RESHIP Project

Research Newsletter

Issue 1 | March 2024

In this issue

RESHIP's newsletter is designed and edited by Mario FELLI (CNR).

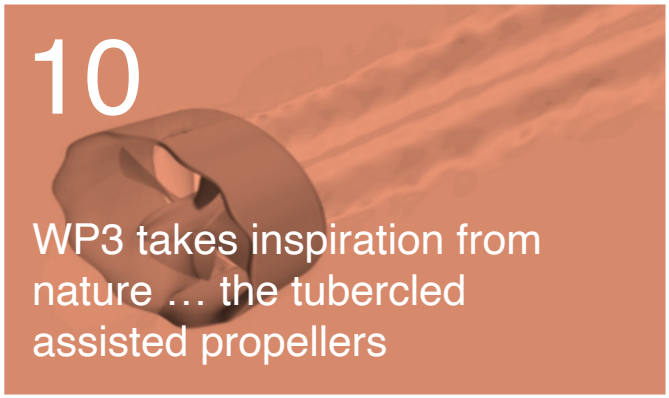
www.reship-project.com

3 Who we are … the RESHIP Project

6 OS ENERGY experience on board ''Fortuna Crane"

7 Let's sail hydrogen

9 Photogrammetry and 3D scanning for digitalizing ''Fortuna Crane"



11 Insights into ducted propellers

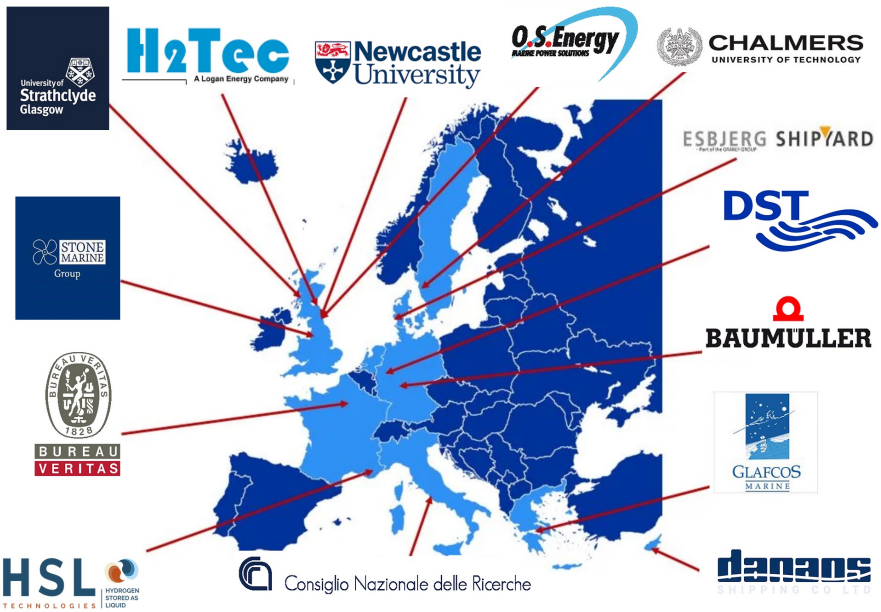
13 RESHIPing … but not only seagoing vessels

14 ''The long and winding road"

RESHIP is funded by the European Union's Horizon Europe Research and Innovation Programme.

Who we are…

The RESHIP Project



RESHIP brings together a team of world-leading multidisciplinary experts from Universities and Research Center, Shipyards, Industry and Classification Societies including key patent holders from both shipping and hydrogen sectors.

RESHIP consortium is made of 14 partner organisations from 9 European Countries.

RESHIP Project is coordinated by HYSILABS

Our Research Aims

RESHIP is a three year Project that aims at enhancing energy efficiency performance and at addressing the current challenges for hydrogen usage onboard, including high energy demand, abrupt power spikes, demanding energy storage requirements. The specific and measurable objectives are listed as below.

PROPELLER

Redesign open and ducted propellers with novel bioinspired features, Tubercle Assisted Propulsors (TAPs), using multi-objective design and optimisation methods to be hydrogen compatible and widely applicable to different vessel types.

ESD

Review the currently developed energy saving solutions and identify hydrogen preferred standalone and combined solutions for inland, short-sea and ocean-going shipping for both new builds and retrofits to reduce the energy & storage demand and smooth shaft power.

OPERATION

Investigate operational energy efficiency of developed energy saving solutions during manoeuvring and harsh sea conditions with development in the novel and hydrogen compatible automation and control strategy.

