RIGHTSHIP

The RightShip GHG Rating methodology update

Calculating and comparing CO_2 emissions from the global maritime fleet

Background

While international shipping is the most carbon efficient mode of commercial transport, total emissions are comparable to those of a major national economy, and as such provides the opportunity for significant emissions reduction. According to the International Maritime Organization's (IMO) Fourth Greenhouse Gas (GHG) Study[1] , shipping emitted 1,056 million tonnes of CO_2 in 2018, accounting for about 2.89% of the total global anthropogenic CO_2 emissions for that year.

In July 2011, the IMO Marine Environment Protection Committee (MEPC) adopted mandatory measures to reduce GHG emissions from international shipping through amendments to MARPOL Annex VI Regulations. These amendments included the application of the Energy Efficiency Design Index (EEDI) which required all ships built from 1 January 2013 to meet a minimum level of energy efficiency.

On 17 June 2021, the IMO adopted amendments to MARPOL Annex VI at MEPC 76, introducing regulations 23 and 25 - the Energy Efficiency Existing Ship Index (EEXI). The EEXI requires ships to attain approval once in a lifetime and must be completed by the first annual, intermediate or renewal survey due, whichever is the earliest from 1st January 2023.

RightShip's existing GHG Rating calculations were based on a vessel's CO_2 emissions at 75% of their Maximum Continuous Rating (MCR), and validated through their Energy Efficiency Design Index (EEDI) or Existing Vessel Design Index (EVDI™) certificates and calculations.

However, where EEXI compliance is achieved through Engine Power Limitation (EPL) or Shaft Power Limitation (ShaPoLi), this value is calculated at 83% of the limited MCR (called MCR_lim). Thus, while the CO_2 emission number can be significantly reduced through EPL with a relatively small reduction in maximum operational speed leading a better GHG Rating, the vessel will continue to have the same speed-power-fuel emission profile and therefore may emit the same amount at a given speed. We do not want charterers to create policies that discriminate against vessels of older tonnage because they have implemented EPL/ShaPoLi or because they are pre-EEDI.

RightShip believes that power limitation should neither give undue advantage nor be discriminatory to such vessels, while promoting vessel efficiency to cut down CO_2 emissions. Therefore, the revised GHG Rating methodology addresses such barriers with a speed corrected approach and evaluates all vessel within a peer group (i.e., of similar size and type) at a common speed. The improved speed-corrected approach to the GHG Rating is a necessary adjustment to an existing system.

This easy-to-use tool enables charterers, shipowners, ship managers, ports and terminals, and finance institutions to identify the most energy efficient vessel in the market. This ensures appropriate reward for shipowners who invest in technology and/or design to improve their vessels and aligns with ambitious industry decarbonisation targets.

[1] IMO, 2020, Fourth IMO GHG Study 2020, International Maritime Organization, London, UK.

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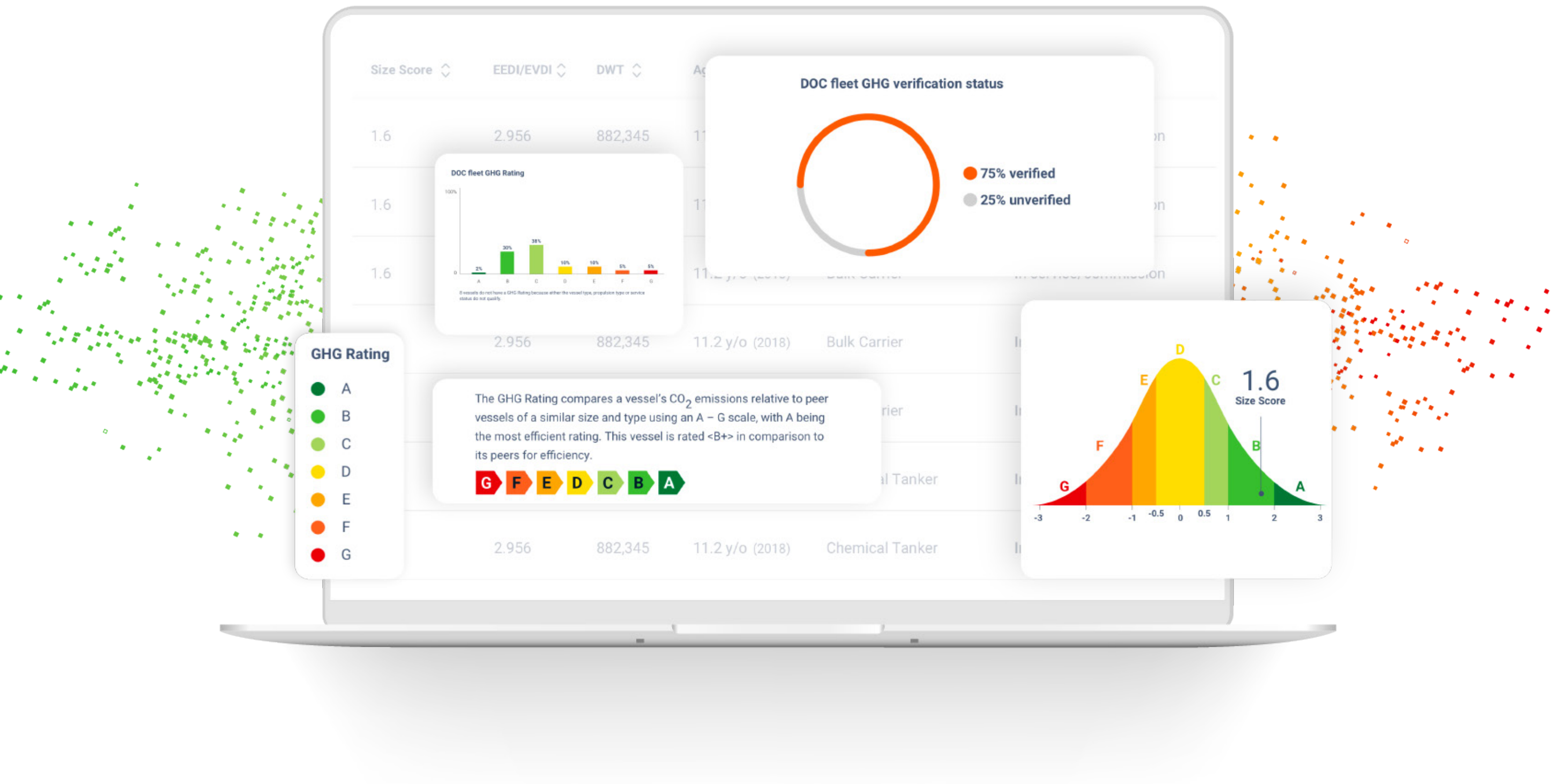


1. Summary

The IMO has defined energy efficiency as grams of CO_2 per tonne nautical mile and the IMO MEPC formulated both EEDI and EEXI as measures of a ship's CO_2 emissions. Both are calculated using characteristics of the ship at build, incorporating parameters that include ship capacity, engine power and fuel consumption.

