16th International Conference on Greenhouse Gas Control Technologies **GHGT-16**

23-27th October 2022, Lyon, France

Ship-based CO_2 capture – Port integration

Michel Mælum[a]*, Anette Mathisen[a], Chameera Jayarathna[a], Ragnhild Skagestad[a], Jed Belgaroui[b]

[a]*SINTEF Industry, Forskningsparken, Hydrovegen 67, 3936 Porsgrunn, Norway*
[b]*TotalEnergies EP Norge AS, Postboks 168, 4001 Stavanger, Norway*

Abstract

The maritime sector aims to reduce CO_2 emissions from international shipping by at least 50 % by 2050 [1]. 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). The objective of the "EverLoNG" [2] project is to accelerate the implementation of the SBCC technology by: (i) Demonstrating SBCC on-board in LNG-fuelled ships; (ii) Optimising SBCC integration to the existing shipping infrastructure; (iii) Facilitating the development of SBCC-based full CCUS chains; (iv) Facilitating the regulatory framework for the technology.

A ship with on-board CO_2 capture and its ports of call requires distinct integration than what is common today. The current infrastructure includes:

- Cargo handling - often the main purpose of calling the port
- Other services like,
    - Water and electricity supply
    - Waste removal (residues, oily mixtures, garbage, and sewage)
    - Bunkering

In case of onboard CO_2 capture with an amine-based absorbent, it is expected that both the captured CO_2 and spent amine for reclaiming need to be received and handled at the port of call. Currently, there are no guidelines on the logistics of CO_2 and solvent receival from the ship to the port and the loading of reclaimed or fresh solvent from the port to the ship. These challenges must be solved before a larger port network of CO_2 receival- and solvent reclaiming facilities can be organized.

Methodology

The design and performance of the onboard CO_2 capture unit is the focus of other parts of the project. Here, only an indicative calculation of expected CO_2 and spent absorbent volumes to be transferred between the ship and the port will be performed. The storage conditions of CO_2, onboard the ship will be investigated, and the optimal storage pressure and temperature reassessed by highlighting the potential consequences for downstream transport, processing, and storage facilities. Furthermore, the quality of the CO_2 coming from the onboard capture facility will be evaluated,

and implications of the impurity level will be investigated. CO_2 quality will influence design of offloading systems and the solvent reclaiming plant on the port side. The potential improvements of the CO_2 stream, further storage, transportation from the port to either a utilization facility or to permanent storage infrastructure will be clarified.

Case studies

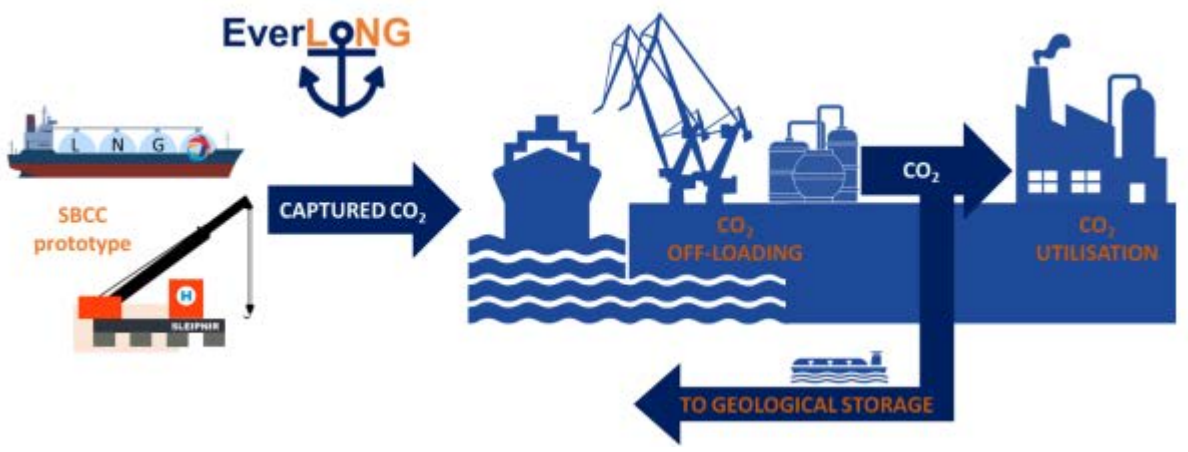
Appropriate port location for CO_2 receival within the shipping paths and their essential facilities and infrastructure will be discussed. Most convenient port location needs to be considered for such a development together with existing infrastructure which is already available at the port, potential link to storage infrastructure and the distance to potential CO_2 utilization customers. The process design and identification of all required process equipment at the port side will be evaluated based on number of ships arriving to the ports and their size, type and footprint/dimensions.

Further, typical shipping routes particularly in Europe will be investigated together with travel across the Atlantic Ocean to the US. The routes are chosen based on regularity, diversity and assumed LNG propulsion. Currently the three suggested case studies are (subject to change):

- Melkøya (Norway) – Bilbao (Spain) by an LNG cargo tanker
- Bremerhaven – Newark, by a container ship
- A roundtrip in the West Mediterranean out of Barcelona by a cruise ship

Expected results

The result of the work will be summarized in the article which will describe the different alternatives for offloading of both CO_2 and spent solvent. How, when and at which ports the offloading and loading should take place will be discussed and presented. The strategy for storage of solvent and CO_2 onboard may depend upon several factors. One of them is the traveling distance and it will be described in the guidelines and will be further clarified by the case studies.
The results from the project work will be aligned with important and relevant parties in the value chains. Ship owners and operators, port authorities and storage facilitators are well represented in the EverLoNG project ensuring a viable outcome. CO_2 potential customers will be engaged for utilization purposes. The guidelines will help for both industry and government to plan a network of ports which will be upgraded to CO_2 and solvent treatment hubs for the shipping, utilization, and storage sectors.



Keywords: CO_2 capture; CCUS; SBBC;

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