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How is GHG intensity calculated for LNG and biofuels as marine fuel?

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On April 11, the International Maritime Organization (IMO)'s Marine Environment Protection Committee approved the 'IMO Net-Zero Framework.' Going forward, how the GHG intensity of LNG and biofuels is calculated will attract attention. Below, I explore this issue based on the new regulation and existing guidelines.

The regulation relating to the IMO Net-Zero Framework will be implemented using GHG fuel intensity (GFI).

The 'Target annual GFI' comprises two targets: a 'Base target' and a stricter 'Direct compliance target.' The Base target will decline from 89.6 gCO₂eq/MJ by 2028 (a 4% reduction from the GFI in 2008) to 65.3 gCO₂eq/MJ by 2035 (a 30% reduction compared to 2008), while the Direct compliance target will decline from 77.4 gCO₂eq/MJ by 2028 (a 17% reduction compared to 2008) to 53.2 gCO₂eq/MJ by 2035 (a 43% reduction compared to 2008). In cases where the 'Attained annual GFI' (discussed later) is larger than the Direct compliance target, ships must make up the shortfall by acquiring 'Remedial Units' from the IMO Net-Zero Fund for \$100/tCO₂eq (2028-2030; the prices from 2031 to be determined). For the part that the Attained annual GFI is larger than the Base target, ships must (1) transfer (purchase) Surplus Units from other ships; (2) use Surplus Units banked from previous reporting periods; or (3) acquire Remedial Units from the IMO Net-Zero Fund for \$380/tCO₂eq (2028-2030; the prices from 2031 to be determined). A ship can receive Surplus Units in cases where ships achieve the Direct compliance target, for the overachieved amount.

On the other hand, Attained annual GFI will be calculated, taking into account the GFI Calculation Guidelines that are to be developed by the IMO. The GHG intensity of each fuel type in that equation will be calculated on a well-to-wake basis, taking into account the 2024 LCA Guidelines, as may be amended.

The 2024 LCA Guidelines present a calculation methodology divided into well-to-tank (WtT) and tank-to-wake (TtW). WtT is calculated by adding (1) the emissions associated with the

feedstock extraction/cultivation, processing, transport and delivery, and (2) the emissions from carbon stock change caused by land use change, and then subtracting (3) soil carbon accumulation via improved agricultural management and (4) credit from CCS. For the time being, (2) the land use change component and (3) soil carbon accumulation are set to zero, pending methodological guidance to be developed by the IMO. TtW is calculated based on the emissions from fuel combustion and slippage. Where TtW values are concerned, a value calculated regardless of the carbon source (includes CO₂ emissions from biomass combustion), and a value calculated taking into account the carbon source for fuels of biogenic origins or made from captured carbon (emissions from fuel combustion and slippage, minus the biomass growth and the used captured CO₂ as carbon stock to produce synthetic fuels) are calculated.

In the case of biofuels, the (2) land use change component in WtT will attract attention. In the 2024 LCA Guidelines, this is determined as the yearly average of the difference between the carbon stock associated with the land-use in January 2008 or 20 years before the raw material was obtained, whichever was later, and that after 20 years. As an example, using the default values of the IPCC inventory guidelines to calculate a case in which the tropical rainforests of South America are converted to cropland, the figure would be 230.5gCO₂eq/MJ (with energy yield calculated at 180GJ/ha, a slightly old figure), which is well above the IMO's target. However, in a large number of cases in the future, the land use 20 years prior will be energy crops, and in those cases, the emissions of this component can be expected to be almost zero. As the GFI, emissions associated with cultivation, processing and transport will be added to this, while the CCS credits and so forth will be subtracted. Aside from the direct land use change outlined above, there is also indirect land use change, which is a change in the use or management of land that occurs outside the product system being assessed, induced by increased biofuel demand or commodity price. Because quantitative assessments of the GHG effects of indirect land use changes are uncertain, the 2024 LCA Guidelines state that quantitative values are not calculated but that a qualitative risk-based approach should be used.

For LNG's TtW, using the 2024 LCA Guidelines' default factors and assuming the percentage of fuel which escapes from the energy converter without being oxidized is 0.01-3.5%, the figure is 58.0-76.3 gCO₂eq/MJ, which ends up exceeding the IMO's targets between 2028 and 2035 (in a case where the percentage of leakage is 0.1%, the 2035 Base target is met). Additionally, if WtT is calculated with an upstream methane leakage of 2%, the figure is 31.4 gCO₂eq/MJ, and this will be added to TtW. In using LNG, it will thus be essential to reduce upstream methane leakage, utilize CCS credits, and so on.

The GHG intensity of LNG and biofuels will be discussed in the course of the amendment of the 2024 LCA Guidelines and the development of the GFI Calculation Guidelines by experts.

How the land use change (in particular the indirect land use change), soil carbon accumulation, and captured CO₂ used in synthetic fuel are to be handled will attract attention.

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