In 2012, RightShip developed an Existing Vessel Design Index (EVDI™) to work alongside the EEDI within a Greenhouse Gas (GHG) Rating system to enable comparisons of all similar vessels within peer groups. RightShip, with the implementation of the revised GHG Rating system, will start accepting the EEXI as a similar metric over-riding EVDI™ for existing ships. The revised speed corrected GHG Rating uses EEDI, EVDI and EEXI and allows relative comparison of a ship's CO_2 emissions to vessels of a similar size and type. Ship types are largely consistent with those used by IMO MEPC.

This document details the calculations and methodology of the revised GHG Rating and contains practical examples of their application to the shipping industry.

2. IMO EEDI/EEXI

EEDI/EEXI were developed by IMO MEPC to measure the theoretical CO_2 emission performance of ships over 400 gross tonnes and are calculated from ship design and engine performance data. Designed to stimulate innovation and technical development of all elements influencing the energy efficiency of a ship from a design perspective, the metrics are calculated using the following formula

[2]

$$\frac{\overbrace{\left(\prod_{j=1}^{M} fj\right)\left(\sum_{i=1}^{nME} P_{ME(i)}.C_{FME(i)}.SFC_{ME(i)}\right)}^{\text{Main engine(s)}} + \overbrace{\left(P_{AE}.C_{FAE}.SFC_{AE}*\right)}^{\text{Auxiliary engine(s)}} + \overbrace{\left(\left(\prod_{j=1}^{M} fj.\sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)}.P_{AEeff(i)}\right) C_{FAE}.SFC_{AE}\right)}^{\text{Energy saving technologies (auxiliary power)}} - \overbrace{\left(\sum_{i=1}^{neff} f_{eff(i)}.P_{eff(i)}.C_{FME}.SFC_{ME}\right)}^{\text{Energy saving technologies (main power)}}}{\underbrace{f_i.Capacity.V_{ref}.f_w}_{\text{Transport work}}}$$

In which:

- ME and AE - the Main Engine(s) and Auxiliary Engine(s)
- P - the power of the engines (kW)
- CF - a conversion factor between fuel consumption and CO_2 based on fuel carbon content
- SFC - the certified specific fuel consumption of the engines (g/kWh)
- Capacity - the deadweight or gross tonnage (tonnes)
- V_{ref} - the ship speed (nm/h), and
- fj - a correction factor to account for ship specific design elements (eg. ice-class)

The calculated EEDI/EVDI/EEXI is a theoretical measure of the mass of CO_2 emitted per unit of transport work (grams CO_2 per tonne nautical mile) for a particular ship design.

$$\text{EEDI/EVDI/EEXI} = \frac{CO_2 \text{ emissions}}{\text{Transport work}}$$

[2] IMO, 2018, 2018 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX (EEDI) FOR NEW SHIPS. Resolution MEPC 308 (73). International Maritime Organization, London, UK.

IMO, 2021, 2021 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY EXISTING SHIP INDEX (EEXI). Resolution MEPC 333 (76). International Maritime Organization, London, UK

3. RightShip's revised GHG Rating

In 2012, RightShip developed a systematic and transparent means of comparing the relative theoretical efficiency of the existing fleet utilising EEDI and EVDI data.

With the introduction of EEXI in 2023, RightShip will adjust the GHG Rating methodology to answer the mathematical challenges resulting from the introduction of engine power limitation (EPL) into the EEXI calculations through a speed corrected approach. This is intended to continue to provide a 'level playing field' for comparison of vessels within the same peer group, whilst driving the industry towards innovations and further decarbonisation.

The GHG Rating will continue to provide an innovative measure that allows comparison of a ship's theoretical CO_2 emissions relative to peer vessels of a similar size and type using a simple A - G scale. Ship types are largely consistent with those used by IMO MEPC.

The A - G rating enables charterers to identify the most energy efficient vessel, ship owners to be rewarded for investing in innovation, banks to reduce their ESG risk by investing in efficient vessels, and ports and terminals to reward efficient vessels with reduced port fees and other incentives.

3.1 EVDI™

RightShip's Existing Vessel Design Index (EVDI™) is a data point used to calculate the GHG Rating, together with the corresponding reference speed (V_{ref}).

Similar to the IMO MEPC's EEDI, RightShip's EVDI™ measures a ship's theoretical CO_2 emissions per tonne/nautical mile travelled. However, unlike the EEDI, which is applied only to new ships, the EVDI™ is designed for application to existing vessels where EEXI data is unavailable.

The 2007 Denmark paper that initially proposed the EEDI to the IMO at MEPC 57 (MEPC 57/INF.12) stated "it is not inconceivable that design indices or equivalent may be applied retroactively to existing ships."[3] RightShip agreed with this approach and developed the EVDI calculation to account for over 48,000 existing vessels in the global fleet.

RightShip's EVDI™

- Over 48,000 existing ships

IMO MEPC's EEDI

- New ships from 1 January 2013

IMO MEPC's EEXI

- Existing ships from 1 January 2023

[3] IMO, 2007. Prevention of Air Pollution from Ships, MEPC57/INF.12, p. 32, Danish Government

3.1.1 Data validity

EVDI™ values are calculated from vessel design information and associated data. The primary sources of this data are:

- RightShip's Platform
- Ship-sourced data
- Classification societies
- IHS Markit database

RightShip recognises that the reliability of its calculations directly correlates with the accuracy of source data used. As a digital solution provider, RightShip has developed its cloud-based platform to contain the details of more than 200,000 vessels. Around a quarter of this figure is the world's trading fleet, with additional data on a range of other smaller vessels.