CARRIER

Research novel onboard hydrogen solution with energy efficient liquid inorganic hydrogen carrier HydroSil, to reduce the energy consumption in the process of storage, release and utilisation.

RECOVERY

Develop energy recovery solution with combined heat and power to revalorise the energy output (waste heat) in the release process from the onboard carrier HydroSil.

WATER

Validate the use of river/sea water as a reactant for the carrier at large scale; exploit the fresh water circulation onboard using the output from the fuel cell as the reactant for hydrogen release.

BALLAST

Investigate the impact on ship operation in ballasting and operational propulsion efficiency, due to the weight changes of the hydrogen carrier during release, two times heavier after release.

DEMONSTRATION

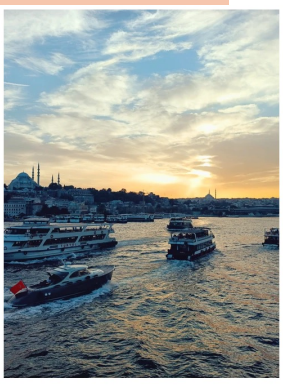
Perform prototype development and demonstration using the selected target vessel for a fullscale exploitation to investigate performance at sea.

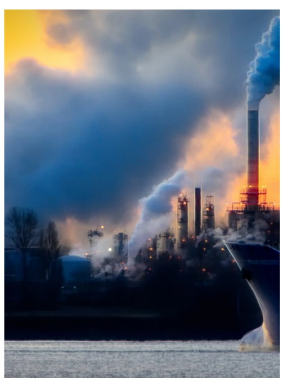
IMPACT

Research the potential impacts in technical, environmental, economic, safety and regulatory for the applications to marine and inland waterway ships and fleets.

UPSCALE

Develop and standardise the developed technological solution; upscale the technology for high power application; communicate with regulatory bodies for wider uptake.

Let’s start together…

on board ‘’Fortuna Crane”

The vessel "Fortuna Crane" of the associated partner O.S. Energy Ltd. will serve as a test ship for various systems that are being developed as part of the RESHIP project. This will include both the H2PG and a new type of propeller design, the tubercle assisted propulsors (TAPs).

In this context, a regular, not project-related shipyard stay with docking in mid-February 2024, was used to gain an overview about the ship with a special focus on areas that are relevant for RESHIP. The opportunity to inspect the ship’s hull and its propulsion and manoeuvring systems rarely arises, so it was gratefully seized. This is even more important since older ships often undergo modifications over the years, which are not always fully documented in drawings etc.

Particular attention was paid to the aft ship geometry, as this has a considerable influence on the inflow and operating conditions of the two propellers. In particular, the large skeg and the stern thruster installed in it have to be mentioned in this regard. The two three-bladed propellers and their design, as well as the rudders, were also inspected.

Finally, the opportunity was taken to talk to the captain about typical operating areas and profiles of the "Fortuna Crane". This information is valuable for planning the subsequent test voyages, especially as the current charter involves travelling long distances at low ship speeds for operational reasons.

"...Visiting the Fortuna Crane while in drydock in Svendborg was pivotal for the consortium, particularly for members not exclusively involved in maritime fields. This visit provided them with first-hand experience of the vessel's layout and functionality. Additionally, other consortium members conducted essential work to gather information required for developing drawings. Overall, the visit to our vessel was highly successful despite challenging weather conditions in Denmark, including temperatures of -5°C and snowfall throughout the day. The experience provided valuable insights, even if the journey to airports amidst the Baltic's wintry weather made for memorable experiences for consortium members..."

James Moore (OS Energy)

Previous page
Stern of the Fortuna Crane during dry docking.

Current page:
Bow of the Fortuna Crane during dry docking (top)
RESHIP team on board Fortuna Crane (bottom)

OS ENERGY experience on board Fortuna Crane

James Moore
OS ENERGY

The team has undertaken various operations on the vessel, including sea trials, vessel hazard surveys, and organizing a consortium event for members to visit the Fortuna Crane during drydock.

A significant milestone involved traveling to Denmark and conducting a sea trial in Esbjerg to gather preliminary data on engine shaft power to the propellers. A torque measuring device was mounted on the shafts of the vessel, enabling precise measurement of power distribution to each propeller. Despite encountering adverse weather conditions with wind speeds of 25 knots and sea state 5, resulting in waves of 2.5m to 4m, the data collected facilitated initial propeller design development. Further sea trials are planned in calmer conditions to finalise the design with additional data.

