customers using consistent, industry-approved methodology and tools. As more and more global companies that ship goods around the world consider how to reduce the impact of their transport and logistics networks, the availability of credible data and easy-to-use tools become increasingly important.

Today, CCWG tools represent the industry standard for measuring and reporting ocean carriers' environmental performance on carbon-dioxide emissions.

Business partners also need to engage in meaningful dialogue about how the environmental performance of moving cargo can be improved over time. That is why CCWG provides a network where:

» Peer group companies can share best practices for integrating environmental criteria into business decision-making;

» Shipping customers can directly engage with their transportation providers to build appropriate environmental expectations;

» Shipping customers use CCWG as a one-stop shop to keep abreast of latest developments in methodology across the transport supply chain.

Furthermore, CCWG continues to play an important role engaging with experts and influencers about methodology development at regional and global levels, as policy makers evolve toward regulating GHG emissions in the maritime industry.

CCWG Year-over-Year Aggregated Trade Lane Emissions Factors

Every year CCWG carriers report on vessel-specific environmental performance data to BSR via a standard template and based on the CCWG CO_2 methodology. The aggregated data is provided to shipping customers via individualized carrier scorecards.

The following data reports on over 2,900 ships calculated from 23 of the world's leading ocean container carriers, collectively representing around 85 percent of ocean container capacity worldwide. These results are based on primary data from vessels operating during the calendar year.

Our 2014 annual release indicates that average CO_2 emissions per container per kilometer for global ocean transportation routes have declined by more than 7.7 percent from 2012 to 2013 and by over 22 percent since 2009.

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.

Over the years CCWG has developed the CCWG CO_2 methodology which has been tested and approved by the CCWG members. The general objective of the CCWG CO_2 methodology is to: establish a robust and user-friendly industry standard on how to collect, calculate, and use CO_2 emissions data for ocean container transportation based on actual (primary) performance data directly from container carriers.

By applying the CCWG CO_2 methodology it is possible in a credible manner to:
» Describe and explain how CO_2 emission factors are calculated and how the CCWG CO_2 methodology is aligned with international recognized standards such as the GHG Protocol supply chain guideline, the European EN 16258 standard and IMOs EEOI guidelines;
» Ensure standardized and comparable CO_2 emission calculations for shippers and carriers which encompasses:
    - Calculation of CO_2 emissions from transporting individual or groups of shipments;
    - Calculation of absolute CO_2 footprint for shippers.
» Ensure credible benchmarking of carrier's CO_2 performance so shippers make informed buying decisions and carriers make informed decisions to improve performance.

CCWG Aggregate average trade lane emission factors 2009-2013

CO$_2$ Emissions by Trade Lane (grams of CO$_2$ per TEU kilometer)	2013 (2,900-plus vessels)		2012 (2,300-plus vessels)		2011 (2,000-plus vessels)		2010 (1,900-plus vessels)		2009 (1,260 vessels)	
	Dry	Reefer	Dry	Reefer	Dry	Reefer	Dry	Reefer	Dry	Reefer
Asia to Africa	61.8	96.0	63.1	99.8	70.6	98.8	81.6	115.3	84.9	110.5
Asia to the Mediterranean	54.9	89.6	54.0	85.7	65.0	93.9	65.0	95.5	67.5	96.7
Asia to the Middle East and India	54.6	87.8	64.5	96.1	69.1	96.8	71.9	100.4	73.7	103.5
Asia to North America (East Coast)	62.9	92.7	68.1	95.3	71.9	97.4	74.8	101.0	78.2	97.4
Asia to North America (West Coast)	56.2	87.1	59.1	87.9	65.1	92.3	69.8	97.8	74.2	97.1
Asia to North Europe	43.8	76.6	47.1	75.9	52.2	80.4	55.4	84.4	67.3	93.9
Asia to Oceania	61.7	94.8	73.8	106.4	79.1	109.1	103.9	133.2	92.8	120.3
Asia to South America (East and West Coasts)	53.5	83.6	60.5	90.7	67.4	94.4	75.1	102.8	80.6	104.4
Europe (North and Mediterranean) to Africa	69.5	113.7	77.0	120.2	87.6	129.0	85.7	128.8	88.7	122.7
Europe (North and Mediterranean) to Latin America and South America	63.7	94.8	68.2	99.6	79.3	108.6	82.3	115.7	87.3	114.9
Europe (North and Mediterranean) to Middle East and India	54.0	87.6	66.6	99.2	70.9	101.5	69.5	101.9	76.2	106.1
Europe (North and Mediterranean) to Oceania (via Suez or Panama)	78.4	109.7	81.5	113.1	87.6	118.2	94.8	126.5	101.5	128.6
Intra-Americas (Caribbean)	86.5	122.8	103.4	147.2	87.9	116.6	101.8	142.9	102.3	133.4
Intra-Asia	87.5	129.8	75.0	105.5	70.4	99.0	80.9	112.5	76.1	100.7
Intra-Europe	93.6	143.1	92.2	138.1	118.1	174.7	104.8	152.2	72.8	102.6
Mediterranean to North America (East Coast, including the Gulf)	70.3	100.7	79.6	113.9	79.3	110.9	88.5	125.7	80.0	108.8
Mediterranean to North America (West Coast)	60.8	90.4	76.8	112.4	85.9	119.2	56.8	87.1	59.7	89.9
North America to Africa	84.0	118.1	89.5	127.1	76.9	103.9	87.3	122.6	97.4	139.7
North America to Oceania	74.7	101.6	81.3	109.2	85.5	112.9	87.7	115.3	100.5	126.9
North America to South America (East Coast and West Coast)	67.4	100.1	68.6	102.1	71.4	97.0	77.8	110.6	85.0	112.8
North America (East Coast) to Middle East and India	65.2	90.9	77.0	101.0	78.7	104.6	81.6	106.4	84.2	108.6
North Europe to North America (East Coast, including the Gulf)	75.0	101.7	78.2	107.6	75.9	103.6	81.2	111.6	85.4	112.5
North Europe to North America (West Coast)	69.4	97.9	69.6	98.2	75.2	102.3	74.0	100.0	79.8	104.6
South America (East Coast and West Coast) to Africa	58.8	92.3	69.5	94.1	68.6	89.5	84.6	116.0	77.8	97.8
Other	57.7	103.3	79.6	114.3	90.5	128.3	n/a	n/a	n/a	n/a
Fleet-Wide Average CO$_2$ Performance	58.3	91.8	63.1	94.1	68.1	97.4	72.2	102.7	75.2	98.2