The data on the platform is collected from a variety of sources. Ship owners are able to upload approved class certification and supporting documents on design information and associated data through an easy to use interactive system which is then processed by our internal specialists. This verification process is typically undertaken when owners are seeking to ensure the data we hold on file matches their technical documents, and in particular when they are seeking to improve their ratings.

Otherwise, charterers may request a vetting of a particular vessel in which owners may be required to provide information about their vessel. Therefore, the platform is constantly being updated with new information.

Where data is not provided directly by ship owners we are able to utilise other databases such as IHS Markit where data is exchanged via API.

RightShip welcomes feedback pertaining to any missing or additional information including retrofits or upgrades through RightShip's Platform or by emailing *environment@rightship.com*

3.1.2 Assumptions

Where ship specific data is not available, such as specific fuel consumption, the values used in the EVDI™ calculation are based on the same assumptions used in the Second IMO GHG Study 2009[4] and/or detailed in IMO Circulars on calculation of the energy efficiency measure. RightShip's approach utilises the same data set recognised by IMO MEPC in their establishment of an EEDI reference line for new ships. Assumptions are shown below:

> Specific Fuel Consumption (Main Engine), SFC_{ME}:

Engine age	Above 15,000 kW	15,000 – 5,000 kW	Below 5,000 kW
Before 1983	205	215	225
1984 - 2000	185	195	205
2001 +	175	185	195

[4] IMO, 2009, Second IMO GHG Study 2009

> Specific Fuel Consumption (Auxiliary Engine), SFC_{AE}:

Engine age	MCR_{AE} > 800 kW	MCR_{AE} < 800 kW
Any	220 g/kWh	230 g/kWh

> Power (Main Engine), P_{ME}: = 0.75 MCR_{ME}

> Power (Auxiliary Engine), P_{AE}:

MCR_{ME}	> 10,000 kW	< 10,000 kW
P_{AE}	$=(0.025*MCR_{ME})+250$	$0.05*MCR_{ME}$

> Ship Speed, V_{ref}: Design Speed

> Capacity:

- 100% deadweight, for bulk carriers, tankers, gas tankers, ro-ro cargo and general cargo ships
- 70% deadweight, for container ships
- 100% gross tonnage for passenger and ro-ro passenger ships

> CO_2 Conversion Factors, C_F:

Fuel Type	Carbon Content	C_F (t-CO_2/t-Fuel)
Diesel/Gas Oil (DGO)	0.875	3.206
Light Fuel Oil (LFO)	0.86	3.151
Heavy Fuel Oil (HFO)	0.85	3.114
Liquified Petroleum Gas (LPG)		
> Propane	0.819	3.000
> Butane	0.827	3.030
Liquified Natural Gas (LNG)	0.75	2.750
Methanol	0.3750	1.375
Ethanol	0.5217	1.913

Table 1: EVDI assumptions

3.1.3 Ship types

The categories of ship used for the derivation of comparative GHG Ratings predominantly follow those in MARPOL, Annex I (Revised 2021)[5] :

01	Bulker
02	Chemical tanker
03	Container
04	Crude & products tanker
05	Cruise ship
06	General cargo
07	LNG carrier
08	Gas carrier
09	Refrigerated cargo ship
10	Vehicle carrier
11	Ro-ro passenger
12	Ro-ro cargo ship
13	Combination carrier

Table2: Ship types for peering

Non-standard propulsion: The EEDI, as presently constructed, is not designed or intended for application to vessels with a non-conventional propulsion system. It is anticipated that the IMO will develop refined parameters, formulas, and reference baselines for these ships in the near future. These vessels (including LNG and passenger vessels which have diesel-electric, turbine, and other non-conventional means of propulsion) do not have calculated EVDI's and GHG Ratings in the system.

3.2 Speed corrected GHG Rating

3.2.1 Definition of the new GHG Rating methodology:

A ship's CO_2 emission (gCO_2/ton.nm) at the reference speed (V_{ref}) of the slowest moving vessel in the target ship's peer group.

[5] IMO, International Convention for the Prevention of Pollution from Ships (MARPOL), Annex I .

3.2.2 Methodology

The sea trial and associated speed-power performance data is obtained within the IMO framework and guidelines to arrive at a no wind, no wave, no sea current, depth and water temperature correction. However, there is a gap, as identified from various surveys and discussions with the market, wherein sea trials are completed at ballast draft conditions, or as single or few point speed trial runs, which are then extrapolated to form the whole curve.

Considering the above limitations, a theoretical approach based on principles of naval architecture, specifically around the 'Admiralty Coefficient' - sometimes referred to as propeller law - is taken to arrive at a speed corrected $gCO_2/t.nm$. This coefficient is also referenced in the EEXI guidelines[6] Section 2.2.3:

Admiralty Coefficient:

$$\text{Propulsion Power (P)} \propto \frac{\Delta^{\frac{2}{3}} .\ Speed^3}{Constant}$$

Where Δ = Displacement

At a defined displacement and (EEDI/EVDI/EEXI) draught condition:

$$\text{Propulsion Power (P)} \sim Speed^3$$

At power P_{ME} and associated Speed V_{ref}, this becomes:

$$P_{ME} \propto V_{ref}^3 \qquad \text{--- (1)}$$

3.2.3 Assumptions

This section discusses various terms and aspects of the EEDI/EVDI/EEXI formula and their relationship with the Admiralty Coefficient leading into the speed corrected approach.