During another visit to the vessel, we provided information to consortium members regarding shore connections and conducted a hazard survey on deck related to the hydrogen container. We identified 20 previously unnoticed hazards, such as light bulbs on deck, electrical connections on the crane, and equipment on deck. These hazards must be addressed and rectified before the trial demonstration to ensure the removal of all possible ignition sources around the container.

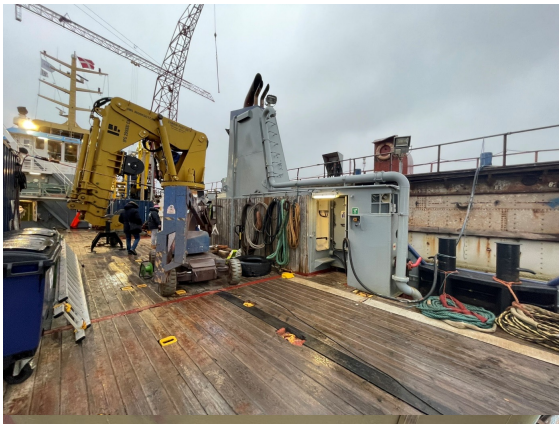
Let's sail **Hydrogen** …

Daria Matignon
HSL TECHNOLOGIES (HYSILABS)

"RESHIP project aims to redefine energy efficiency solutions not only from the hydrodynamics point of view but also researching on the whole hydrogen to power process to redesign the power and propulsion system for hydrogen powered vessels."

The detailed design of our Hydrogen Power Generator (H2GP) is almost finalized thanks to the united efforts of *HSL Technologies, H2Tec, Baumuller, Glafcos Marine* and *O.S. Energy. Bureau Veritas* followed all the development closely in order to gather necessary data for the future modelling and optimisation of the designed system in a holistic way. *University of Strathclyde* and *Newcastle University* along with DST also participated in the early stages for the definition of specification requirements for the use of hydrogen onboard.

A visit and inspection of the *Fortuna Crane* ship from *O.S. Energy*'s fleet was conducted last February (during the drydock in Denmark) to better understand the future placement of the container on the deck of the vessel.



What is H2PG?

The H2PG consists of a hydrogen release reactor (which allows to release hydrogen from the novel hydrogen carrier HydroSil developed by *HSL Technologies*) which is coupled with a fuel-cell provided and integrated by *H2Tec*. The full system including all complementary equipment sourced by *H2Tec* and electrical connections carefully calculated and selected by *Baumuller* will be fitted in a standard 20 ft container which will be later placed onboard of our target vessel *Fortuna Crane*.

HSL Technologies was able to perform the necessary tests of the hydrogen released from the carrier HydroSil by means of a prototype of the future onboarded reactor. Those tests allowed to verify and to confirm necessary quality (grade D) to assure the compatibility with the fuel cell.

The next important steps include finalization of details for getting the final arrangement of the container out of the two already developed by *Glafcos Marine*.

The visit was also a chance to meet the crew and to brief them on the upcoming demonstration and the functioning of the innovative equipment as this part of ESD is less familiar for the crew that the TAPs part.

The ongoing work mostly concerns the preparation for the crucial and probably most exciting part of the project - real-life demonstration of the developed equipment planned for March-April of 2025. Before the onboarding, we plan to perform all necessary tests and system calibration on land with the support of our partner – *Esbjerg shipyard*. In the meanwhile, sourcing, procurement, assembling and testing of separate subsystems are ongoing in compliance with the detailed design.

To onboard the H2GP we have to get the approval from class, flag and port authorities. This is going to be the partners' focus for the next moths.

Top

HSL Technologies charge and release processes

Mid

Prototype release reactor and purification assembly used for hydrogen quality tests by HSL Technologies

