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The role of CCS in the maritime industry

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Abstract:

The maritime sector is responsible for 3% of the worldwide greenhouse gas emissions. Due its essential role in global trade, the emissions from shipping are set to significantly increase in the coming decades if no drastic measures are taken to prevent these emissions. Reducing the emissions of the maritime sector has been a challenge due to the international aspects of both ownership and operations. However, the International Maritime Organization (IMO) and the European Commission have now set clear targets to reduce emissions and bring this sector closer to net-zero by 2050.
Several strategies can be considered individually or combined to achieve the emission reduction: energy efficiency, onboard renewable energy propulsion source, switch to reduced or low-carbon fuels, Electrification, and onboard Carbon capture and storage (OCCS).
Over the past few years, the research and industrial interest toward OCCS has drastically increased with much research focusing on technology development, technology comparison [1], integration, techno-economic[2] and life cycle analysis [3], etc. However, while a deeper understanding of the feasibility and performance of onboard carbon capture and storage are now available, the question of if and when onboard carbon capture and storage will the most advantageous emissions reduction option for a ship.

As part of the CCShip project, SINTEF Energy Research and SINTEF Ocean have focused on the detailed design, integration, and techno-economic analysis of onboard CCS from two ship scenarios [4]:

- Retrofit case: The BAIACU vessel owned by Klaveness is chosen as the case study which is a combination carrier that transports both dry bulk cargo and wet cargo like crude oil. As a retrofit case, the main dimensions of the ship are kept unchanged to deploy an OCCS unit, while the energy consumption and corresponding fuel usage are studied. In this case, the maximum capture rate is limited by the power and heat available in the machinery room.
- Newbuild case: This scenario explores various redesign options to accommodate a CCS system with a high CO_2 capture rate, with the aim of minimising CO_2 emissions from the vessel. The main goal of the newbuild case is then to prevent a reduction in cargo space with a minimum extension of the ship length during CCS integration while maintaining the original ship specifications from the retrofit case.

Building on these detailed evaluations, we aim in this work to understand when OCCS will be more suited than switching to low-carbon fuels, mainly biofuels, hydrogen, and ammonia. The comparison will take into account aspects such as cost and emissions of low-carbon fuels (biofuels, hydrogen, ammonia), shipping distance, subsequent CO_2 transport and storage cost, etc.

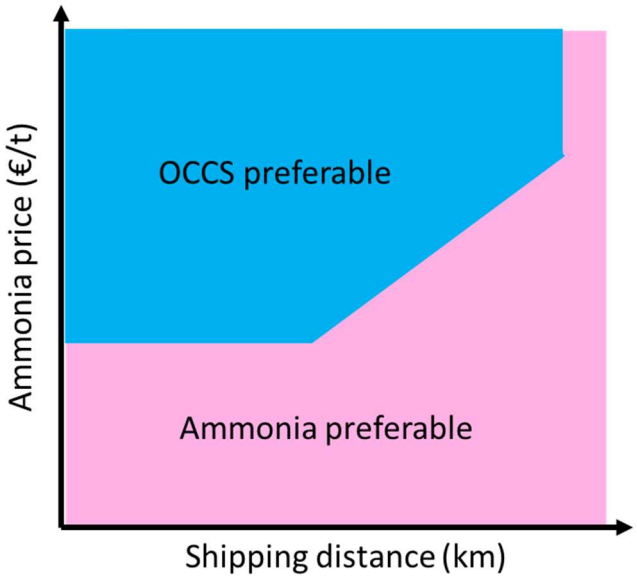

Figure 1: Illustration example of the type of results that will be presented. Here, comparison of OCCS with fuel switching to ammonia as a function of the ammonia fuel cost and the transport distance.

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