EEDI/EVDI/EEXI (g CO_2/DWT-NM) =

Main engine emissions — *Aux. engine emissions* — *Aux. engine energy savings* — *Main engine energy savings*

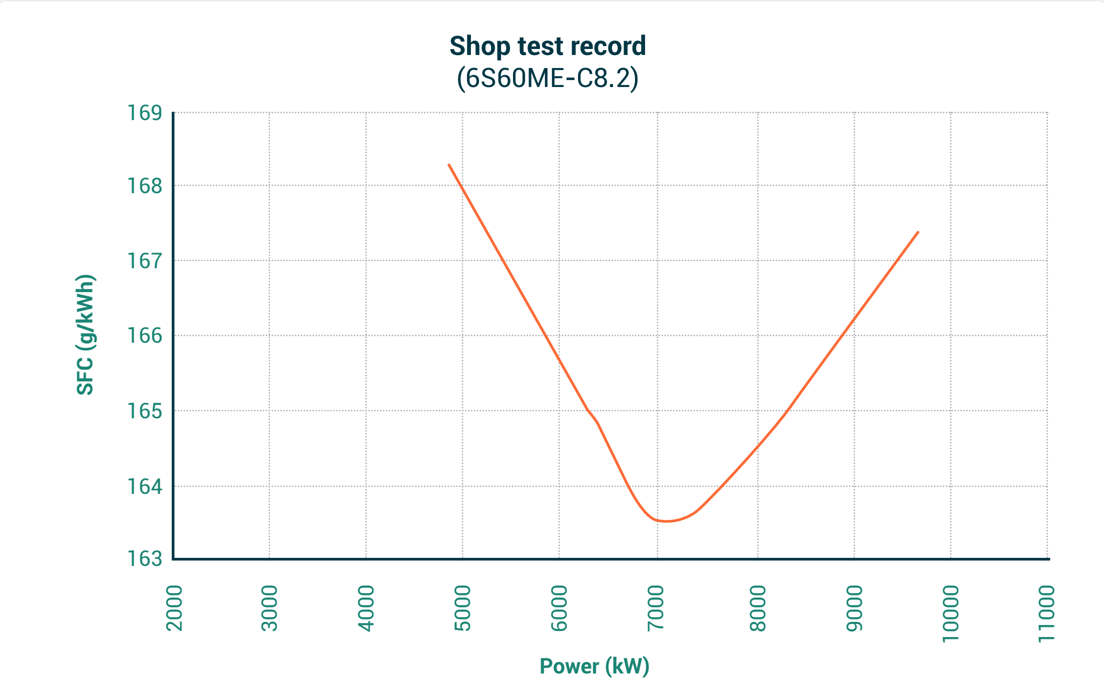
$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE}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

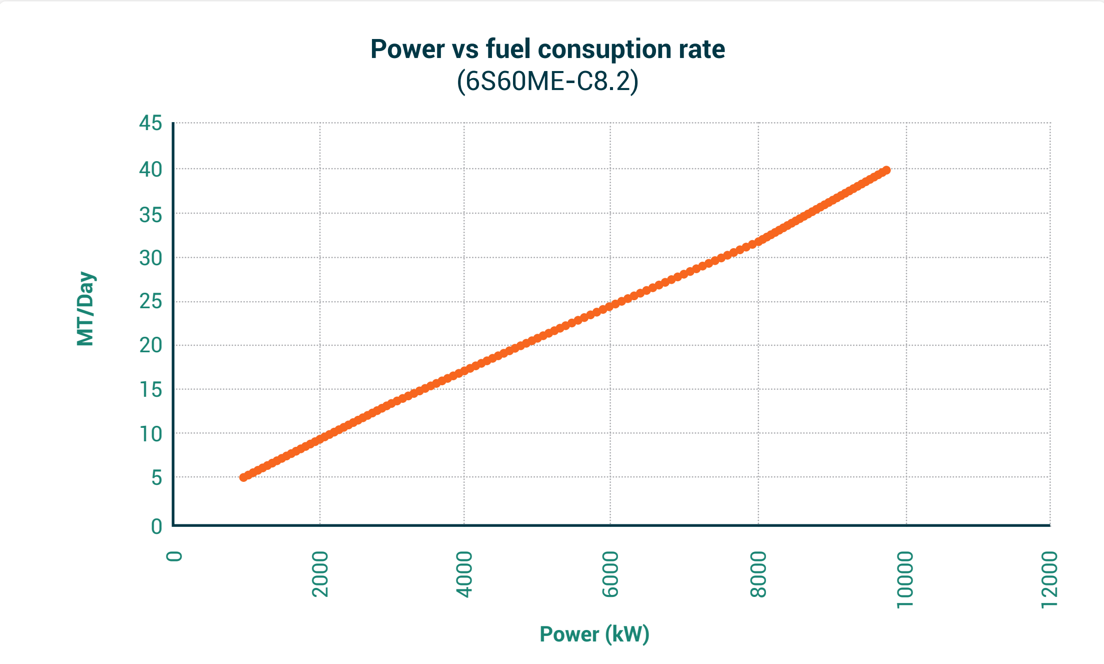
Transport works

[6] IMO, 2021, 2021 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY EXISTING SHIP INDEX (EEXI). Resolution MEPC 333 (76). International Maritime Organization, London, UK

a. Main engine emissions

While Power (kW) and SFC (g/kW-hr) are parabolically related as per test bed reports, Power is directly related to fuel consumption rate and hence CO_2 emissions.





POWER (P_{ME}) α Fuel consumption rate (g/hour)
where Fuel consumption rate (g/hour) = P_{ME}*(SFC@P_{ME})

Correlating from (1) **Fuel consumption rate α V_{ref}^3** --- (2)

b. Auxiliary engine emissions

Reference EEDI guidelines[7] Section 2.2.5.6, the power of auxiliary engines (PAE) is dependent on the propulsion engine power. Hence in accordance with point a above and ignoring the constants in referenced sections, broadly:

$$P_{AE} \propto P_{ME}$$

Thus, correlating from (1) and (2), **Fuel consumption rate α V_{ref}^3** --- (3)

c. Auxiliary engine energy savings

This factor has no dependency on PME so will be treated as constant in the speed corrected approach. Additionally, the contribution of this factor is minimal when compared to the emissions and energy savings referenced in assumption (a) above and (d) below.

d. Main engine energy saving devices

a. Air lubrication

Reference innovative technology guidelines[8] Section 1, this system operates by reducing the power demand from the propulsion engines to run at the same V_{ref}. With reference to the EEDI/EVDI/EEXI equation, the Admiralty Coefficient is still applicable with such technologies as they offset the curve while preserving its nature.

