01 | 2020

CIMAC Position Paper

Zero Carbon Energy Sources for Shipping

From the Greenhouse Gas Strategy Group

The first edition of this CIMAC Position Paper was approved by the members of the CIMAC Council at its meeting on November 21, 2019.

Context for GHG Reduction in Shipping

CIMAC e.V. (International Council on Combustion Engines) is an international organization, founded in 1951 to promote technical and scientific knowledge in the large engine technology sector. CIMAC is supported by engine manufacturers, engine users, technical universities, research institutes, component suppliers, fuel and lubricating oil suppliers, classification societies and several other interested stakeholders.

As global greenhouse gas (GHG) emissions continue to rise, the need for every sector to contribute to climate change mitigation becomes even more urgent. Although not directly included in the Paris Agreement, the international shipping sector must contribute in delivering its share and needs to cut down GHG emissions too. With the Initial IMO GHG Strategy, the maritime sector has meanwhile defined its own targets for 2050: reducing CO_2 emissions per transport work by 70% in 2050 and reducing total GHG emissions by at least 50% in 2050 compared to 2008[1]. CIMAC regards the deployment of net zero or zero carbon fuels[2], in line with the *Getting to Zero Coalition*, as necessary to achieve the needed GHG emission reductions.

Zero and Net Zero Carbon Fuels

While biofuels may contribute in particular for the transitional period, and electrification and hybridization presumably playing a bigger role in short-sea and inland shipping, employing zero carbon or net zero carbon fuels seems the only way to achieve the GHG reduction level aimed for in the long-term[3], besides other technical and operational energy efficiency measures. These fuels based on hydrogen with a (net) zero carbon footprint can be produced via different pathways (Figure 1) which exist with adequate maturity.[4]

Ideally, hydrogen is produced via electrolysis using electricity from renewable energy sources such as wind, solar or hydro (Figure 2). As electrolysis and the production of renewable energy still needs to be scaled-up considerably for a global supply of hydrogen with a zero carbon footprint, alternative production pathways could enable a faster transition and an immediate reduction of GHG emissions. Carbon capture and storage (CCS) deployed with steam methane reforming of natural gas or pyrolysis could be an intermediate step to produce hydrogen with a lower carbon footprint in the near-term.[5] The establishment and upscaling of renewable energy and related fuel production pathways require time which is limited in the face of long vessel lifetimes in shipping and the urgent need to reduce GHG emissions.

Hydrogen can be transported and used either pressurized, liquefied or via a liquid organic hydrogen carrier (LOHC). Hydrogen is today used in more industry sectors than only shipping. It is expected that hydrogen with a (net) zero carbon footprint will play an important role in many industries, in order to reduce GHG emissions in line with the Paris Agreement.

The final products range from net zero carbon fuels like synthetic methanol containing carbon from renewable sources (biomass combustion or direct air capture) up to zero carbon fuels which are carbon-free such as ammonia.

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[1] Resolution MEPC.304(72)
[2] As outlined by the *Getting to Zero Coalition* which CIMAC supports.
[3] DNVGL (2019) – Maritime Forecast to 2050, p.34
[4] CIMAC White Paper 2 (2020) – Zero and Net Zero Carbon Fuel Options
[5] CIMAC White Paper 1 (2020) – Production Pathways for Hydrogen with a Zero Carbon Footprint

From hydrogen, synthetic carbon-free fuels, e.g. ammonia, and carbon-based fuels such as methane or diesel can be produced. Depending on the process (e.g. Fischer-Tropsch or methanol synthesis) further refining steps are needed. Synthesis and conditioning of these synthetic fuels have a direct impact on the cost, as additional energy consumption for fuel production requires additional investment upfront and different pathways require different infrastructures.

