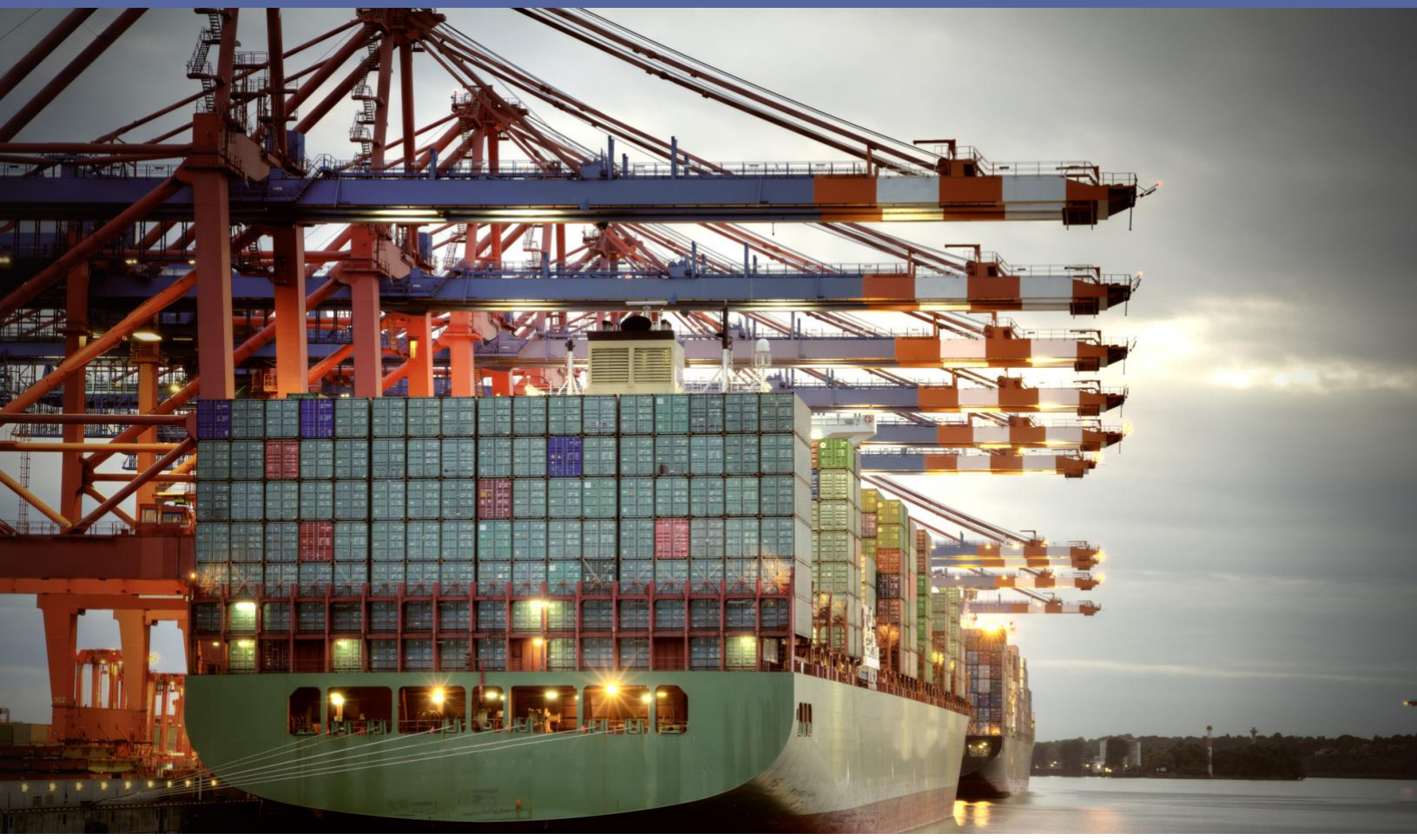
JULY 2020

2019 Global Container Shipping Trade Lane Emissions Factors

Clean Cargo



clean CARGO Sustainable Transportation

A BSR Collaboration

BSR

About 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 and 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.

In 2020, Clean Cargo prioritized three key pathways for action:

- **Evaluation:** providing Shippers and Forwards with easy-to-use carrier-specific trade lane emissions factors, based on primary activity data. The Clean Cargo Reporting Framework enables Shippers and Forwarders to benchmark the environmental performance of their ocean freight suppliers.

- **Sustainable Procurement:** Clean Cargo provides its members with guidance, surveys, and tools to assess the sustainability of their business partners and of their own procurement practices. Clean Cargo members have access to metrics, questionnaires, and our Sustainable Freight Procurement Framework to enable a sustainability-based dialogue across the value chain.