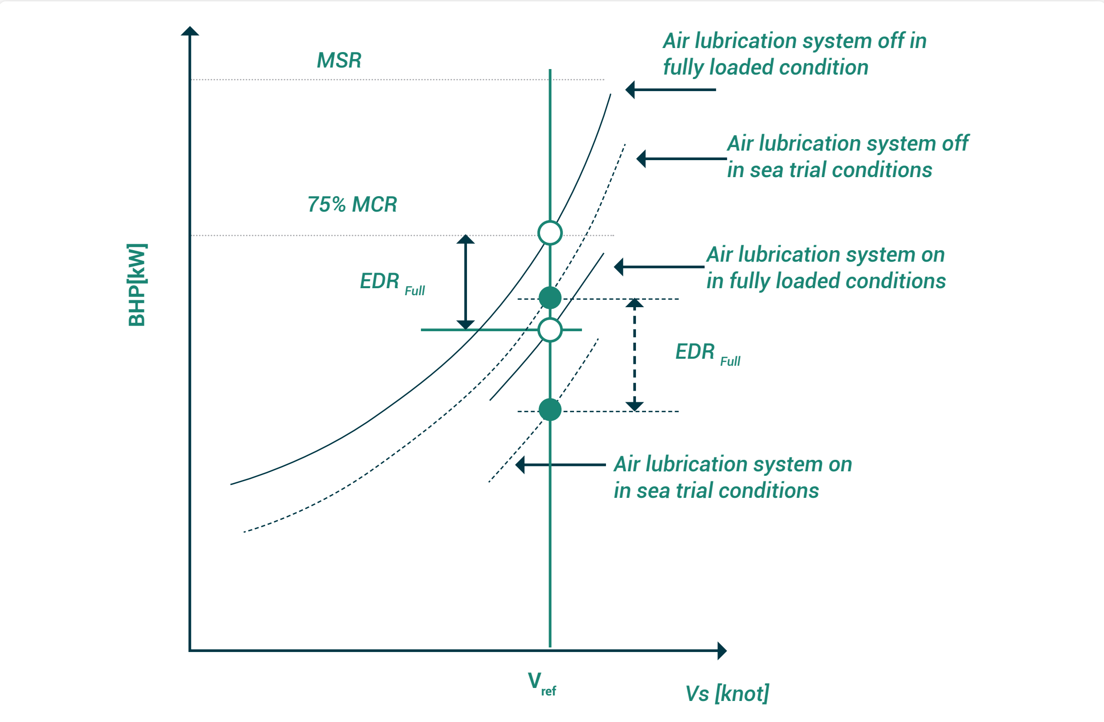


Figure 1: Offset of the speed-power curve power due to air lubrication

[7] IMO, 2018, 2018 GUIDELINES ON THE METHOD OF CALCULATION OF THE ATTAINED ENERGY EFFICIENCY DESIGN INDEX (EEDI) FOR NEW SHIPS. Resolution MEPC 308 (73). International Maritime Organization, London, UK.

[8] IMO, 2021, 2021 GUIDANCE ON TREATMENT OF INNOVATIVE ENERGY EFFICIENCY TECHNOLOGIES FOR CALCULATION AND VERIFICATION OF THE ATTAINED EEDI AND EEXI. MEPC.1/Circ.896. International Maritime Organization, London, UK.

b. Wind Assisted Propulsion Systems (WAPS)
Reference innovative technology guidelines[9] Section 2.3:

The available effective power of wind assisted propulsion systems as innovative energy efficient technology is calculated by the following formula:

$$(f_{eff} \cdot P_{eff}) = \left(\frac{1}{\sum_{k=1}^{q} W_k}\right) \cdot \left(\left(\frac{0.5144 \cdot V_{ref}}{\eta_D} \sum_{k=1}^{q} F(V_{ref})_k \cdot W_k\right) - \left(\sum_{k=1}^{q} P(V_{ref})_k \cdot W_k\right)\right)$$

$F(V_{ref})k$ is $F(V_{ref})_k = (\Delta C_{Fx})_k * (0.5\ \rho\ V_k^2\ A)$ the force matrix of the respective wind assisted propulsion system for a given V_{ref}. It represents the propulsion force in kilo Newton (kN) for the respective wind speed and angle.

Under no wind conditions in which a sea trial corrected curve is obtained, Vk = V_{ref}, therefore:

$\mathbf{f_{eff} \cdot P_{eff}\ \alpha\ V_{ref}^3}$

Implementing (2) converts this relationship to:

Fuel consumption saving rate α $V_{ref}3$ -- (4)

e. Formulation

Broadly, the above assumptions can be bundled together to conclude that the numerator in the EEDI/EVDI/EEXI calculation is approximately related to the vessel speed (V_{ref}) following the Admiralty Coefficient and linear relationship of power and fuel consumption rate.

Fuel consumption rate α $V_{ref}3$ -- (5)

The fuel consumption multiplied with corresponding carbon factor of the fuel type results in:

CO_2 emission α $V_{ref}3$ -- (6)

It should also be noted that the contribution of propulsion machinery emissions in EEDI/EVDI/EEXI formula is much more than auxiliary emissions present in the formula.

Removing the constants, the EEDI/EVDI/EEXI equation converts to the below approximation:

$$\text{EEDI/EVDI/EEXI}\ \alpha\ \frac{Cost\ to\ society}{Benefit\ to\ society} = \frac{CO2\ Emission}{Transport\ work} = \frac{CO2\ emission}{DWT\ x\ Speed}\ \alpha\ \frac{Speed^3}{DWT\ x\ Speed}$$

At Speed = V_{ref} EEDI/EVDI/EEXI α (V_ref^3)/V_ref -- (7)
EEDI/EVDI/EEXI α V_ref^2 -- (8)

Therefore, at any speed V_2, $\frac{E_2}{E_1} = \frac{V_2^2}{V_{ref}^2}$ where E_1 = EEDI/EVDI/EEXI

and E_2 = Speed Corrected Intensity (SCI)

[9] IMO, 2021, 2021 GUIDANCE ON TREATMENT OF INNOVATIVE ENERGY EFFICIENCY TECHNOLOGIES FOR CALCULATION AND VERIFICATION OF THE ATTAINED EEDI AND EEXI. MEPC.1/Circ.896. International Maritime Organization, London, UK.

