GHG EMISSION REDUCTION POTENTIAL OF FUELS

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Introduction

The Paris climate agreement targets to reduce global warming to less than two degrees Celsius by 2100 compared to pre-industrialization level. Transport carbon dioxide (CO_2) emissions represent about 23 % of global emissions (IEA, 2023) and shipping almost 3 % of global greenhouse gas (GHG) emissions (IMO, 2020). The EU has finalized the FuelEU Maritime legislation. Maritime GHG emissions will be included in the EU Emission Trade System (ETS) beginning in 2024. The International Maritime Organization (IMO) has updated its GHG targets in 2023. Both EU and IMO will use a life cycle approach for calculating GHG emissions of fuels.

The FuelEU Maritime targets to decrease the reference value of 91,16 grams of CO2 equivalent per MJ (GHG emissions) by 2% from 2025, 6% by 2030, 14,5% by 2035, 31% by 2040, 62% by 2045, and 80% by 2050 (EU, 2023). The revised IMO targets are to reduce annual GHG emissions by at least 20%, striving for 30%, by 2030, compared to 2008 and at least 70%, striving for 80%, by 2040, compared to 2008 (IMO, 2023).

However, 93,5 % of the current world fleet operates on conventional fuels and 48,7 % of ordered ships still consists of conventionally fueled ships. Of these, roughly 6% of the current world fleet and 42% of the ships on order are fossil LNG or LPG fuelled ships (DNV, 2023). Which fuels can help conventional ships to reduce their life cycle GHG emissions?

Materials and methods

The legislative life cycle GHG emission calculations are based on the product's (fuel's) life cycle assessment (LCA) according to the ISO 14040/14044 standard series (ISO, 2006). In addition, the legislative methodologies have additional requirements on, for example, allocation and use of emission factors. Alternative fuel pathways chosen for this comparison are mainly suitable for conventional ships. Alternative fuels that require different ship powertrains are presented for comparative purposes. GHG emissions of fuel pathways are from legislation or literature.

Well-to-tank (WTT) GHG emissions of fuel include raw material production and transport, fuel refining, product transport and distribution steps. Tank-to-wake (TTW) GHG emissions refer to the fuel use step. WTT and TTW together are well-to-wake (WTW) GHG emissions from the fuel's whole life cycle.

Results

Life cycle GHG emissions of fuels depend on raw material type, raw material transport type, transport distances, energy and chemical use in the chosen refining technology, product transport and distribution.

Based on the analysis, renewable fuels and e-fuels are the best alternative fuel options from the GHG reduction point of view if compared with fossil MGO fuel.

Life cycle GHG emissions for alternative fuels, in particular methanol and ammonia, are clearly higher than those of conventional fossil fuels if produced through any pathway other than bio or renewable electricity. LNG is a promising option for reducing TTW emissions, but the implications are negligible from a WTW standpoint.

Implications on sustainable maritime operation

The life-cycle GHG performance is essential for choosing suitable marine fuels. In addition, the fit for use of a fuel is equally important, especially when considering the amount of ships that are operating conventional powertrains. Renewable fuels such as co-processed fuels, HVO and FAME are drop-in fuels that offer potential for significant GHG reduction in the near-future. Storage stability, acidity, microbial growth and many other parameters are of concern in marine applications, where fuels may be stored for long periods of time in suboptimal conditions. Renewable fuels produced from waste and residue raw material, through appropriate technologies, offer a drop-in level of fit for use and confidence for the buyer. High GHG reduction potential fuels, such as renewable fuels or e-fuels, can't alone fulfill the GHG reduction demand, which is why all suitable technological solutions and their development are needed to decrease global GHG emissions of the shipping sector and hence contribute to the two degrees Celsius target.

Biomass use for energy and materials is one of the key mitigation options to reach the 1.5 °C GMT target set in the Paris Agreement, as highlighted by the IPCC and many other key analyses. Reasons to use sustainable biomass, on the one hand, and the possibilities and synergies for supplying sustainable biomass, on the other, are underpinned with strong evidence, also providing insights on how displacement issues can be avoided. Sustainable biomass supplies can contribute 20–30% of the future global energy supply, leading to reduced overall mitigation costs. (Faaij, 2022)

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