

Figures from Countdown Explainer: How IMO LCA Guidelines work in the NZF

Countdown to IMO NZF
2025



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

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How the IMO LCA Guidelines connect to NZF compliance

Fig 1

IMO Net-Zero Framework

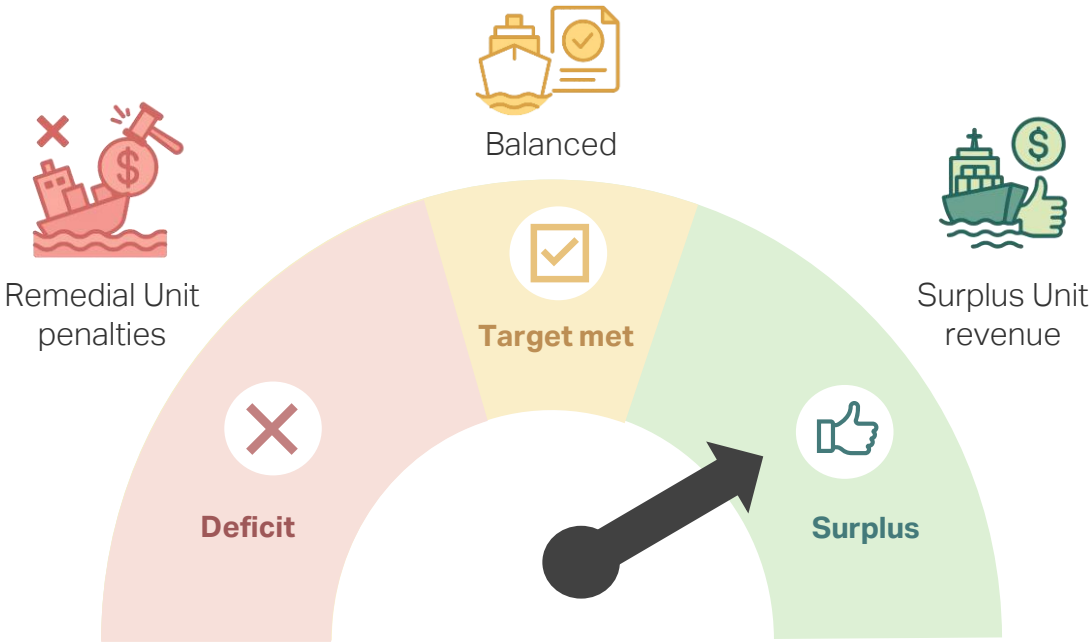
IMO LCA Guidelines

2024 LCA Guidelines are found in Resolution MEPC.391(81)

Methods to calculate **emission factors**



IMO NZF Compliance Balance



GHG Fuel Intensity (GFI)
(gCO₂eq/MJ)