3.2.4 Sample calculation

Attained EEXI = 4.00 gCO_2/t.nm
V_{ref} = 13.45 knots
New reference speed = 12.0 knots (assumed V_{ref} of slowest moving vessel in the peer group)

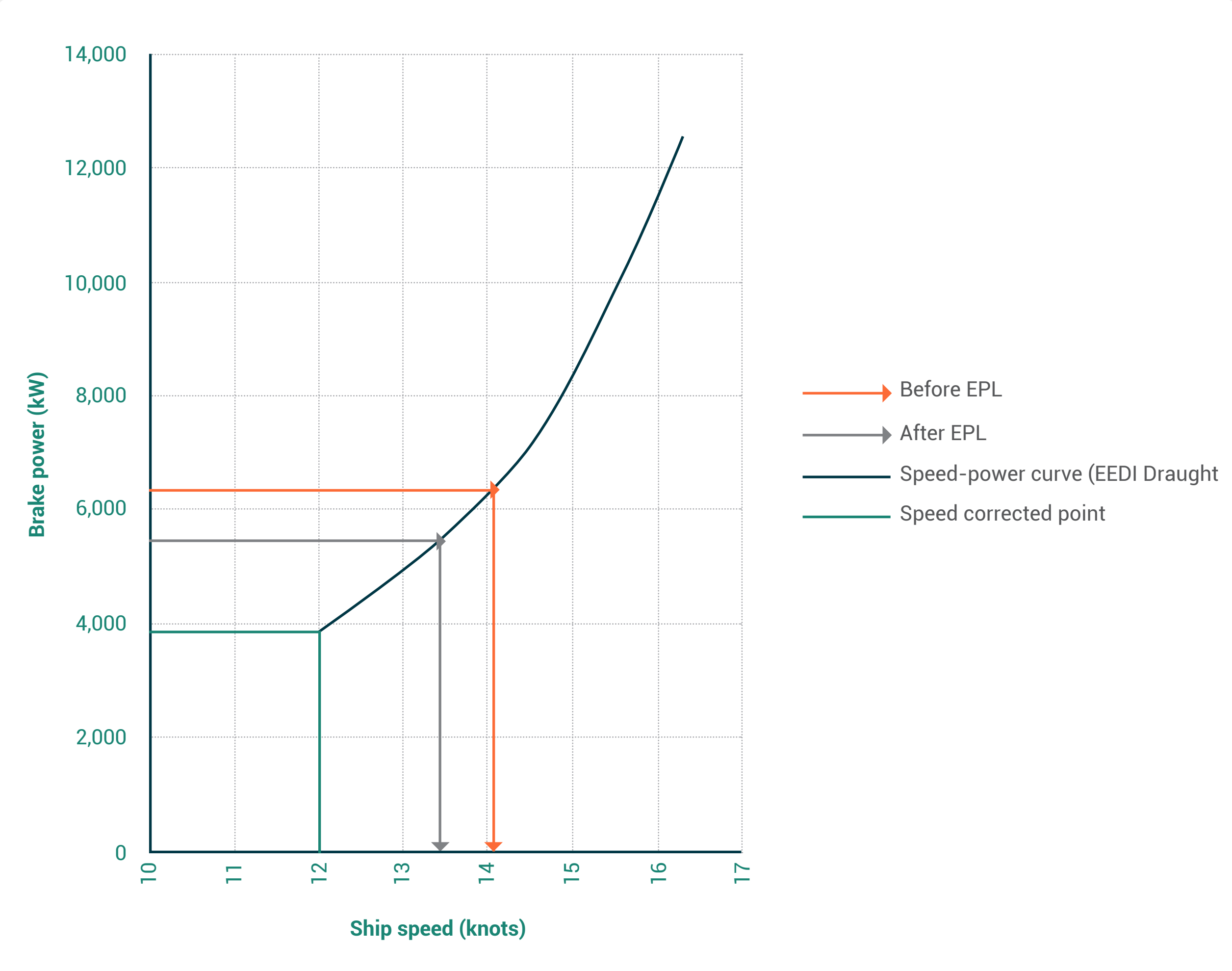


Figure 2: Speed power curve

Therefore, using (8) approximate emission intensity of this vessel at any speed on its EEDI draught can be calculated as:

$$\frac{E_2}{E_1} = \frac{V_2^2}{V_{ref}^2}$$

Where
E_2 = Speed corrected intensity at the new speed, gCO_2/ton-mile
E_1 = EEDI/EEXI, gCO_2/ton-mile
V_2 = Reference speed (in knots)
Using equation (8): E2 = E1 * $(V2/V_{ref})^2$
= 4.00 x $(12/13.45)^2$ = 3.18 gCO_2/ton-mile

Speed corrected intensity (SCI) at 12 knots = 3.18 gCO_2/ ton-mile

3.2.5 Speed corrected sample outlook

The calculation explained in section 3.2.4 above will be applied to all vessels in that peer group. The below image is an insight into the emission intensity distribution before and after the speed correction, where a reference speed of the slowest moving vessel in the peer is applied.

