RETROFIT SOLUTIONS TO ACHIEVE 55% GHG REDUCTION BY 2030

By **EU Horizon RETROFIT55 project team**

The RETROFIT55 project aims to address the urgent need for decarbonisation in the maritime industry by developing innovative retrofitting solutions and green technologies to reduce fuel consumption and greenhouse gas (GHG) emissions. Focusing on ship efficiency improvements and the utilisation of zero- and low-emission energy sources, the project seeks to achieve the targets set by the ZEWT partnership, which aims to reduce fuel consumption in waterborne transport by at least 55% before 2030 compared to 2008 levels.

To achieve these objectives, the project consortium explores various retrofitting solutions, including air lubrication systems (ALS), smart energy management, holistic hydrodynamic and operational optimisation, wind-assisted propulsion, fuel cells, and hybridisation of propulsion systems. Recognising that no single retrofitting solution can achieve the necessary emissions reductions, the project emphasises the intelligent combination of existing high Technology Readiness Level (TRL) systems and the development of additional solutions that may reach TRL 7 to 8. The project also acknowledges the interdependence of retrofitting systems, requiring a balanced approach to maximise overall improvement while considering the impact on individual system gains.

The RETROFIT55 project aligns with the Design and Retrofit section of the Waterborne Strategic Research and Innovation Agenda (SRIA) and intersects with other areas such as the use of sustainable alternative fuels, energy efficiency, electrification, and digital green initiatives. By integrating these advancements into existing ships, the project seeks to ensure compliance with regulatory frameworks, cost-effectiveness, and sustainability throughout the life cycle of the vessel. The project will develop an advanced web-based Decision Support System (DSS) that features an up-to-date catalogue of retrofitting solutions, ready for deployment at the project's end and easily expandable thereafter. The DSS will facilitate the combination of retrofitting solutions to achieve a targeted 35% reduction in GHG emissions compared to the original ship design.

The WASP aspect of the project focuses on the development of two wind-assisted solutions: one based on rigid sails, and another based on flexible sails.

The rigid-sails solution is already installed on a ship and will provide relevant data for the development and validation of digital twin models. The flexible-sails solution is currently installed on boats and catamarans but not on large ships. Both solutions aim to fold or collapse when there is no wind or during port approaches to prevent interference with manoeuvring. The project also involves the development of digital twins for sail management, enabling performance predictions by combining thrust and lateral force computations with the ship model.
The project emphasises the importance of stowing the systems to a small size and modularizing them for simple retrofitting. The goal is to reach TRL8 by the project's end, supporting widespread industry adoption through performance predictions and capital investment decisions.

The ALS aspect of the project aims to reduce the frictional resistance of ships by injecting compressed air bubbles into the seawater, which dilutes the local viscosity and significantly reduces water friction. This reduction in friction can lead to a substantial decrease in fuel consumption and associated greenhouse gas emissions.

The ALS developed in the project utilises a largely passive air lubrication system (PALS) that minimises the power required for bubble production by employing a Venturi mechanism. Compared to existing solutions, the PALS system offers improved bubble generation, inboard injection of bubbles, and enhanced control over the lubrication speeds. The system is designed to optimise the effect of lubrication and provide potential net performance improvements twice that of currently available systems. The project involves further development through laboratory experiments, computational fluid dynamics (CFD) simulations, and optimisation of the system's installation, configuration, and management.

In one of the work packages (which is dedicated to the Hydrodynamic Design Optimisation) emphasis will

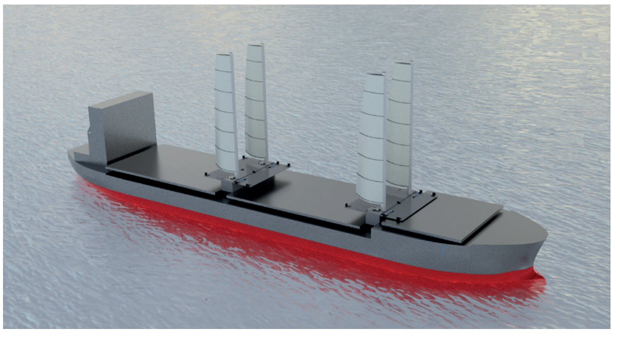

FIG 1. APPLICATIONS FOR RIGID SAIL (LEFT) AND FLEXIBLE SAILS (RIGHT)

