Capturing the carbon in a ship

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The shipping industry is under much pressure to cut its greenhouse gas emissions in the coming years. We at Deltamarin are seeing this first-hand. Today, each of our design projects involves us examining and implementing various technologies to enhance performance and reduce the carbon footprint. We are investing heavily in our research & development to gain and maintain industry-leading knowledge of the technologies implemented on ships. One emerging technology that has maybe received less attention in the maritime greening context is post-combustion carbon capture.

In short, such a system can extract CO_2 from a ship's exhaust gases, after which the captured material is liquefied, stored onboard, and eventually discharged to shore for either permanent storage or further use. Deltamarin recently participated in a joint industry project with Total, Minerva and DNV. We studied zero-emission pathways for tankers, with carbon capture technology examined among many other options. One of the conclusions was that it could provide "the 30% step" in carbon footprint before going into more expensive low- or zero-carbon fuels.

The project has been thought-provoking and led us to scrutinise the potential applications of carbon capture further. Specifically, earlier this year, we joined forces with Wärtsilä Exhaust Treatment to study how the system could be implemented in passenger-freight ferries (ro-pax). Our partner has recently announced that it has product development underway, and the company is also installing a pilot plant at its test facility in the Norwegian Moss.

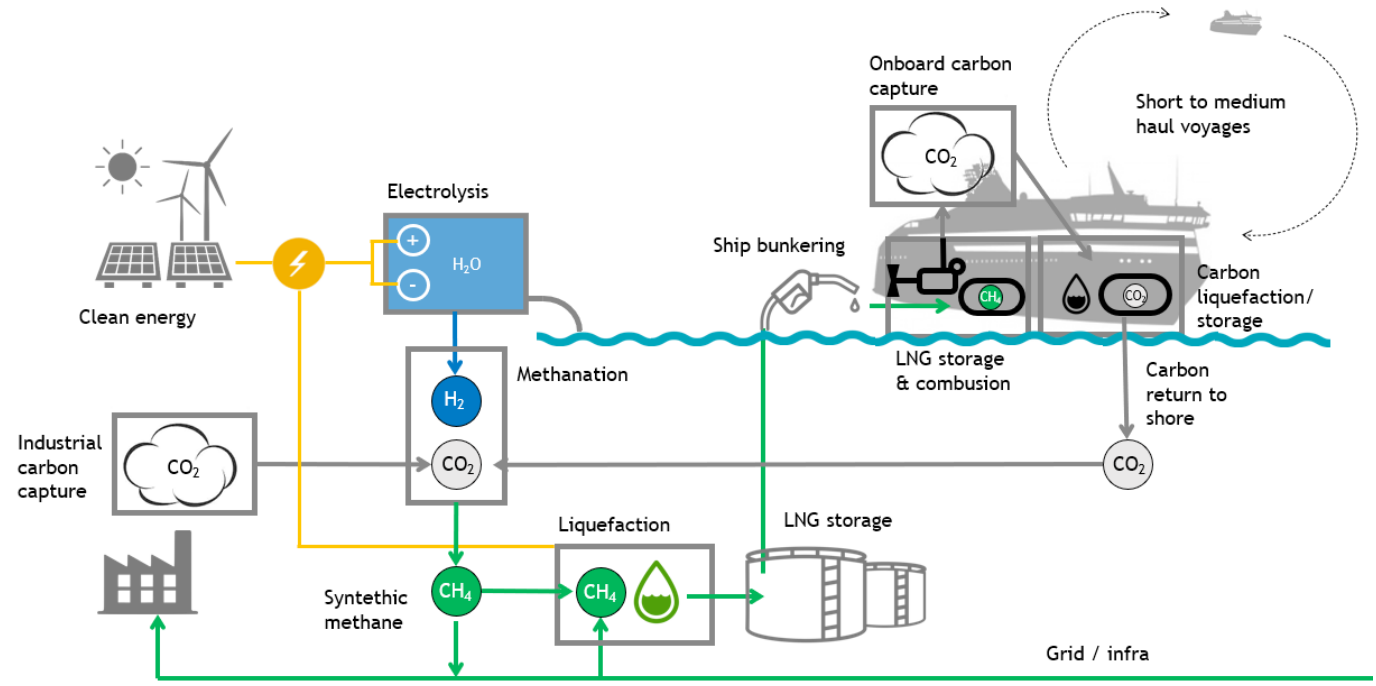
Why ferries?