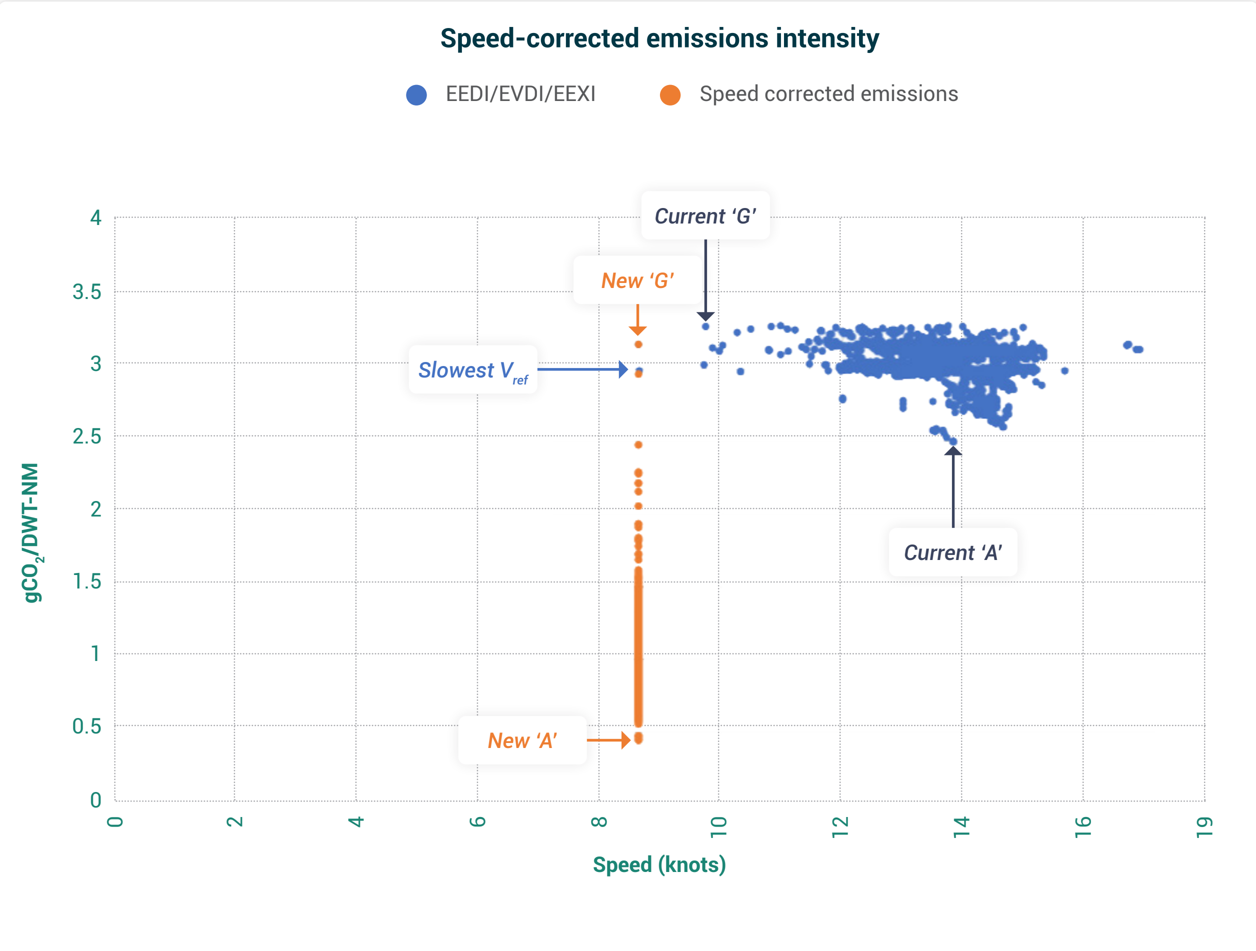


Figure 3: Speed corrected intensity (gCO_2/T.NM)

3.3 GHG Rating A - G scale

A vessel's GHG Rating is presented using the A-G energy efficiency scale and relative performance is rated with the most efficient vessels awarded A, the least efficient awarded G.

Figure 4: GHG Rating A - G scale

The GHG Rating size group is based on the size score, which indicates the number of standard deviations by which a vessel varies from the average for similar sized vessels of the same ship type.

If the distribution of the size scores exactly fit a normal distribution, the score ranges would match the fixed percentiles of the data set mentioned in Figure 5. The vessel's position on the A-G scale is determined by the size score and GHG Rating key as follows:

GHG Rating	G	F	E	D	C	B	A
Size score	< = -2.0	> -2.0	> -1.0	> -0.5	> 0.5	> 1.0	> 2.0
Area under curve	2.5%	13.5%	16%	36%	16%	13.5%	2.5%

Figure 5: GHG Rating key

The bell curve below in Figure 6 shows the percentage distribution with the corresponding letter displayed in the appropriately coloured area under the curve. The x-axis is expressed as a count of standard deviations which matches the size score in the key.

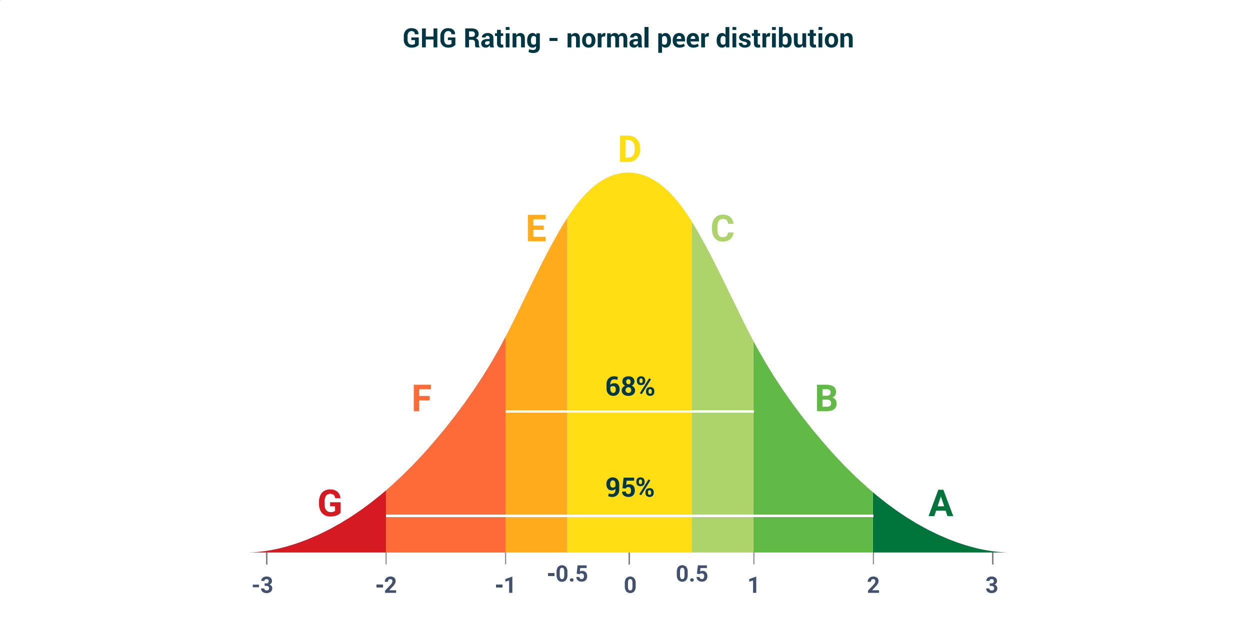


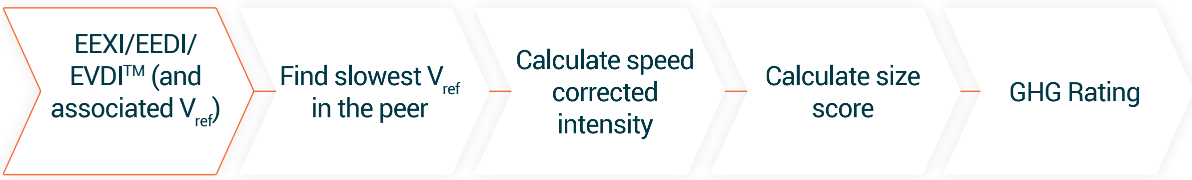
Figure 6: GHG Rating key – normal peer distribution

It is important to note that as each vessel size group is a subset of the entire ship type group, the percentages within each subset's size group will have some variability from these percentages.