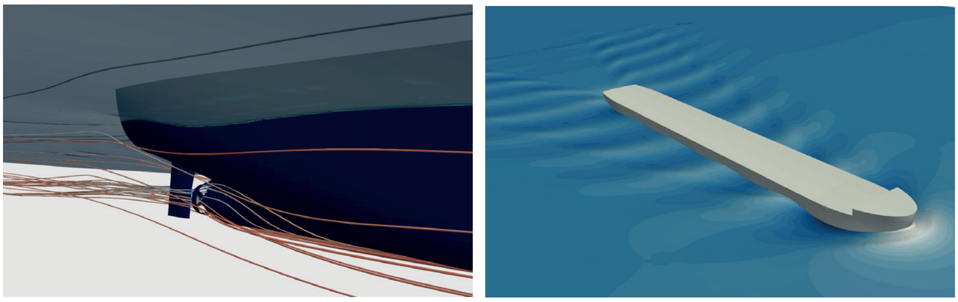

FIG 2. RESULTS FROM CFD COMPUTATIONS – VELOCITY STREAMLINES (LEFT) AND WAVE ELEVATION (RIGHT)

FIG 3: CASE STUDY VESSELS – BULK CARRIER (LEFT) & RO-RO VESSEL (RIGHT)

be placed on the interaction between hydrodynamic design and other energy saving measures adopted, in order to realistically assess the cumulative effect and optimise the ship's design in a holistic way.

Attention will also be given to optimising for realistic operational profile (speed, displacement, wind and sea conditions), based on available operational data.

Another work package will focus on analysing the energy systems on board existing ships and proposing new solutions that can improve the ship efficiency and reduce the GHG emissions. The implemented solution will enable a significant reduction of ship-related pollution in port area, which is particularly important especially in Emission Control Areas (ECA).

Developed solutions will be based on a combination of retrofit solutions like shaft generators, battery banks, fuels cells and, wherever compatible with the ship use, photovoltaic plants. The different solutions will be integrated within an energy management system that will make the main power plant operating always at the optimum working point when in navigation, storing the excess of energy which can be used in combination with fuel cells or photovoltaic plants during the manoeuvre and stay of the ship in port.

Regulatory aspects are also considered during development. The objectives include determining the full system design, optimising fuel savings, evaluating risks, obtaining classification approval in principle (AiP), and meeting installation and operation requirements.

The project includes a task focused on hydrodynamic optimisation at realistic operational conditions for two case study ships: a bulk carrier and a ro-ro vessel.

The aim is to explore retrofitting solutions that improve the hydrodynamic design of these ships based on data provided by operators, with a specific focus on the ships' actual operating speed range and encountered sea states, rather than assuming ideal weather conditions. Various tools, including higher fidelity computational fluid dynamics (CFD) and potential flow solvers, as well as reduced-order engineering models, are utilised to calculate the effects of ship motions on propeller performance and assess the propulsion efficiency of the vessels in wind and wave conditions. The solutions considered include bow retrofitting to better align with actual or modified speed and displacement profiles in realistic sea states, as well as propeller retrofitting to optimise the propulsion system for lower operating speeds and reduced thrust requirements. This can be achieved through the installation of other energy-saving technologies and the modification of propeller design, such as incorporating winglets at blade tips, optimising tip rake distributions, and adjusting blade roughness to control blade tip cavitation. The outcomes of this task are expected to have broad applicability to a wide range of ship types, as the selected bulk carrier and ro-ro vessels represent two major categories with distinct design characteristics.

Exploitation, dissemination, and marketing activities shall be organised during the course of this project, in order to ensure and maximise the visibility and sustainability of the project outcomes and its commercial continuation after project closure. Planned activities aim to attract the interest of all types of relevant stakeholders, such as ship operators/managers, large shipping lines, and players in commodities markets as well as shipbuilders and ship design consultancy companies. Work groups to be reached include relevant industry and research communities, consortia from relevant EU and/or national/international projects and initiatives, users/commercial communities relevant to project's use cases, like shipping, shipbuilding, and service providers, including pertinent professional bodies.

Regular updates on the project's progress will be posted on our dedicated website: www.retrofit55.eu. ■