GHG RATING METHODOLOGY

HOW SHIPS ARE COMPARED

Rather than adopting a 'one size fits all' approach, the GHG Rating provides comparison of a peer group of vessels, for example comparing a 100,000 DWT bulk carrier to a bulk carrier of a similar size and type.

Ship types for comparison align with the IMO's documentation and guidance.

Categories include bulk carriers, chemical tankers, container ships, crude & product tankers, cruise passenger and general cargo ships, LNG tankers, LPG tankers, refrigerated cargo ships and ro-ro cargo ships.

In terms of sizes for comparison vessels are compared to other vessels plus or minus 10% of their DWT.

EVDI

The core measure for comparing the relative efficiency of the world's fleet is grams of CO_2 per tonne nautical mile.

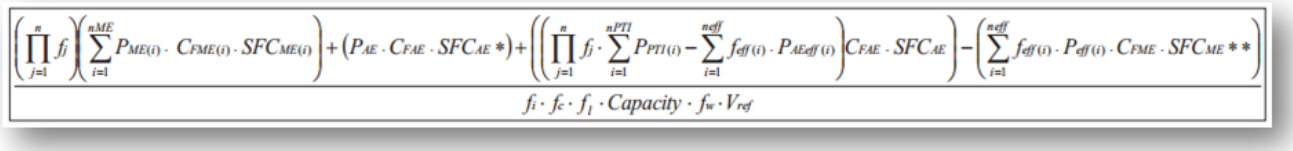
RightShip utilise one of two sources when determining an individual vessel's efficiency:

- EEDI (Energy Efficiency Design Index) – measures the theoretical CO_2 emission performance of new ships over 400 gross tonnes and is calculated from ship design and engine performance data. This is a regulatory requirement for new ships developed by the IMO (and applied on an ad-hoc basis to existing vessels).
- EVDI (Existing Vessel Design Index) – developed by RightShip, this index also measures a ship's theoretical CO_2 emissions per nautical mile travelled. However, the EVDI can be applied to existing vessels as well as new builds (where EEDI is not available/applicable).

As the two methods compare relative efficiency on the same basis, a like-for-like comparison of efficiency is achievable – as outlined in DNV GL's review of RightShip's methodology in 2015.

EVDI Formula

While the GHG Rating is relatively easy to interpret, the methodology used to calculate the GHG Rating is complex. The EVDI formula is as below:



$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)}\right) - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}**\right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref}}$$

RATING DISTRIBURION

The GHG Rating compares the relative efficiency of a ship using the EVDI (or EEDI is applicable).

The peer group comparison is based on the number of standard deviations a vessel's EVDI varies from the average for similar sized vessels of the same ship type.

In general, the distribution of the size group fit the following fixed percentiles of the data set.

GHG Emissions Rating	A	B	C	D	E	F	G
Size Score	>2.0	>1.0	>0.5	>-0.5	>-1.0	>-2.0	<=-2.0
Area Under Curve	2.5%	13.5%	16%	36%	16%	13.5%	2.5%

GHG Emissions Rating Key – Normal Peer Distribution

NORMAL PEER DISTRIBUTION

The bell curve below illustrates the percentage distribution with the corresponding letter displayed in the coloured area under the curve.