Our starting point was that ro-paxes could be good candidates for carbon capture as they operate on fixed routes where the captured CO_2 can be frequently discharged to shore, and less volume is needed for onboard storage. Many of the ferry operators have also selected liquefied natural gas (LNG) as their fuel. LNG has some inherent benefits with an absorption-based carbon capture system as it offers clean exhaust gases, and the engine fuel supply can be used as a heat sink for liquefaction of the captured CO_2.

If green energy is available in the operational area, it would also be possible to use the captured CO_2 to produce synthetic LNG through electrolysis and methanation. It would then make part of the CO_2 circulate back into the fuel supply. Obviously, such infrastructure would also require some adjacent industrial users.

The study compared a medium-sized 155 m-long ferry newbuild with alternative fuel arrangements for marine gas oil (MGO), heavy fuel oil (HFO) and LNG, the last two coupled with a carbon capture system. Dimensioning of the exhaust gas treatment, the carbon capture system, and related auxiliaries were made in close co-operation with Wärtsilä, taking into account the ship's heat balance. The vessel was then compared in the technical aspects of CAPEX, OPEX, and emissions across three different routes. Compliance with the current and upcoming regulations, like the Energy Efficiency Design Index (EEDI) and the Carbon Intensity Indicator (CII), was also checked.

The study concluded that a carbon capture system is technically feasible within the given arrangement of the case ship without compromising cargo or passenger spaces. The achievable CO_2 capture rates





vary depending on the operating profile – from roughly 25% at the lowest for the HFO scenario to nearly 40% for the LNG ship. When comparing the emissions against an MGO ship, the aggregate reduction with LNG and carbon capture could exceed 50%.

The additional CAPEX required for carbon capture and related auxiliaries was calculated in detail using our cost modelling plus information received from Wärtsilä. When put into the scale of the total newbuild cost, carbon capture implementation requires about 5-to-7% extra investment.

It looks promising!

Of course, the key question is: can this also make commercial sense, and if so, under what circumstances? Achievable capture rates depend on several factors, e.g., how much waste heat is available for the system. The capture rates can be analysed when the heat balance of the ship, space restrictions for the systems, and the configuration are known. After that, the payback time for carbon capture systems depends on two main things: how much fuel is burned during the operation (frequency and speed on the route) and the level of tax applied on CO_2 emissions (the CO_2 tax and CO_2 disposal cost difference to be precise).

The HFO ship with carbon capture reached payback times of less than five years at around €110/tonne of a CO_2 tax on the most intensive route. In general, the LNG ship with carbon capture had quicker payback times, as the capture rates are higher than for the other options, while the investment in the system is a bit lower. LNG with carbon capture already reached a five-year payback at €50/tonne on the fastest route. On slower routes, the payback times for both fuels were longer, but each of the examined combinations was under ten years, and half of them were below five years at €150/tonne.

The end conclusion of the study is that carbon capture looks technically feasible for ship integration – a very interesting option in reducing CO_2 emissions from ferries indeed. The technology looks particularly promising for LNG-fuelled vessels due to some inherent benefits of the fuel.

As the technology will be built on existing knowledge of exhaust gas cleaning systems, it can also be expected to become available sooner than some low- and zero-carbon fuels, which might require longer timelines to make the supply and distribution infrastructure available. Naturally, each ship and operation is different. Still, carbon capture onboard a vessel definitively provides an up-and-coming alternative for ferry owners and operators who wish to set their course for decarbonisation. ■

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