The formula for the attained GFI can be found in *IMO NZF, Regulation 33*



Overview of the key elements in the 2024 LCA Guidelines

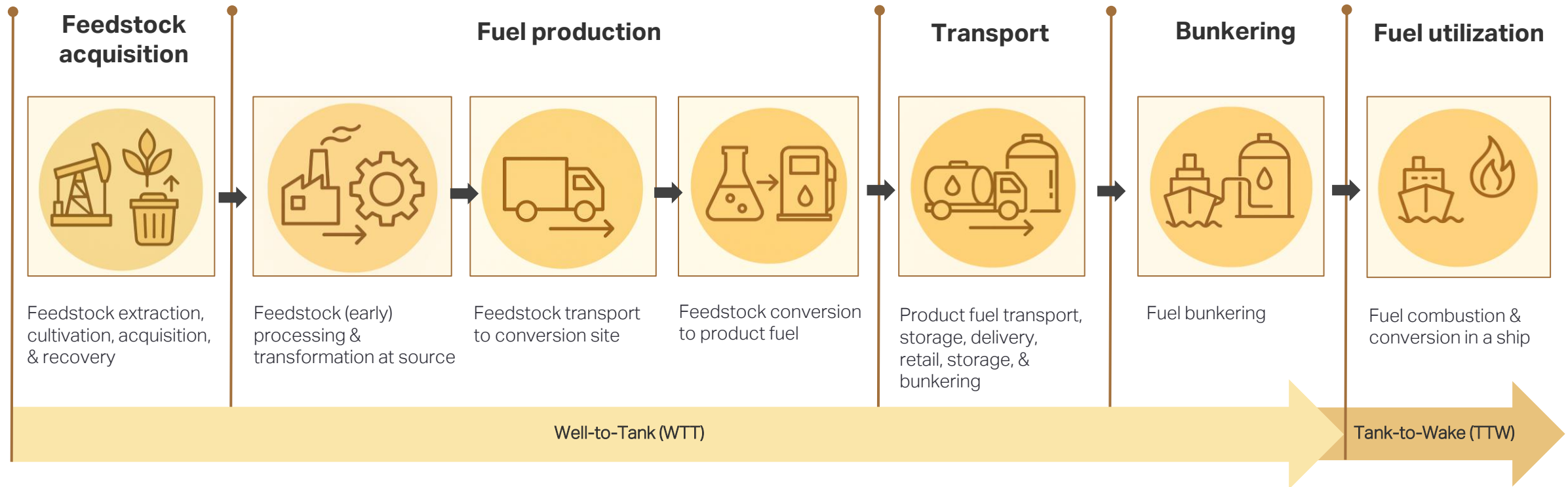
Table 1

Scope	Full life cycle emissions including upstream (WTT) and use onboard (TTW).
Well-to-Tank (WTT) coverage	Emissions from fuel/feedstock sourcing, production, conversion, transport, and bunkering.
Tank-to-Wake (TTW) coverage	Emissions resulting from fuel utilization onboard (e.g., combustion), including potential leaks (fugitive emissions and slip), when relevant for the GHG assessment.
Well-to-Wake (WTW) coverage	Sum of the WTT and TTW emissions: full life cycle GHG emissions for a given fuel from sourcing of feedstock to the fuel use onboard a vessel in an energy converter.
Emissions covered	CO ₂ , CH ₄ , N ₂ O
System boundaries	Feedstock sourcing, feedstock transport, fuel production, fuel conversion, fuel transport, fuel distribution, fuel bunkering, and onboard use (fuel combustion).
Methodological approach	Attributional LCA. Quantification per segment to the overall GHG intensity of the final fuel or energy product. Expansion of the boundaries can be considered on a case-by-case basis.
Life cycle stages	1. Feedstock extraction/cultivation/acquisition/recovery; 2. Feedstock (early) processing/ transformation at source; 3. Feedstock transport to conversion site; 4. Feedstock conversion to product fuel; 5. Product fuel transport/storage/delivery/retail storage/bunkering; and 6. Fuel utilization onboard a ship.
Functional unit	Grams CO ₂ equivalent per megajoule of fuel delivered to the ship (gCO ₂ eq/MJ).