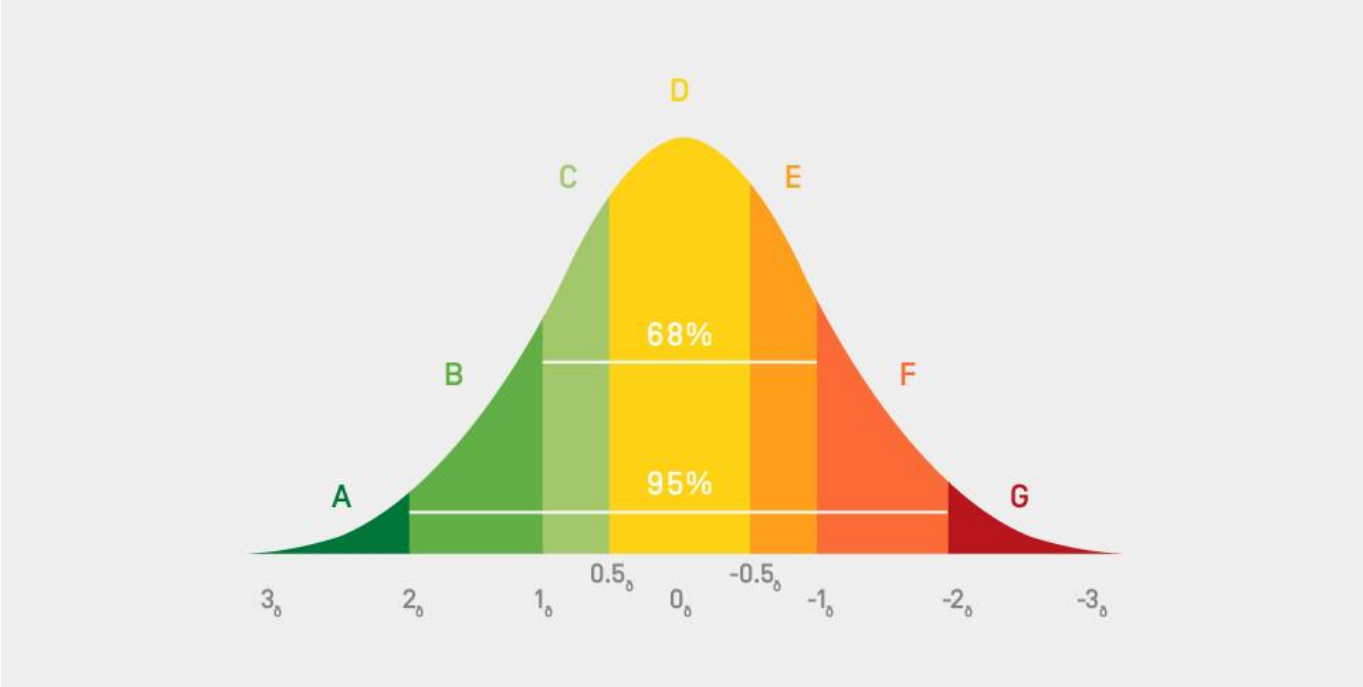
The x-axis is expressed as a count of standard deviations which matches the Size Score in the key.

Example

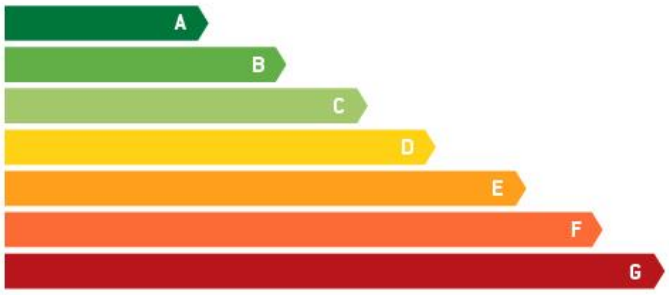
For example, a 176,382 deadweight tonne bulk carrier has a GHG Rating of D, with a size score of -0.345.

It is considered alongside ships of plus or minus 10% of its deadweight, and is therefore compared to vessels within the range of 158,744 to 194,020 deadweight tonne.

In this case, as there are 1,060 ships in the peer group, approximately 735 are more efficient and 325 are less efficient than this particular vessel.



GHG Emissions Rating Key – Normal Peer Distribution

EVDI (grams CO2 per tonne nautical mile)	2.956
Ship Type, Comparison Factor	Bulker, DWT
GHG Emissions Rating	
Size Score (Z Score)	-0.345
GHG Emissions Rating Key	A>2.0 B>1.0 C>0.5 D>-0.5 E>-1.0 F>-2.0 G<=-2.0
Top Rated Peers	Stella Lucy (A), Min May (A), Stella Laura (A)
Peer Group	Peers(Minus) = 321 Peers(Plus) = 735, Peer DWT Range = 158,744-194,020

Example Bulk Carrier Rating

VESSEL VERIFICATION

The data used to calculate a vessel's GHG Emissions Rating can be viewed:

- In RightShip Qi – for RightShip customers
- By sending an e-mail to the environment team who will assist you with GHG Ratings and the vessel verification process.
- Via the Shipping Efficiency website which provides access to the GHG Rating free of charge. A username and password can be set up to gain access.