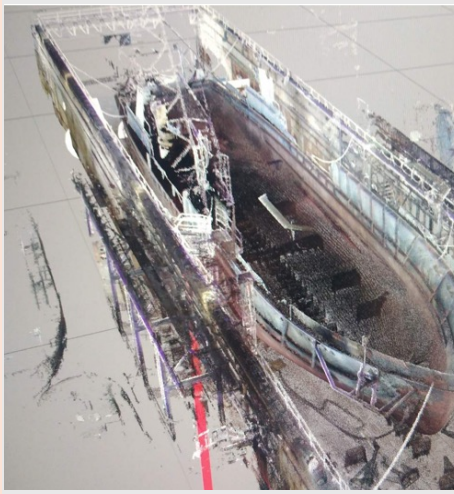
Bottom

The Fortuna Crane vessel

Photogrammetry and 3D scanning for digitalizing Fortuna Crane

GLAFCOS MARINE

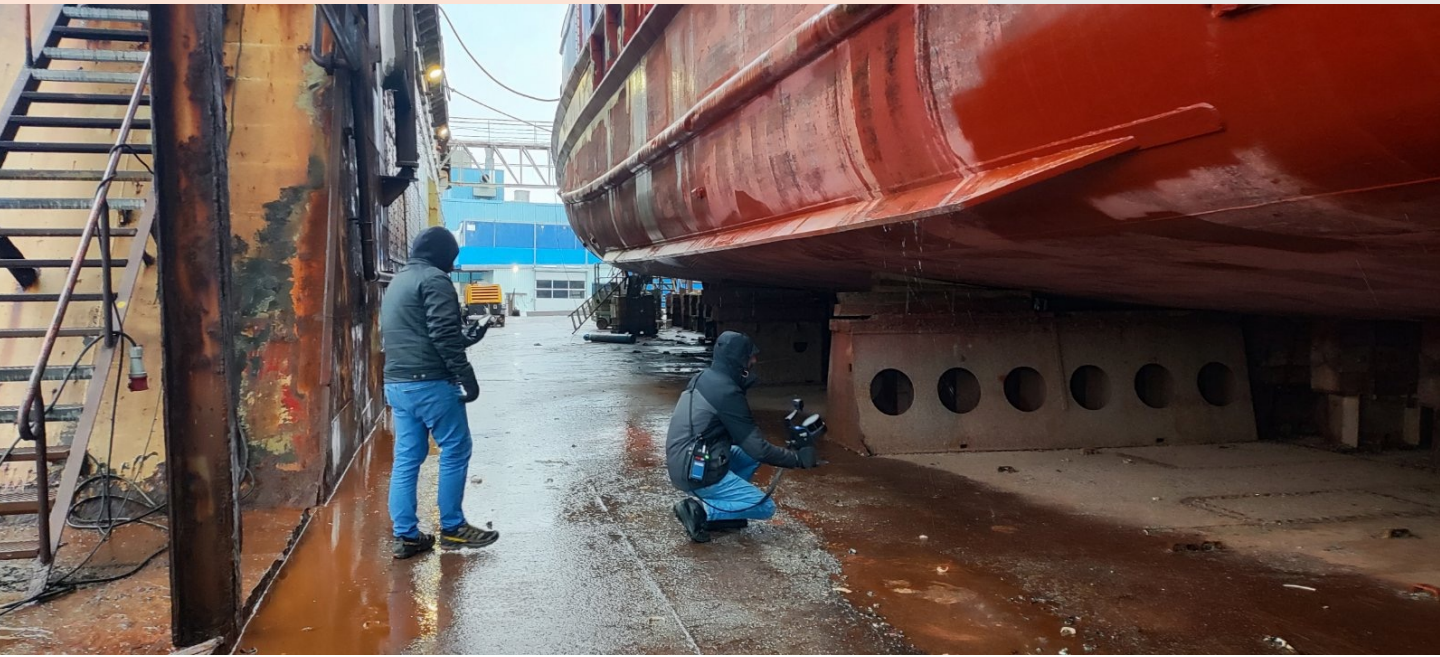
Photogrammetry and 3D scanning of the Fortuna Crane vessel were employed by GLAFCOS team to ensure an updated and detailed design of the target ship, during dry docking. These technologies facilitated the capture of precise measurements and details of the ship's structure, aiding in the accurate integration of developed technologies, ESDs, and HydroSil into the design process.



Top
Detailed 3D model of the propeller captured by photogrammetry

Mid
Detailed 3D model of the ship generated from point cloud data obtained through 3D scanning

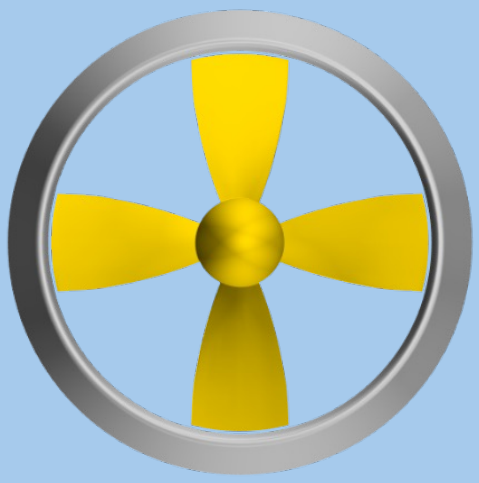
Bottom
3D scanning process employed by GME personnel on the target vessel

