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Demonstration of ship-based carbon capture on board of two LNG fuelled ships

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Abstract

The maritime sector aims to reduce CO_2 emissions from international shipping by at least 50% by 2050. Ship-Based Carbon Capture (SBCC) is proposed as a low-cost alternative to decarbonize the maritime sector, as compared to zero-emission fuels (ammonia, hydrogen). One of the objectives within the 'EverLoNG' project is to accelerate the implementation of the SBCC technology by demonstrating it on board of LNG-fuelled ships. For this purpose, 2 ships are selected: the Sleipnir semi-submersible crane vessel, from Heerema Marine Contractors, and an LNG tanker from Total Energies. Information on these two ships is given in Table 1.

Ship-Based Carbon Capture (SBCC) is currently at TRL 4 (technology validated in the lab). EverLoNG will advance SBCC to TRL7 by prototyping and demonstrating the technology on-board, accelerating the commercialization of SBCC. The prototyping activity is a key innovation of EverLoNG, as it will let us address research questions related to the effect of ship motion on the systems operation. This will close a knowledge gap that is connected to the main hazard of SBCC identified so far – the possibility that the SBCC system interferes with the main engine's availability (due to varying pressure drop of the system). Quantifying this impact and finding ways to mitigate this (e.g., by adding a blower to the exhaust system) will be an important contribution towards de-risking implementation. Demonstrating aspects related to emissions and solvent management will also allow us to better inform the design of full-scale systems, as well as provide reliable data for the life cycle assessments (to be performed with the project).

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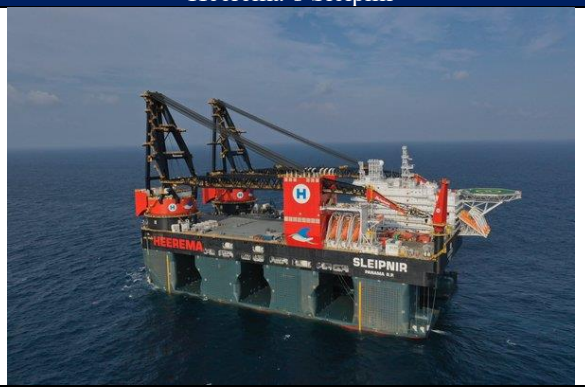
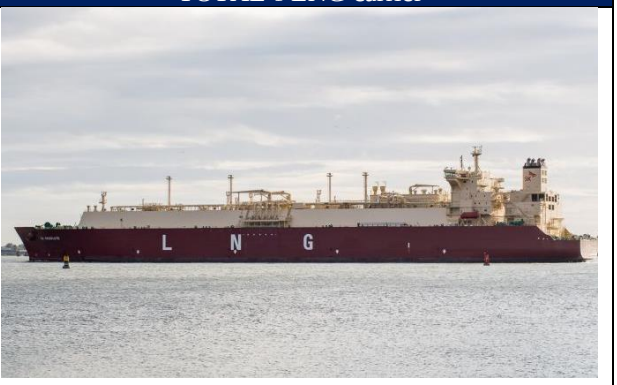
Table 1. Ships for on board SBCC demonstration

Heerema's Sleipnir	TOTAL's LNG carrier
	
Type: Semi-submersible crane vessel Main Power: 96 MW total main power plant, consisting of 12 engines of 8 MW each, divided over four engine rooms (three engines per engine room). Fuel (dual): Low sulphur Marine Gas Oil (MGO) and Liquefied Natural gas (LNG)	Type: LNG tanker Main propulsion power: 24 MW (2 engines) Power generation: 14 MW (2 x 4.3 MW / 2 x 2.8 MW) Fuel (dual): Liquefied Natural gas (LNG) and Low sulphur Marine Gas Oil (MGO) / Low sulphur Heavy Fuel Oil (HFO)

The EverLoNG partners are currently busy with the design of the prototype unit. Procurement is expected to start in February 2022. The construction and commissioning phases will then proceed, and the system will be installed onboard of the LNG tanker in January 2023, for a 6-months demonstration period. Demonstration on-board of the Sleipnir should happen in late 2023 or early 2024, depending on the ship's schedule.

The prototype is designed to capture CO_2 using 30wt% monoethanolamine (MEA) aqueous solution. The system will comprise a gas pre-treatment step (cooling, removal of impurities), a CO_2 capture plant with a regular absorber-stripper configuration, a compression and liquefaction plant, and a storage tank in which up to 6 m^3 of liquid CO_2 will be stored. This mobile plant will have a capacity to process 120 Nm^3/h of exhaust gas, producing ca. 250 $kgCO_2$/day. The heat required in capture plant to regenerate the solvent will be recovered from the heat available in the exhaust gas. A preliminary arrangement can be seen in Figure 1.

At the conference, we will present the final lay-out of the prototype, the outcome of the HAZOP study, the results obtained during the commissioning phase, and the plans for the demonstration campaigns. Lessons learned and differences between the design philosophy for land-based systems and ship-based systems will be discussed.

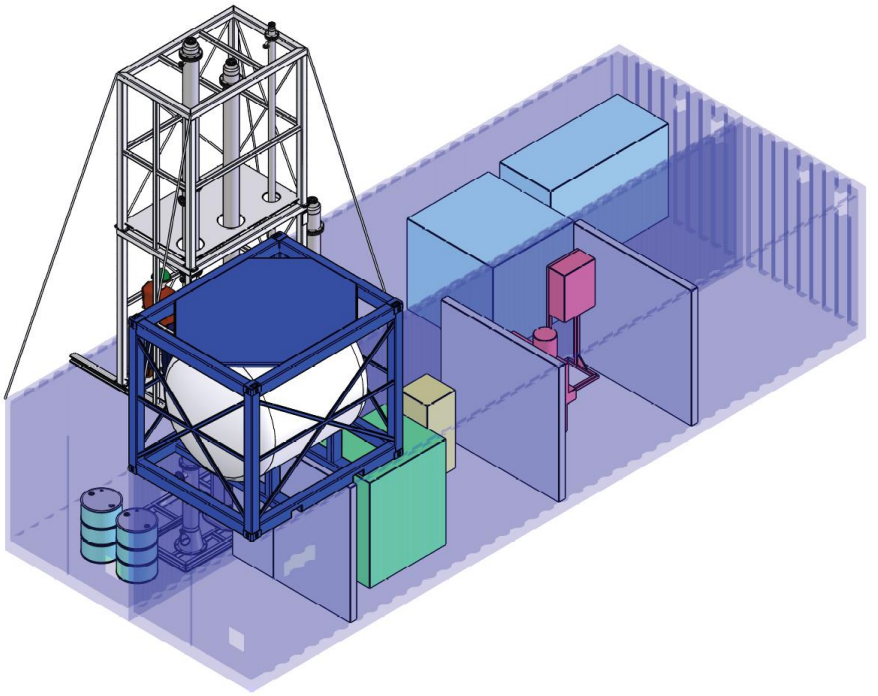


Figure 1. Preliminary arrangement of EverLoNG's SBCC prototype

Keywords: Carbon capture; Maritime; Ships; Demonstration