Source data for the GHG Rating

RightShip recognises that the reliability of its calculations directly correlates to the accuracy of source data. RightShip continues to work closely with ship owners, managers, yards and classification societies to validate the data used for the calculations.

The data utilised for the GHG Rating calculation is, as far as practicable, in line with the IMO guidelines (MEPC.245(66)) for EEDI calculation. RightShip obtains data for the GHG Rating from various industry sources as outlined below.

The source data for the GHG Rating is based on the hierarchy found in the table below.

As outlined in the DNV GL review, due to the pre-defined set of data assumptions applied to 'non-verified' vessels, there is an incentive for shipowners to update relevant data within Qi as it is likely to result in an improved GHG Rating.

Preference / verification level	Data type	Data source / example
Most preferred / highest level of verification	Energy Efficiency Design Index	Classification Societies e.g. EEDI Technical Files EEDI certificate (including supplement)
	Ship specific specifications	Ship-sourced data, e.g. sea trial and shop test supplied by the vessel owner / manager
	Industry / third party data sources	Engine manufacturer's specifications Data sourced from ship yards
Least preferred / benefit from verification	IHS Maritime database Industry publications	IMO publications IHS Maritime Database

RELEVANT DOCUMENTATION

The following documentation is requested to ensure the ship particulars are up to date:

- EEDI Technical File – as defined in the IMO Guidelines (MEPC.245(66)) for EEDI calculation.

If the EEDI Technical File is not available, please provide the documentation outlined in the table below.

Upon receipt of the documentation, RightShip's sustainability team will review and update the vessel particulars and provide the updated GHG Rating.

Documentation type	Relating factor	Relevant details
Sea Trial	Vref Speed (Knots)	Trial Speed at Summer/ Scantling Load Draught at 75% Maximum Continuous Rating (MCR). In the form of a sea trial curve (calculated and/or model curves are acceptable)
Shop Test - Main and Auxiliary Engines	Number of Engines Power of engines (MCR) Specific Fuel Consumption (SFC) Fuel Type (test conditions)	SFC for the Main Engine is read at 75% MCR SFC for the Auxiliary Engines is read at 50% MCR
Class Certificate and/or Ship Capacity Plan	Capacity	Deadweight (DWT) Gross Tonnage TEU (if applicable) CBM (if applicable)
	Ship classification notations	Common Structural Rules (include LBP and LWT) Ice-class Shuttle tankers Cubic-capacity correction factor General cargo equipped with cranes
Other documentation as appropriate	Innovative energy efficient technologies	Examples include waste heat recovery and shaft motor generator

ENGINE SPECIFIC FUEL CONSUMPTION (SFC) ASSUMPTIONS

As stated above, SFC figures are sourced from vessel-specific shop tests or EEDI technical files.

If the data is not provided by the ship owner, the values used in the calculation are based on the same assumptions used in the IMO GHG Study and / or detailed in IMO Circulars on the calculation of the energy efficiency measure as listed below.

Main Engine Assumptions (SFC_{ME})

Engine age	MCR_{ME} (kW) (kW)	SF SFC_{ME} (g/kWh)
Pre 1983	> 15,000	205
	5,000 to 15,000	215
	< 5,000	225
1984–2000	>15,000	185
	5,000 to 15,000	195
	< 5,000	205
2001–2007	>15,000	175
	5,000 to 15,000	185
	< 5,000	195
Post 2008	>15,000	175
	5,000 to 15,000	185
	< 5,000	195

Auxiliary Engine Assumptions (SFC_{AE})

1. MCRAE (kW)	SFCAE (g/kWh)
> 800 kW	220
< 800 kW	230