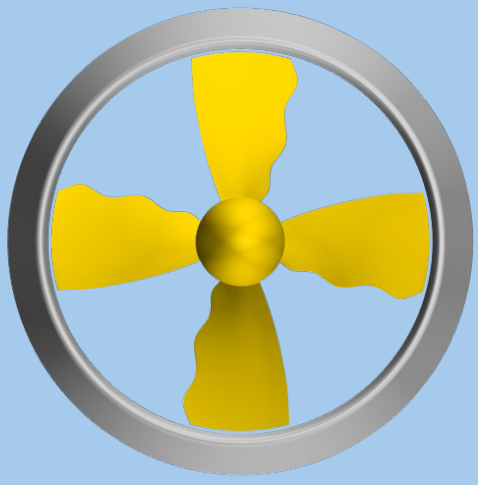


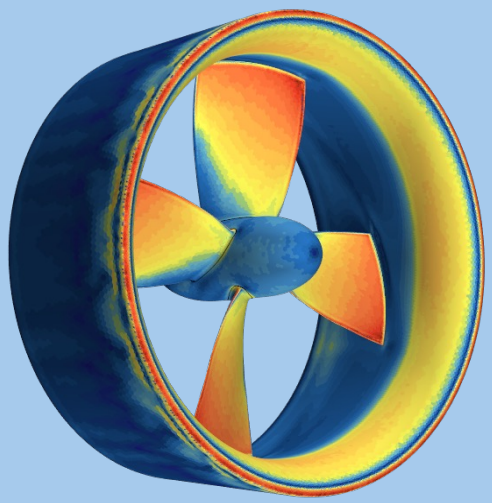
WP3 takes inspiration from nature ...

the tubercled assisted propellers

Tapas Kumar Das
University of Newcastle







The WP3 in the project is dedicated to the development of innovative hydrogen-preferred Energy Saving Devices (ESD) for both marine and inland ships, focusing on key advancements in Tubercle Assisted Propeller (TAP) technology. The Energy-saving devices are innovative technologies designed to enhance the efficiency and sustainability of ships using hydrogen fuel cell propulsion systems. These devices play a crucial role in reducing energy consumption, operating costs, and environmental impact in the maritime industry. By optimizing the way ships operate, energy-saving devices aim to make hydrogen fuel cell-powered vessels more competitive and eco-friendlier. As a basis for evaluating the effectiveness of TAP technology, several numerical analyses have been conducted for the ducted propeller in open water condition. In addition, self-propulsion tests were also carried out for the TAP designs. Marine propellers are also subjected to oblique flow, mainly due to the manoeuvring, turning and motion caused by waves. Numerical analysis is also planned for understanding the performance of such propellers under oblique flow conditions.

