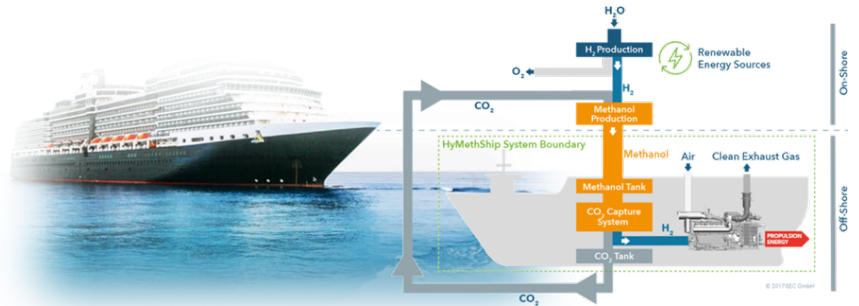


**LEC EvoLET
LEC Evolutionary Large Engines
Technology for Sustainable En-
ergy and Transport Systems**

Programme: COMET – Competence
Centers for Excellent Technologies

Programme line: COMET-Centre K1

Type of project: mulit-firm/strategic
Duration: 2018-2021



HYMETHSHIP_GREEN REVOLUTION ON THE HIGH

A CLOSED-LOOP CARBON CYCLE ON BOARD SHIPS HAS BEEN INTRODUCED THAT COMBINES THE BENEFITS OF WELL-KNOWN LIQUID FUEL BUNKERING AND STORAGE WITH CO2 EMISSION-FREE HYDROGEN COMBUSTION IN A LARGE ENGINE

The challenge

Until recently, the primary focus of ship emissions reduction was on sulfur oxides and particulate matter emissions. In 2018, however, the International Maritime Organization adopted a resolution to decrease the emissions of greenhouse gases from marine transportation by 50 % by 2050, thus shifting attention to carbon dioxide emission reduction. Goals are far beyond what efficiency increases alone can deliver. Disruptive concepts and changes in fuel or energy supply are required. While the use of hydrogen as a carbon-free fuel in land-based applications seems straightforward, logistics, safety requirements and most of all space constraints strongly favor the use of liquid fuels with high energy density. Currently there is no clearly favored solution in sight. Thus, various viable solutions need to be examined in depth and approved.

The innovation

HyMethShip is a marine propulsion concept featuring a methanol-based closed-loop carbon cycle with on-land methanol synthesis using H₂ plus recycled CO₂ and onboard methanol decomposition to H₂ used for propulsion and CO₂ for later methanol synthesis. The HyMethShip has the potential to reduce carbon dioxide emissions by more than 95 % while virtually eliminating sulfur oxide and particulate matter emissions and reducing nitrous oxide emissions below Tier III levels.

The implementation

LEC initiated the HyMethShip project, assembled a consortium of 13 international project partners, and received funding from the European Union's Horizon 2020 program.

SUCCESS STORY

The HyMethShip uses methanol bunkering, onboard steam methanol reforming, precombustion carbon capture and hydrogen combustion in an internal combustion engine. Ideally, green methanol is produced onshore from the captured carbon dioxide, thus closing the carbon cycle. The advantages of this concept are its use of established reciprocating engine technology, bunkering of a liquid fuel that does not require high pressure or cryogenic storage, and the recovery of engine waste heat for the precombustion carbon capture process.

The LEC developed a flexible hydrogen combustion system for a full-scale 1 MW engine demonstrator, built the fuel production subsystem and integrated it together with the full-scale engine into a technology demonstrator. The project also included the design of a case study for a full-scale ship to demonstrate the integration of the complete system into the vessel. Based on this design, a classification society conducted a comprehensive risk and safety assessment of the design and operation strategies.

The impact

The technology demonstrator was built at the LEC facilities and commissioned in September 2021. The initial test of the entire system demonstrated the hydrogen operation of the engine and the efficient use

of waste heat for methanol reforming. A reduction in CO₂ emissions of 40 % was achieved. The demonstrator forms the development platform for the evaluation of subsystems, the implementation of identified improvement measures and the development of additional technology components for fuel pre-treatment and carbon dioxide capture.

The LEC has benefited greatly from collaboration with company and scientific partners from the maritime industry and is actively working to expand its network in the community. Initiation of a real-world lab demonstration is planned to be procured by LEC GETS.

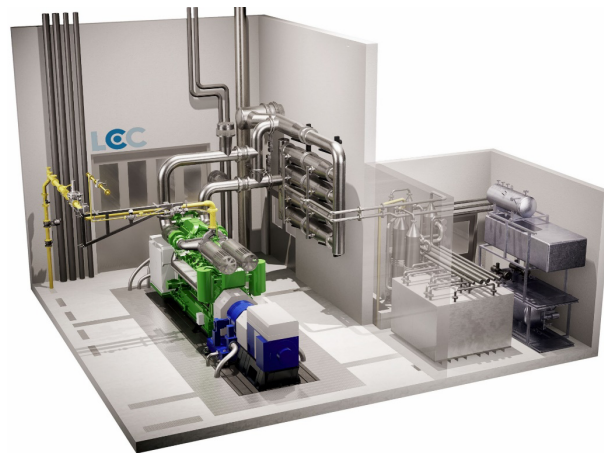


Figure 1: HyMethShip demonstrator © LEC GmbH

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