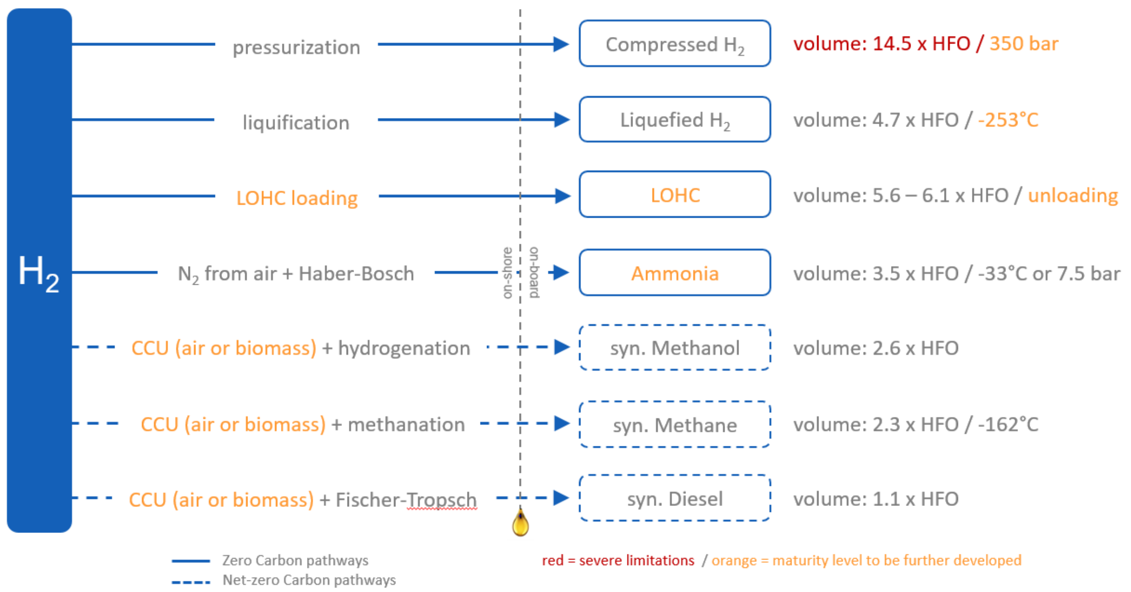

Figure 1: (Net) Zero carbon fuel production pathways (non-exhaustive); fossil pathways as transitional technologies; CCU=Carbon Capture and Utilization; SMR= Steam Methane Reforming (Source: ABB, 2020)