Insights into **ducted propellers**

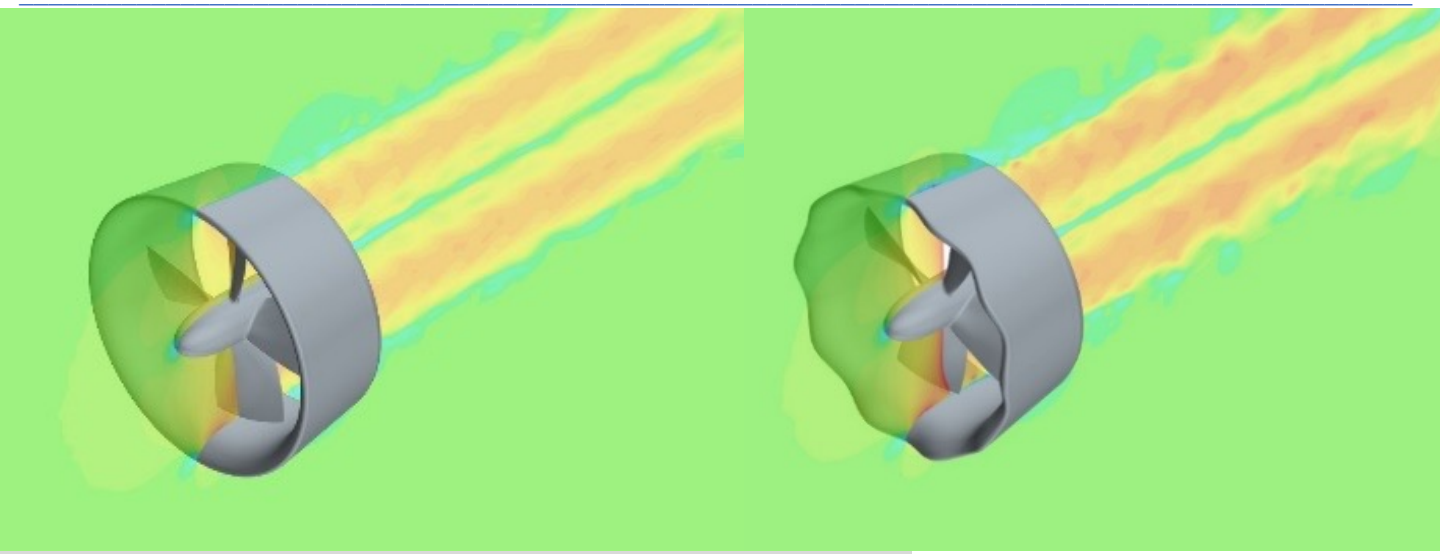
Rickard Bensow
CHALMERS University

Ducted marine propellers are a critical component of modern ship propulsion systems, offering a range of advantages such as increased efficiency, enhanced manoeuvrability, improved thrust, and reduced cavitation and noise in specific operating conditions.

In the RESHIP project, the concept revolves around implementing a ducted propulsor featuring tubercles along the leading edge (LET), either on the propeller, the duct, or both components. Although there exists a risk for flow separation during extreme movements, the presence of tubercles aims to mitigate this risk. Additionally, tubercles offer flexibility in pitch distribution along the propeller blade, enabling a broader range of efficient operation. This innovative approach enhances propulsion system performance and resilience in varying marine environments.

Advanced modeling techniques such as CFD methods play a crucial role in optimizing marine propulsion systems and allow researchers to simulate and analyze the complex flow patterns and behavior within propulsion components.

To optimize the propulsion system, it is crucial to understand and explore the hydrodynamic performance of the ducted propulsion system utilizing two types of ducts: 19A and LET (see Figure in the next page), in oblique flow conditions, to consider the effects of waves.



For this, unsteady RANS (SST k-ω) for the verification and LES method for the parametric study in STAR CCM+, as the numerical tool, has been employed. To validate the numerical solution, the results of the RANS and LES method are compared to available experimental data. Numerical results show that the RANS method has a very good agreement with the experimental results. A comparison has been made between the hydrodynamic coefficients of the 19A and the LET at the advance ratio of 0.7 (See Figure).

This shows that the LET duct can improve the ducted propeller performance at straight flow without any inclination. Also, the open water efficiency of the ducted propeller with the LET duct is higher than the ducted propeller with the 19A duct. More detailed information can be found in a conference paper titled "Open Water Performance of Two Different Ducted Propellers in Oblique Flow," presented at the 8th Symposium on Marine Propulsors (SMP) in March 2024 in Berlin.

After a sufficient understanding of the hydrodynamic behavior of the ducted propeller is obtained, it is necessary to know the effective parameters and to optimize ducted propeller. Optimizing a ducted propeller presents several challenges, including the complex interactions between different components at varying operational condition.

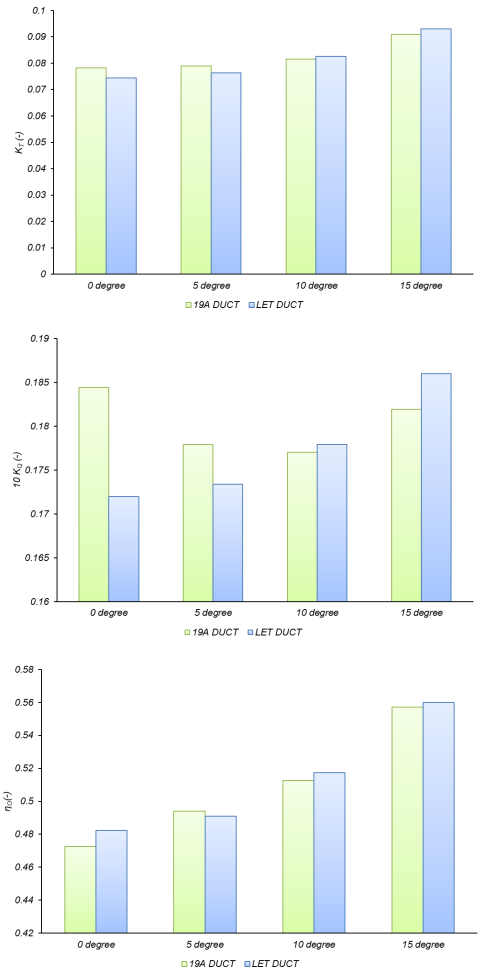
In future work within RESIP, optimization will be conducted for each part of the propulsion system, such as the duct and propeller. This involves parameterizing the geometry to automatically generate system geometry by adjusting input parameters. For optimization, input variables are defined, with the objective function aiming to maximize thrust and minimize torque. The optimization process involves defining an initial population, determining the relationship between input and output variables, and applying optimization methods.