- **Decarbonization Peer-to-Peer Learning**: an increasing number of organisations are adopting Scope 3 targets, and the overall decarbonization challenge for shipping is significant. Clean Cargo provides members with the latest research and thought leadership on transition pathways. The Clean Cargo network also allows members to co-create decarbonization pilots and resources and to learn from peers, thereby accelerating the definition of sustainability/climate strategies and their implementation.

More information is available on our website: www.clean-cargo.org

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 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] BSR's data collation, review, aggregation, and reporting process and procuredures are also audited by a third party every three years. A Technical Committee made up of independent experts was

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

[2] Available upon request.

established in 2020 to assess our data quality and to identify key drivers for evolutions in performance, as well as to suggest improvements in our methodology and processes.

Scope and Main Findings

The following index is derived from **emissions reported by approximately 3,500 vessels, calculated from 17 of the world's leading ocean container carriers who collectively represent around 85 percent of ocean container capacity worldwide**. A complete list of Clean Cargo members can be found on our webpage.[3] These results are based on primary data from vessels operating during the calendar year.

2019 Findings

In early 2020, 17 carriers reported their 2019 CO_2 and SO_x data to Clean Cargo and had that data verified by a third-party. This represents 85 percent of global container capacity. Key findings include:

- CO_2 performance improved compared to 2018, with the global industry average showing a decrease of 5.6% and 2.5% for CO_2 Dry and Reefer indexes, respectively.
- Improvements on our CO_2 Dry index were seen on major tradelanes, such as:
    - Asia to-from North Europe with a 3% reduction
    - Asia to-from North America West Coast and Asia to-from North America East Coast with a 6% reduction
    - Asia to-from Middle East / India with a 12% reduction
    - Asia to-from Mediterranean / Black Sea with a 12% reduction

The picture is mixed for thinner (less trafficked) tradelanes as they are more sensitive to individual vessel allocations and therefore display more variation.

We observed a decrease in SO_x emissions (-10.2% globally), although our methodology and calculations do not yet factor in the increasing use of Exhaust Gas Cleaning Systems.

A mapping of Clean Cargo membership divided by vessel size and type shows a clear increase in the fleet size, which results in an increase in the total amount of fuel consumed by the group. There were no major changes in fuel types, with vessels remaining mainly on HFO. We observed a slight increase in MDO and a substantial increase in LFO, LNG, and hybrid fuels, even if they still represent a small proportion of the total fuel consumed. LNG is used mainly on small vessels, while the hybrid fuels use is spread among the larger sizes of vessels. Ultra large vessels are still running on HFO or conventional fuels.

10-Year Trends

Over the last 10 years, the main trends observed through the Clean Cargo reporting framework were:

- Clean Cargo Fleet capacity grew by 153%, from 8 to 20.4 mil. TEU
- Heavy fuel oil decreased from 97.2% to 86.6% of fuel used.
- Lower emissions correlate with higher transport work, increasing ship size and tradelane length

[3] https://www.clean-cargo.org/current-membership

How to Use Clean Cargo Data

Important: 2020 Methodology Changes

Clean Cargo Methodology has undergone several changes, to align with emerging standards and to provide a more realistic calculation of shipping emissions. As such our results are now displayed using both the previous and the updated Clean Cargo methodology. **Users of this report should ensure they are comparing emission factors based on similar Utilization Factors and Fuels.**

Reporting Outputs

Every year, Clean Cargo collects data from container cargo carriers and produces the following carrier-specific trade lane emission factors, available for all shippers and forwarders on our dedicated platform which is only accessible to members:

- **Tradelane CO_2** (Dry and Reefer) **emissions** by carrier and average of Clean Cargo (in gCO_2/TEUkm)
- **Tradelane SO_x emissions** by carrier and average of Clean Cargo (in gSO_x/TEUkm)
- **Year-Over-Year comparisons for CO_2** (Dry and Reefer) and **SO_x** by tradelane and carrier[1]

The Clean Cargo general formula to calculate vessel CO_2 emissions (in gCO_2/TEUkm) is:

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

How To Use Clean Cargo Emissions Factors

Clean Cargo emissions factors, available on 32 tradelanes for CO_2 Dry and CO_2 Reefer, can be used by shippers and forwarders to calculate their own emissions associated to their shipment. The following steps are to be followed to calculate absolute emissions (in grams of CO_2):

1. Select your relevant Tradelane
2. Calculate the distance (in kilometers) between the two ports, and add a 15% distance allowance to that port-to-port distance to adapt for route variations or detours.
3. Identify your emissions factor (Dry or Reefer) and the number of TEU containers (refer to Clean Cargo methodology for other container size conversion factors)
4. Calculate absolute emissions (in grams): Emission Factor (in g/TEUkm) * number of TEU * (distance in km + 15%)
5. *Additional step to be used only with emission factors based on a 100% Utilisation Factor i.e. for data prior to 2018:* To apply a 70% Utilization Factor, the user must divide absolute emissions by 0.7.

