

Further reading on EEOI

Indicator Definition

- Indicator = $M_{CO_2} / \text{Transport Work}$, i.e. the ratio of the mass of $CO_2(M)$ emitted, per unit of transport work carried out;

$$\sum_j FC_j \times C_{Fj}$$

EEOI = ----- (this is the basic expression of EEOI for a voyage)

$$m_{\text{cargo}} \times D$$

- Where, the average of the indicator for a period or for a number of voyages is obtained, the Indicator is calculated as

$$\sum_i \sum_j (FC_{ij} \times C_{Fj})$$

Average EEOI = ----- this expression of EEOI does not give a simple average of the EEOI, among number of voyage

i) **Eqn. Z**
$$\sum_i \sum_j (FC_{ij} \times C_{Fj})$$

where,

j = the type of the fuel; **i** = the voyage number; **FC_{ij}** = the mass of consumed fuel j at voyage i; **C_{Fj}** = Mass conversion factor of fuel j to CO_2 ; **m_{cargo}** is the cargo carried in tonnes or work done (number of TEU or passengers) or gross tonnes for passenger ships; and, **D** = distance in nautical miles corresponding to the cargo carried or work done.

The unit of the EEOI depends on the measurement of cargo carried or work done, e.g. tonnes CO₂ / (tonnes. miles); tonnes CO₂ / (TEU. nautical miles); tonnes CO₂ / (person. nautical miles), etc.

CF is a non-dimensional conversion factor between fuel consumption measured in g and the CO₂ emission also measured in g as based on carbon content. The value of CF is as follows:-

| Type of Fuel | Reference | Carbon content | CF(t-CO ₂ /t-fuel) |
|------------------------------|---------------------------------|----------------|-------------------------------|
| Diesel / Gas Oil | ISO 8217 Grades DMX through DMC | 0.875 | 3.206000 |
| Light fuel oil(LGO) | ISO 8217 Grades RMA through RMD | 0.86 | 3.151000 |
| | ISO 8217 Grades RME through RMK | 0.85 | 3.114400 |
| Liquefied Petroleum Gas(LPG) | Propane | 0.819 | 3.000000 |
| | Butane | 0.827 | 3.030000 |
| Liquefied Natural Gas(LNG) | | 0.75 | 2.750000 |

Rolling Average: This concept when used, can be calculated in a suitable time period, e.g. one year closest to the end of a voyage for that period, or number of voyages, e.g. 6 Or 10 voyages, which are agreed as statistically relevant to the initial averaging period. The "rolling average EEOI is then calculated for this period or number of voyages by the equation, "Equn. Z" as shown above.

Fuel Consumption: FC, i.e. all the fuel consumed at sea and in port or for a voyage or period in question, e.g. a day, by main and auxiliary engines including boilers and incinerators.

Distance Sailed: the actual distance sailed in nautical miles (deck log-book data) for the voyage or period in question.

Voyage: the period between a departure from a port to the departure from the next port. (Other definitions are also acceptable)

Ship and cargo applicable to the guidelines:

- Dry cargo carriers
- Tankers
- Gas tankers
- Container ships
- Ro-ro cargo ships
- General cargo ships
- Passenger ships including ro-ro passenger ships

Cargo includes: -

- All gas, liquid and solid bulk cargo
- General cargo
- Containerized cargo (including the return of empty units)
- Break bulks
- Heavy lift
- Frozen and chilled goods,
- Timber and forest products
- Cargo carried on freight vehicles
- Cars and freight vehicles on ro-ro ferries and passengers (for passenger and ro-ro passenger ships)

Cargo Mass Carried or work Done: In general, cargo mass carried or work done is expressed as follows:

- For dry-cargo carriers, liquid tankers, gas tankers, ro-ro cargo ships and general cargo ships, metric tonnes(t) of the cargo carried should be used;
- For container ships solely carrying containers, number of containers (TEU) or metric tons(t) of the total mass of cargo and containers should be used;
- For ships carrying a combination of containers and other cargoes, a TEU mass of 10 t could be applied for loaded TEUs and 2t for empty TEUs; and,
- For passenger ships, including ro-ro passenger ships, number of passenger or gross tonnes of the ship should be used;
- Certain ro-ro vessels, which carry a mixture of passengers in cars, foot passengers and freight, operators may wish to consider some form of weighted average based on the relative significance of these trades for their particular service or the use of other parameters or indicators as appropriate.

In some particular cases, the work done can be expressed as follows:-

- For car ferries and car carriers, number of car units or occupied lane meters;
- For container ships, number of TEUs (empty or full); and,
- For railway and ro-ro vessels, number of railway cars and freight vehicles, or occupied lane meters

General Data Recording and Documentation Procedures

The collection of data from ships, should include the type of cargo being carried, the actual distance travelled (from the ship's log book), the quantity and type of fuel used (as per the Bunker Delivery Note), and all information regarding the fuel that is liable to affect the amount of CO₂ emitted. Ideally speaking, the data used should be uniform so that the related information can be easily collated and analyzed to facilitate the eliciting of the necessary information.

Monitoring and Verification

Documented procedures to monitor and measure the required parameters, on a regular basis, ought to be developed and maintained. Parameters to be considered for establishing the procedures for monitoring could include: -

- Identification of the operations / activities, with their impact on the performance;
- Identification of data sources and measurements that are necessary, and specifications of the format;
- Identification of frequency and personnel performing measurements, and,
- Maintenance of quality control procedures for the verification procedures.

The results of this type of self-assessment could be reviewed and used as indicators of the system's success and reliability, as well as identifying those areas in need of corrective action or improvement. In order to avoid unnecessary administrative burdens on ship's staff, it is recommended that the monitoring of an EEOI should be carried out by the shore staff, utilizing the data obtained from the required records viz. official and engineering log books and oil record books, etc.