3.3.1 GHG Rating calculation

Once a peer group is selected, EEXI and related V_{ref} is the preferred metric. However, if this is not provided, then EVDI or EEDI and the associated V_{ref} is selected accordingly. Thereafter, the speed correction as explained in Section 3.2.4 is conducted.

Once the SCI is arrived at for all the vessels in a peer group, a size score is calculated indicating a vessel's position on the Bell distribution profile. The size score thus enables a GHG Rating to be allocated to the vessel.



3.3.1.1 The size score

A size score is a standard measure of the variation of an individual value from a normally distributed average, with a mean of zero and a standard deviation of one. It is calculated by the below formula:

$$\text{Size score} = \frac{(\hat{y}-y_i)}{\sigma}$$

Where:

- y_i is the subject vessel's speed corrected intensity;
- $\hat{y}$ is the weighted mean of speed corrected intensity of the peer vessels; and
- σ is the standard deviation of the speed corrected values for the sampled peer vessels.

The sizescore is the value used in the allocation of A-G ratings to vessels.

3.3.2 Natural adjustment

The GHG Rating is dynamic and will almost always use a different subsample group of vessels for each calculation. As older vessels are scrapped, new vessels are commissioned, or existing retrofits/upgrades are verified at sea trials, the relative performance of the peer group improves, and vessels will be rated against a new average.

3.3.3 Retrofits and upgrades

Vessels that invest in eco-efficiency technologies and/or measures such as waste heat recovery systems or propeller ducts are eligible for recognition from RightShip. Approved enhancement measures will have a plus (+) sign adjoined to their GHG Rating, as shown for the B rated vessel below:

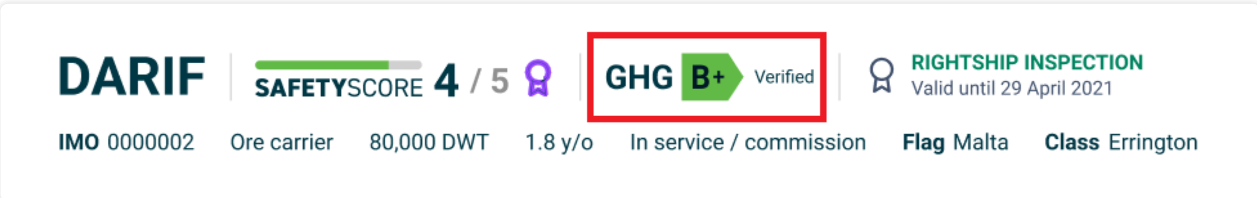


Figure 8: A plus (+) sign is adjoined to a vessel's GHG Rating for recognised retrofits and/or upgrades

RightShip believes it is important to acknowledge and reward owners who have invested capital in systems to operate their vessels above compliance and the plus (+) notation helps to increase the visibility of these endeavours. Aside from the plus (+) notation, the types of Energy Saving Devices deployed are featured for each respective vessel on the Platform.

3.3.4 Sister ships

Some sister ships will have a different GHG Rating. A vessel's EEDI/EVDI/EEXI value is based on many parameters and if any of these parameters - Deadweight, Fuel type, Energy Saving Devices upgrades for example - differ between sister ships it will lead to a different value and therefore a different speed corrected value. This therefore can move them into a different rating bracket.

3.3.5 Comparing existing ships' CO_2 emissions

RightShip's GHG Rating methodology segregates vessels by type and capacity. The major ship types and their calculation subsample criteria are shown below:

Ship type	Capacity (Subsample basis)	Peer range (+/- % of capacity)	Minimum vessels in peer
Bulker	DWT	10%	40
Chemical tanker	DWT	10%	40
Container	TEU	10%	40
Crude & products tanker (inc. OBO)	DWT	10%	40
Cruise	GT	10%	40
General cargo	DWT	10%	40
LNG tanker	CBM	10%	40
LPG tanker (Gas carrier)	CBM	10%	40
Refrigerated cargo ship	DWT	10%	40
Vehicle	DWT	10%	40

Table 3: Peer selection criteria

The 'Peer range (% of capacity)' column indicates the subsample of vessels included in the size score calculation for each ship type. For example: for a bulker vessel 'X' with a DWT 100,000, the subsample will contain bulker vessels in the range 90,000 to 110,000 DWT. If there are less than 40 vessels within the 10% DWT range, then the nearest 40 vessels in terms of capacity will be used to ensure sound statistical comparison. The number of peers in comparison and DWT range considered is shown by the peer group.

Figure 9: Peer group range

Detailed analysis of size scores across RightShip's database shows that the method used to develop a comparative rating of size scores as a component of the RightShip GHG Rating is applicable across the different ship types. The method therefore provides a statistically valid means of comparing the energy efficiency of existing ships.

Notwithstanding a vessel's individual size, speed, and year of build it is possible to demonstrate that certain vessels are simply designed more efficiently, and it is important that this is factored into the decision-making process.

Retrofits and upgrades such as changes to ship design, propulsion and machinery may help to improve a vessel's GHG Rating. Any upgrade or retrofit which has been verified by a classification society can be submitted to RightShip, together with new EEXI certificate enabling the GHG Rating to be recalculated. A vessel's GHG Rating does not consider operational measures such as slow steaming or eco speeds.

By focusing on design, a more meaningful outcome is achievable - enabling a like-for-like comparison and a score which demonstrates how efficiently the vessel can be operated. This benchmark can then be supplemented by operational measures when the ship is in use.

RIGHTSHIP

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November 2022