2020 Methodology Changes

Clean Cargo Methodology has undergone several changes to align with emerging standards, provide a more realistic picture of shipping emissions and to reflect regulatory and compliance practices from carriers.

Fuel-to-CO_2 Conversation Factors

To align with the Global Logistics Emissions Council (GLEC) Framework, the emissions factors used to calculate Clean Cargo have changed from **Tank-To-Wheel (TTW)** and **CO_2 only** to **Well-to-Wheel (WTW)** and **CO_2 equivalent**. To enable mltpile uses, we provide emission factors in both the old and GLEC-aligned format. The emission factors used are detailed in the Annexes.

Utilization Factor

A 70% utilization factor is also now implemented directly in the calculations of the CO_2 and SO_x emissions for all carriers, as an average load factor. **Users should ensure they are not comparing year on year values that are based on nominal capacity (70% v.s. 100%).**

Clean Cargo Aggregate Average Trade Lane Emission Factors 2015-2019												
CO_2 Emissions by Trade Lane (grams of CO_2 per TEU kilometer)	2019 – WTW, CO_2e, 70% UF		2019 – TTW, CO_2, 100% UF		2018 – WTW, CO_2e, 70% UF		2018 – TTW, CO_2, 100% UF		2017 – TTW, CO_2, 100% UF		2016 – TTW, CO_2, 100% UF	
	3493 vessels		3493 vessels		3275 vessels		3275 vessels		3208 vessels		3233 vessels	
Trade Lane	Dry	Reefer	Dry	Reefer	Dry	Reefer	Dry	Reefer	Dry	Reefer	Dry	Reefer
Asia to-from Africa	74.3	133.1	47.1	68.4	72.94	128.39	46.5	81.9	48.9	83.8	51.9	88.0
Asia to-from Mediterranean/Black Sea	50.3	104.8	31.8	82.8	56.86	108.94	36.1	69.2	38.8	71.4	40.2	74.0
Asia to-from Middle East/India	56.2	111.1	35.5	85.4	63.96	116.94	40.5	74.3	46.8	79.3	46.4	80.9
Asia to-from North America EC/Gulf	60.2	107.4	37.9	84.1	63.71	111.07	40.4	70.4	44.7	74.1	48.7	77.3
Asia to-from North America WC	67.1	116.5	42.2	120.4	71.02	120.05	45.0	76.0	46.7	76.8	46.6	77.4
Asia to-from North Europe	42.3	93.1	26.7	98.9	43.44	92.06	27.5	58.3	30.5	61.0	31.7	62.6
Asia to-from Oceania	86.4	138.6	54.8	84.4	89.41	141.51	56.9	90.1	58.9	91.3	59.4	92.5
Asia to-from South America (incl. Central America)	60.5	109.9	38.3	73.3	63.42	111.74	40.4	71.1	41.3	71.6	41.9	73.0
Europe (North and Med) to-from Africa	100.9	164.9	63.3	87.4	91.64	151.82	57.8	95.8	61.3	101.5	56.8	94.3
Europe (North and Med) to-from South America (incl. Central America)	67.4	121.2	42.4	73.4	77.53	132.48	48.9	83.6	48.6	83.4	51.2	84.7
Europe (North and Med) to-from Middle East/India	55.8	108.3	35.2	110.8	58.53	111.52	37.1	70.8	40.0	72.5	38.4	71.7
Europe (North and Med) to-from Oceania (via Suez/via Panama)	80.0	131.2	50.5	127.8	94.47	146.48	59.7	92.6	66.4	99.3	56.0	86.8
Mediterranean/Black Sea to-from North America EC/Gulf	80.1	136.6	50.1	126.6	89.08	143.93	55.9	90.4	61.4	96.2	58.0	92.5
Mediterranean/Black Sea to-from North America WC	77.8	134.4	48.7	107.7	96.53	153.89	60.8	96.9	51.8	84.2	50.0	82.2
North America EC/Gulf/WC to-from Africa	138.9	190.7	87.7	95.0	83.38	133.41	52.9	84.7	71.2	104.7	55.7	83.9
North America EC/Gulf/WC to-from Oceania	106.4	156.7	67.2	107.1	111.03	158.85	70.4	100.8	67.2	96.7	76.3	103.8
North America EC/Gulf/WC to-from South America (incl. Central America)	82.3	134.7	51.6	111.8	89.83	141.13	56.5	88.8	63.4	99.1	59.7	94.4
North America EC/Gulf/WC to-from Middle East/India	66.0	115.9	41.7	98.3	74.03	121.10	47.0	76.9	53.1	84.8	55.3	86.1
North Europe to-from North America EC/Gulf	86.9	141.1	53.8	138.3	88.82	141.05	55.2	87.7	60.4	92.6	59.8	91.1
North Europe to-from North America WC	64.0	117.5	40.0	130.7	70.58	122.85	43.6	75.9	58.4	88.7	39.9	72.9
South America (incl. Central America) to-from Africa	115.9	174.0	73.8	109.4	68.61	118.51	43.7	75.4	45	77.1	45.1	77.6
Intra Africa	118.3	201.2	75.1	88.1	115.66	186.91	73.1	118.1	79.7	130.3	77.0	122.4
Intra North America EC/Gulf/WC	143.2	203.3	89.3	68.4	118.24	175.82	73.9	109.8	117.2	154.7	85.5	119.3
Intra South America (incl. Central America)	103.1	169.9	65.4	82.8	112.15	181.26	71.4	115.4	72.4	114.6	71.2	113.8
SE Asia to-from NE Asia	91.3	150.6	57.6	85.4	94.49	154.50	60.2	98.4	60.2	95.1	69.2	103.6
Intra NE Asia	101.7	173.7	62.8	84.1	72.49	129.16	45.9	81.8	58.1	102.7	71.1	114.8
Intra SE Asia	102.6	176.8	64.9	120.4	109.33	178.90	69.7	114.1	74.3	118.5	75.0	112.2
North Europe to-from Mediterranean/Black Sea	98.8	158.0	61.4	98.9	103.29	163.00	63.3	99.6	63.1	99.7	60.6	95.6
Intra Mediterranean/Black Sea	128.3	220.6	80.4	84.4	100.17	174.27	62.9	109.5	88.6	148.0	85.2	140.2
Intra North Europe	139.8	221.4	82.4	73.3	98.34	162.69	57.5	95.9	87.1	133.9	80.9	122.9
Intra Middle East/India	95.9	171.6	61.1	87.4	96.72	169.48	61.6	108.0	59.7	105.3	58.8	103.7
Other	78.3	139.9	49.3	73.4	68.24	120.53	43.1	76.1	75.2	114.5	59.5	97.1
Fleet-Wide Average CO_2 Performance	**66.2**	**120.1**	**41.7**	**75.6**	**70.59**	**123.54**	**44.2**	**77.5**	**47.2**	**80.1**	**47.7**	**80.6**