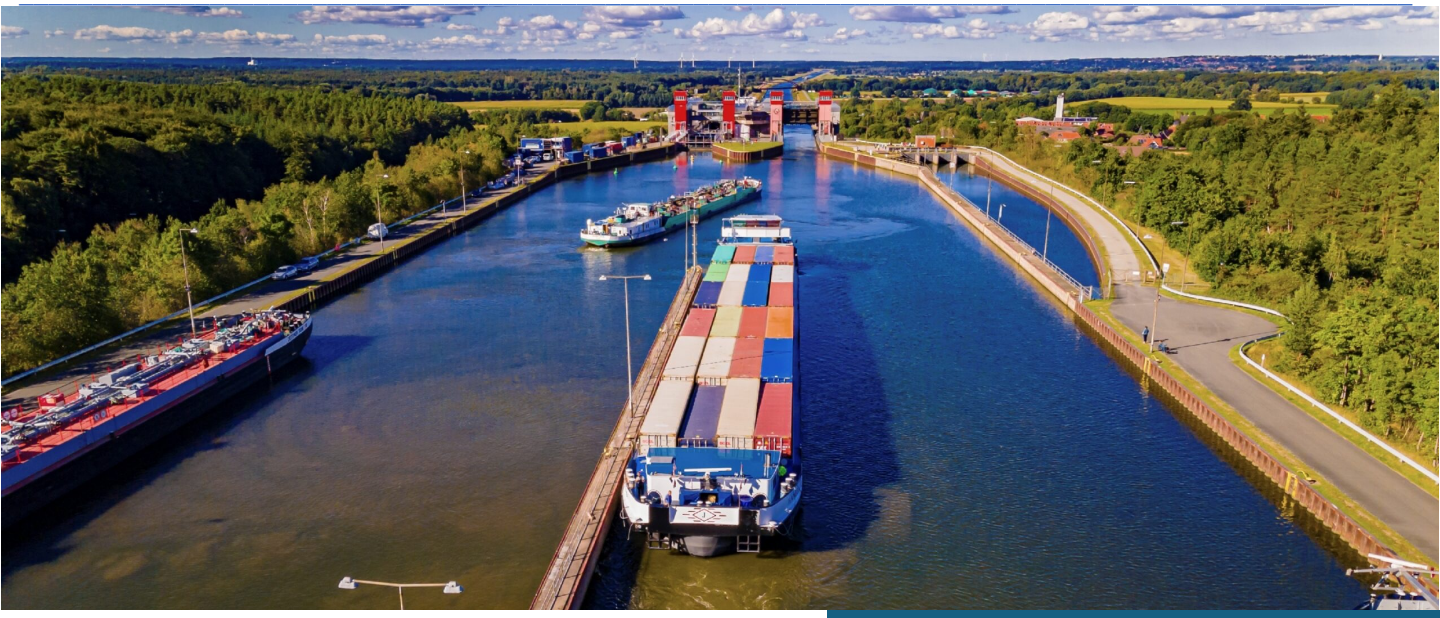
Top

Geometry of a Ducted Propeller: 19A Duct (left), LET Duct (right).

Bottom

Comparison of η_o of propeller KA4.55 within 19A Duct and LET Duct at J=0.7.





RESHIPing … but not only seagoing vessels

Benjamin Friedhoff
DST

As part of WP 3 "Development of hydrogen compatible energy saving devices for maritime and inland ships", DST is investigating energy saving devices (ESDs), that are established for seagoing vessels, for inland vessels. Inland waterway vessels (IWV) sail under operating conditions that are very different from those of seagoing vessels. Accordingly, the ESDs have to be analysed and assessed regarding their applicability for IWVs. It has to be verified if the ESD's functional principles even persist under the operating conditions of inland waterway vessels. For example, all devices and functional principles that are based on sailing in moderate or even high sea states are not applicable to inland waterway vessels, as they do not sail in rough seas. Bridges and narrow waterways exclude wind-assisted propulsion.