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

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 standards on how to calculate CO_2 emissions for transportation.

Therefore for the past two years, CCWG has piloted a methodology and process to collect average vessel utilization data from carriers to better understand variance.

The CCWG secretariat has collected annual average utilization information on each of the 25 trade lanes from carriers anonymously. The main criteria for the utilization information collected from carriers can be found in Annex III together with the aggregated average utilization factors data for 2012 and 2013.

CCWG believes that in future calculations, the average utilization factor can be used in the CCWG standard methodology. However today, the methodology and process of collecting the information is still being piloted. Therefore it 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.

The analysis of the utilization data show that the average utilization across all the largest trade lanes is close to 70 percent, with some variation from year to year. As a result CCWG conclude that 70 percent is a good representative average of the global average utilization. These results are also identical with IMO and WSC recommended average utilization.

The 70 percent utilization factor can be applied across all trades and in all CO_2 calculations, and is a pragmatic solution to a very complex issue. Using it will make absolute CO_2 footprint calculations much more accurate compared to using 100% utilization (nominal capacity). It will also ensure a common and comparable approach across carriers, as there can be variations in how carriers calculate and report utilization data.

In order to apply the 70 percent average utilization factor, the user should divide the CO_2 emission factor that is based on nominal capacity with 70 percent.

For More Information

On behalf of the Clean Cargo Working Group, we hope this report has expanded your understanding of CCWG and the goals and objectives we strive to attain.

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 the CCWG Scorecard.

If you are interested in joining our work and benefiting from our ready-made tools and data, 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.

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, multiplied by 3114.4 gCO$_2$/kg fuel, divided by the product of [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.

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: CO₂ Formula

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:

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

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)
$[m_{RC} = 1.9 TEU \cdot w_{fuel} \cdot x_{Plugs} \cdot z_{time}] = kg$		Mass of fuel used for operating reefers
$[w_{fuel}] = \dfrac{kg}{TEU}$		Mass of fuel consumed by one reefer TEU within one year
$[V_{cargo}] = TEU$		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
$V_{Reefer} = 1.9 TEU \cdot x_{Plugs}$		
$[x_{Plugs}]$		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)

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)
$c = 3114 \dfrac{g}{kg}$	IMO-approved emissions factor, as of 2005

Annex III: Average Utilization Factor Calculation Methodology

For the past two years, CCWG has piloted the collection of primary data to develop an average trade lane utilization factor.

For the principle of transparency, this is the first year that CCWG publicly shares the average utilization factors for each trade lane and fleet-wide. The basic principles of reporting this data can be found below the table.

This year 16 carriers reported their average % utilization in 2013 on 25 trade lanes representing 1.39 trillion TEU-km (approximately 80 percent of CCWG total). Where fewer than 3 carriers reported on any trade lane, the CCWG Fleet-Wide Average Utilization Factor was applied.