System boundaries of the LCA Guidelines

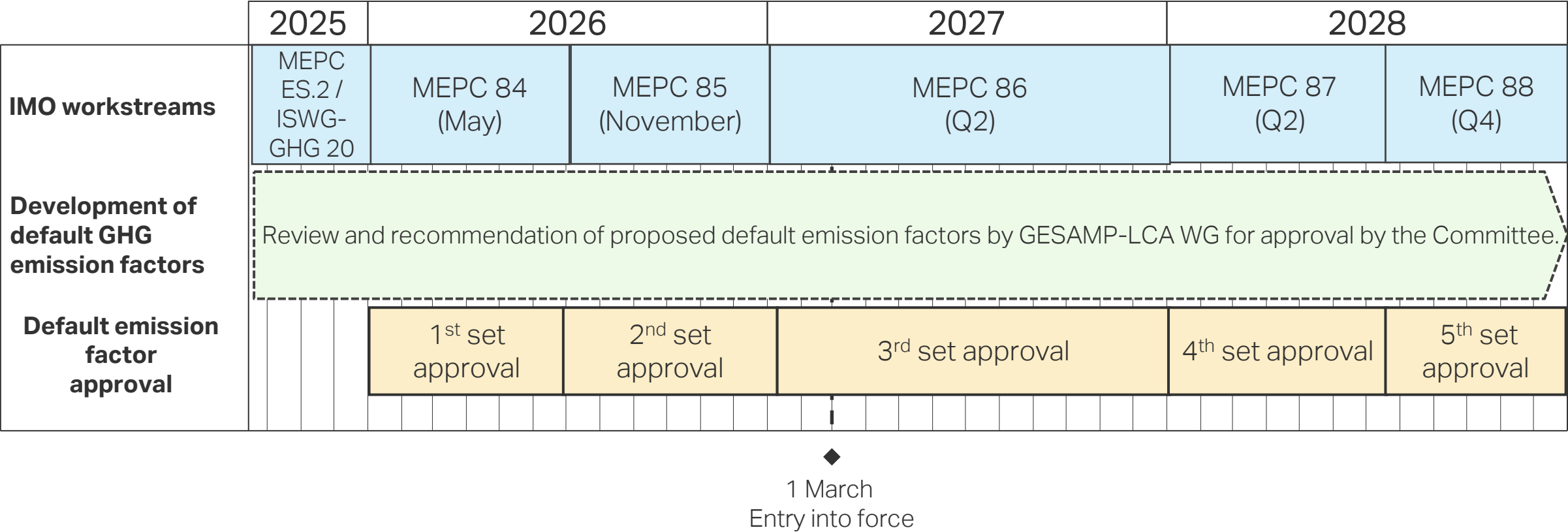
Fig 2



Timeline for default emission factor review and approval

Adapted from MEPC ES 2/3

Fig 3



GHG fuel intensity calculation methodology

Example with heavy fuel oil (HFO)

Fig 4

Inputs

Heavy fuel oil (HFO) with very low sulfur

Fuel Type	LCV (MJ/g)	WTT	TTW		
		(CO ₂ eq/MJ)	C _f CO ₂ (gCO ₂ /gfuel)	C _f CH ₄ (gCH ₄ /g fuel)	C _f N ₂ O (gN ₂ O/g fuel)
HFO (0.10 < S ≤ 0.50%)	0.0402	16.8	3.114	0.00005	0.00018

Values from the 2024 IMO LCA Guidelines
MEPC.391(81) Appendix 2

Global Warming Potential (GWP)

GHG	TTW GWP100
CO ₂	1
CH ₄	28
N ₂ O	265

GWP is a metric expressing the climate impact of non-CO₂ gases relative to CO₂ over a 100-year period. Values are from the 2024 LCA Guidelines.

MEPC.391(81) referencing IPCC AR5 report

Calculation

Tank-to-Wake (TTW)

$$\text{GHG}_{\text{TTW}} = \left(1 - \frac{1}{100} (C_{\text{ship_ship}} + C_{\text{fug}})\right) \times (\text{GWP}_{\text{CO}_2} \times C_f \text{CO}_2 + \text{GWP}_{\text{CH}_4} \times C_f \text{CH}_4 + \text{GWP}_{\text{N}_2\text{O}} \times C_f \text{N}_2\text{O}) + \left(\frac{1}{100} (C_{\text{ship_ship}} + C_{\text{fug}}) \times C_{\text{sfx}} \times \text{GWP}_{\text{fuelx}}\right) - S_{\text{Fc}} \times e_c - S_{\text{Fccu}} \times e_{\text{ccu}} - e_{\text{occs}}$$

With C_{slip_ship}, C_{fug}, S_{Fc}, e_c, S_{Fccu}, e_{ccu}, e_{occs}, C_{sfx}, GWP_{fuelx} = 0

$$\Leftrightarrow \text{GHG}_{\text{TTW}} = (\text{GWP}_{\text{CO}_2} \times C_f \text{CO}_2) + (\text{GWP}_{\text{CH}_4} \times C_f \text{CH}_4) + (\text{GWP0 for HFO}_{\text{N}_2\text{O}} \times C_f \text{N}_2\text{O})$$

$$\Leftrightarrow \text{GHG}_{\text{TTW}} = (1 \times 3.11) + (28 \times 0.00005) + (265 \times 0.00018) = 3.16 \text{ gCO}_2\text{eq/g fuel}$$

$$\Leftrightarrow \text{GHG}_{\text{TTW}} = \frac{\text{GHG}_{\text{TTW}}}{\text{LCV}} = \frac{3.16}{0.0402} = 78.68 \text{ gCO}_2\text{eq/MJ}$$

Well-to-Wake (WTW)

Adding the well-to-tank (WTT) result to the TTW value gives the full WTW GHG emission intensity:

$$\text{GHG}_{\text{WTW}} = \text{GHG}_{\text{WTT}} + \text{GHG}_{\text{TTW}} = 78.68 + 16.8$$

$$\Leftrightarrow \text{GHG}_{\text{WTW}} = 95.48 \text{ gCO}_2\text{eq/MJ}$$



Sources and terms: The calculation includes several terms which, for simplicity, we do not define here. To find their definition and an explanation, please see the 2024 IMO LCA Guidelines (MEPC.391(81), pp.10-11). The same document also includes the GWP values (see p. 10), referencing the Intergovernmental Panel on Climate Change (IPCC) fifth Assessment Report (AR5).

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