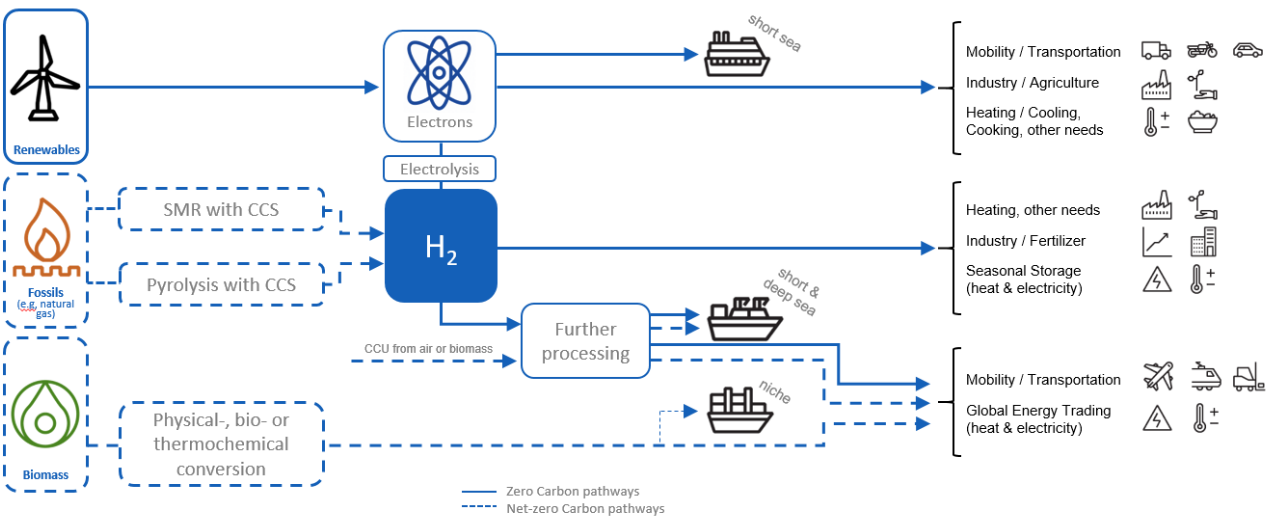

Figure 2: Simplified schematic view of hydrogen production pathways, biomass and fossil pathways as transitional technologies; CCS= Carbon Capture and Storage; CCU= Carbon Capture and Utilization; SMR= Steam Methane Reforming (Source: ABB, 2020)

International policies which are technology-neutral and based on well-to-wake GHG emission calculations are essential to trigger the huge investments needed for the maritime energy transition.

The IMO plans to finalize its GHG Strategy in 2023, including proposals on how to proceed with potential long-term measures such as deployment of alternative fuels. Hence, measures targeting the phase-in of (net) zero carbon fuels need to be considered by 2023 to create an enabling policy environment as soon as possible.

(Net) Zero carbon fuels will find application not only in maritime but also in other transport sectors and energy-demanding industries. These sectors and industries will become increasingly interlinked throughout the whole energy transition, and regarding production of hydrogen and derived fuels. In the maritime sector, the application of different propulsion systems (electrification, fuel cell, hybridization, internal combustion engines (ICE)) will vary for different ship types and consequently the applicability of the different (net) zero carbon fuel types. Even though progress in fuel cell development can be expected, its applicability in deep-sea shipping today is limited. Investments in zero carbon energy sources in shipping are required soon due to the long vessel lifetimes. Thus, the ICE will likely remain the most common propulsion technique for deep-sea shipping, complemented by other propulsion options, because of the ability to combust all these hydrogen-based fuels, biofuels and blends

CIMAC hence takes the following position:

- (Net) Zero carbon fuels represent the most promising energy carrier option for the future of shipping. Thus, the ICE is likely to remain the major prime mover in future maritime propulsion systems for deep-sea shipping, complemented by electrification and hybridization of the machinery, and potentially fuel cells.
- Hydrogen with a (net) zero carbon footprint is the starting product for the main future fuels in shipping.
- Apart from phasing-in (net) zero carbon fuels, the increase of operational and technical efficiencies continues to be a main driver to reduce GHG emissions.
- The contribution of sustainably produced biofuels (gas or liquid) as a future zero carbon energy source for deep-sea shipping can play a role in particular for the transition period, as long as volume constraints are solved without compromising the sustainability.
- To enable a faster uptake of (net) zero carbon fuels and reduction of GHG emissions, the production of hydrogen with steam methane reforming combined with CCS or pyrolysis as an intermediate step could pose as an alternative until sufficient renewable energy (and electricity) is available.
- The IMO must adopt binding measures until 2023 to phase-in net zero and zero carbon fuels and consider a well-to-wake approach. Otherwise, no investment in the production of these fuels can be stimulated to have respective amounts ready at our disposal for the 2030 decade.

Imprint

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CIMAC is the International Council on Combustion Engines, a worldwide non-profit association consisting of National and Corporate Members in 27 countries in America, Asia and Europe. The organisation was founded in 1951 to promote technical and scientific knowledge in the field of large internal combustion engines (piston engines and gas turbines) for ship propulsion, power generation and rail traction. This is achieved by the organisation of Congresses, CIMAC Circles, and other (including local) CIMAC events, and by Working Group activities including the publication of CIMAC Recommendations and other documents. CIMAC is supported by engine manufacturers, engine users, technical universities, research institutes, component suppliers, fuel and lubricating oil suppliers, classification societies, and several other interested parties.
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