Average Utilization Factor by Trade Lane (percent of total nominal capacity utilized)	2013	2012
Asia to Africa	69.0%	64.4%
Asia to the Mediterranean	71.1%	49.8%
Asia to the Middle East and India	74.2%	62.1%
Asia to North America (East Coast)	72.2%	67.9%
Asia to North America (West Coast)	70.2%	67.7%
Asia to North Europe	78.1%	74.1%
Asia to Oceania	67.8%	68.2%
Asia to South America (East and West Coasts)	66.9%	58.0%
Europe (North and Mediterranean) to Africa	60.4%	59.1%
Europe (North and Mediterranean) to Latin America and South America	67.1%	65.9%
Europe (North and Mediterranean) to Middle East and India	73.1%	75.5%
Europe (North and Mediterranean) to Oceania (via Suez or Panama)	73.7%	66.0%
Intra-Americas (Caribbean)	46.5%	66.0%
Intra-Asia	69.2%	53.6%
Intra-Europe	72.5%	66.0%
Mediterranean to North America (East Coast, including the Gulf)	83.2%	66.0%
Mediterranean to North America (West Coast)	73.7%	66.0%
North America to Africa	73.7%	66.0%
North America to Oceania	73.7%	66.0%
North America to South America (East Coast and West Coast)	66.7%	51.6%
North America (East Coast) to Middle East and India	77.3%	66.0%
North Europe to North America (East Coast, including the Gulf)	73.2%	78.0%
North Europe to North America (West Coast)	73.7%	66.0%
South America (East Coast and West Coast) to Africa	73.7%	66.0%
Other	59.2%	66.0%
Fleet-Wide Average Utilization Factor	73.7%	66.0%

REPORTING AVERAGE UTILIZATION FACTOR BY CARRIERS:
Main criteria for the utilization information collected from carriers:

» Utilization information should be calculated based on the two key limiting factors and be an average between these. The limiting factors are:
- Utilization of TEU slots and;
- Deadweight restrictions.

» Should be based on a round trip average (meaning that CO_2 emissions are an average from both head haul and back haul);

» Only based on full containers – i.e. not include empties (meaning that CO_2 emissions from empty back haul sailing and re-positioning of containers, will be allocated to full containers);

» Include lost slots from oversized cargo;

» Consider all slots on operated vessels only (i.e. exclude VSA slots on other carriers vessels);

EXPLANATORY NOTES FOR SOME OF THE MAIN CRITERIA:

Based on round trip
Main reasons for an average round trip approach instead of a split approach between East/West bound (head/back haul):

» A round trip approach is in line with recognized standard methodologies on how to allocate CO_2 emissions from transportation (GHG Protocol, CEN standard etc.);

» Head haul transport (e.g. China-Europe & China-US) is the main reason why we sail between the continents and is the main income from the trades. Back haul is 'only' done because carriers need to reposition equipment (vessels & empty containers) to China in order to enable head haul transport;

» Therefore allocating more CO_2 per container to back haul transport is fundamentally wrong from an allocation of CO_2 emission perspective. Instead the fairest distribution of CO_2 between head/back haul is an equal distribution based on a roundtrip average.

Excluding VSAs
Main reasons for excluding VSAs:

We recognize that this could be material, though it is also acknowledged that currently, carriers would have technical difficulty to collect the appropriate data from other carriers as to the VSA proportion on a vessel not operated by them. It is therefore recommended to include all slots on own operated vessels, thereby accounting for all slots regardless of ownership. In this way we are allocating the appropriate average utilization factor.

AVERAGE UTILIZATION FACTOR FLEETWIDE CALCULATION
After data are reported by carriers using the above methodology, the CCWG secretariat calculates a weighted average utilization factor for each trade lane using the following methodology:

» Carriers report a trade lane average (1-2 decimals)

» Weighted average derived based on TEU-km

» Fleet wide average applied to trade lanes with fewer than 3 carriers reporting

Annex IV: Clean Cargo Trade Lane Definitions

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

Annex V: CCWG Members and Carriers Who Reported Data

CCWG Carriers that Reported 90 percent of their fleets*
APL
CMA CGM
Compania Sud Americana de Vapores S.A (CSAV)
COSCO Container Lines Co., Ltd. (COSCON)
Evergreen Marine Corp. Ltd.
Hamburg Sud
Hanjin Shipping (Hanjin)
Hapag-Lloyd
Hyundai Merchant Marine Co., Ltd. (HMM)
Independent Container Lines Europe NV (ICL)
Maersk Line
MCC Transport
Mitsui O.S.K. Lines, Ltd. (MOL)
Nippon Yusen Kabushiki Kaisha (NYK Line)
OOCL USA Inc (OOCL)
Unifeeder A/S
United Arab Shipping Company (UASC)
Yang Ming Marine Transport Corporation (Yang Ming)
Zim Integrated Shipping Services Ltd. (Zim Line)

*Source: Alphaliner data on fleet size in TEU's and vessel total on December 18, 2013 as percentage of TEU's and vessels reported to CCWG. Includes an adjustment to incorporate fluctuations in fleet size throughout the reporting year.