The main difference, however, is the regular or even permanent operation of inland vessels in shallow water, often with only a few decimetres of water under the keel. This has a fundamental influence on the ship's hydrodynamics, particularly with regard to the flow conditions at the propulsors and rudders, and hence changes the operating conditions of ESDs accordingly.

The relevance of the specific aft ship lines design in combination with the complex hull-propulsor-waterway interaction will be in the focus of further investigation within RESHIP. The representative baseline design for a CEMT Class Va (L × B: 110 m × 11.4 m) has been selected and will soon be tested in DST's shallow water basin. Afterwards, the design will be optimised and tested again to demonstrate the energy saving potential in realistic loading and water depth conditions.

’The long and winding road …’

Year 3

Year 2

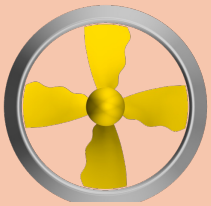
Year 1

Visit and inspection of the ‘’Fortuna Crane’’

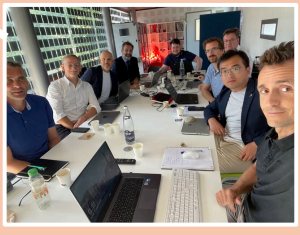
Model construction for testing @ CNR

HydroSil Release Reactor Design and Development

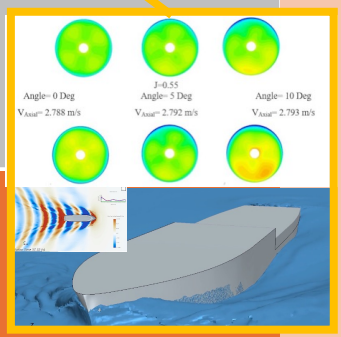
Dry docking of ‘’Fortuna Crane’’



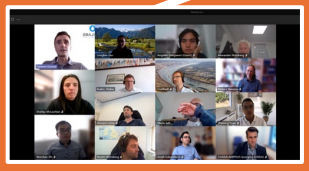
Finalized design of the new (TBC) propeller



In-person meeting hosted by HSL Technologies @ Aix En Provence

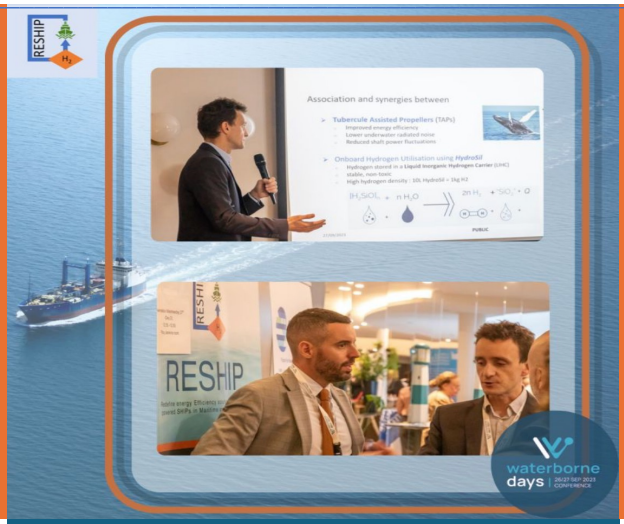


Computational activities for the design of the new (TBC) propeller and ESD



KoF meeting

RESHIP stand and presentation at Waterborne Days 2023

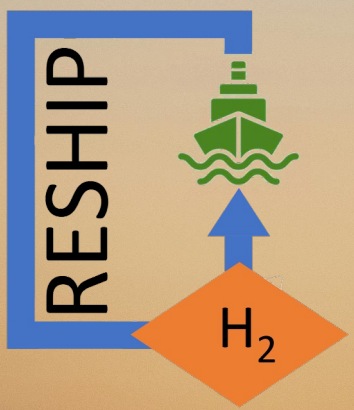


Telling about RESHIP

RESHIP on air @ Italian Television

RESHIP project booth at Zero-Emission Mediterranean 2023

10-12 Oct 2023, Rome



RESHIP PROJECT MANAGER
Daria MATIGNON
HYSILABS
dmatignon@Hysilabs.com

RESHIP PROJECT COMMUNICATOR
Mario FELLI
CNR-INM
mario.felli@cnr.it