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

"WTW": Well-to-Wheel; "TTW": Tank-to-Wheel

For More Information

On behalf of Clean Cargo, 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, please visit the Clean Cargo website at: www.clean-cargo.org.

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, MDO/MGO, LFO, Propane, Butane, LNG, Methanol, Ethanol and Hybrid fuels 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 2019 reporting period. These factors are:

Fuel Type	IMO / MRV Factor – TTW CO2 (gCO_2/kg fuel)	IMO / MRV Factor – WTW CO2e (gCO_2e/kg fuel)
HFO	3,114	3,410
LFO	3,151	3,838
MDO / MGO	3,206	3,920
Propane LPG	3,000	3,654
Butane LPG	3,030	3,691
LNG	2,750	3,640
Methanol	1,375	1,675
Ethanol	1,913	2,330
Hybrid Fuels	3,151	3,838

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

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

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

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, Hybrid fuels)

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

$\left\lfloor \lfloor m_{RC} \rfloor = 1.9\,TEU \cdot w_{fuel} \cdot x_{Plugs} \cdot z_{time} \right\rfloor = kg$ 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

$\lfloor V_{cargo} \rfloor = \boldsymbol{TEU}$ **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-foot, 40-foot, and 45-foot; 1.9 is the average number of 20-foot 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 * .23 kg/kWh * 365 days * 24 hours/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)

$$c_k = \frac{g}{kg}$$ [4]

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

About Clean Cargo

Clean Cargo is a business-to-business leadership initiative that involves major brands, cargo carriers, and freight forwarders dedicated to reducing the environmental impacts of global goods transportation and promoting responsible shipping. Clean Cargo represents around 80 percent of global container cargo capacity and constitutes the leading buyer-supplier forum for sustainability in the cargo shipping industry.

A BSR Collaboration

BSR provides executive leadership and secretariat support for Clean Cargo. Clean Cargo's activities are overseen by the Steering Committee, with active participation of the Clean Cargo membership. BSR is a global nonprofit business network and consultancy dedicated to sustainability. BSR collaborations bring together more than 400 companies, spanning multiple sectors and geographies, to strengthen company performance, improve markets and industries, and contribute to systemic change for a more just and sustainable world.