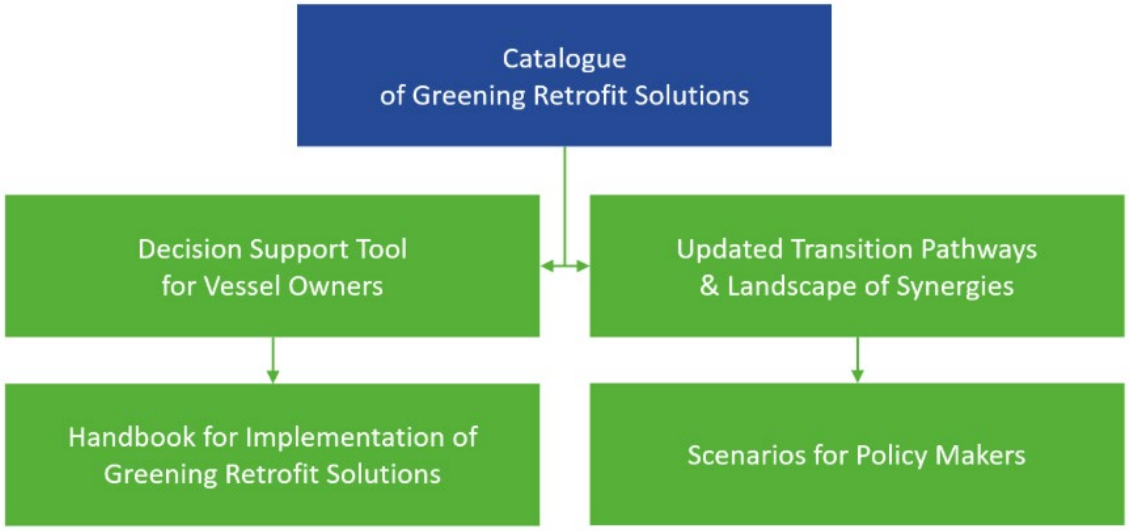
NEWSletter 5

June 2025

30 months of SYNERGETICS

SYNERGETICS – **Synergies for Green Transformation of Inland and Coastal Shipping** – an Innovation Action funded by the Horizon Europe programme of the EU has been operational for 30 months. Establishing synergies between the leading research institutions in the field of ship hydrodynamics and energy transition, innovation centers and shipping industry associations, shipbuilding industry, regulatory bodies, vessel owners, and technology providers, as well as between different European regions, the project is entering its final year of activities with a focus on integrating the knowledge gained so far and creating the Catalogue of Greening Retrofit Solutions, the Handbook for Implementation of Greening Retrofit Solutions and the Scenarios for Policy Makers, supporting the accelerated modernization of coastal shipping and inland waterway transport.



1| SYNERGETICS tools

Activities – Scientific papers

The paper "**Exploration and synchronization of greening of shipping by means of retrofit: the SYNERGETICS perspective**" by Igor Bačkalov, Elimar Frank, Benjamin Friedhoff, Alex Grasman, Justin Jasa, Niels Kreukniet, and Martin Quispel has been published in the book "Transport Transitions: Advancing Sustainable and Inclusive Mobility" in the Lecture Notes on Mobility series. It can be downloaded from the SYNERGETICS website. The following conclusions are drawn: First findings of the Horizon Europe Innovation Action SYNERGETICS are presented. Initial phases of SYNERGETICS integrate the knowledge from past and ongoing research projects (Exploration) with the experience gained from past and ongoing pilots (Synchronisation) to facilitate the green transition of inland and coastal fleets. A comprehensive database of pilot projects was created (The Pilot database) which enabled the identification of the trends in greening of inland and coastal ships. To the best of the authors' knowledge, such a database is unique. It is to be noted that even though the greening of ships is a "hot topic" the relevant information is often scarce. The analysis of the identified trends showed that the shipowners, being faced with large uncertainties linked to implementation of novel technologies, whilst not being sufficiently incentivized, hesitate to engage in greening beyond the pilot application at the lower risk

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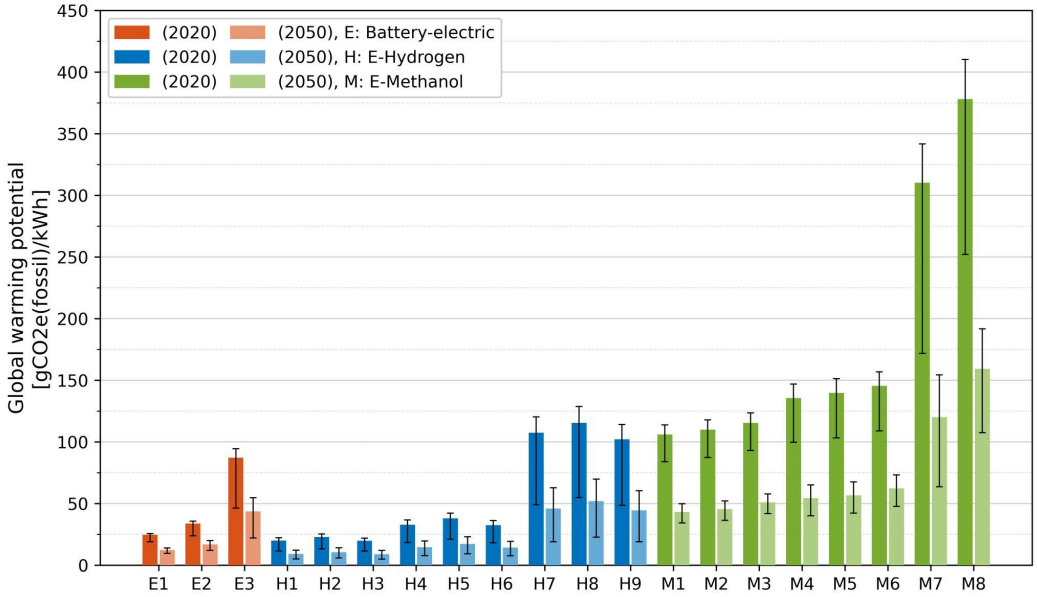
end. Most of the pilots in IWT are performed on small vessels, with lower power demands. In coastal shipping, the total number of pilots is low, and the developments started later than in inland navigation. Thus, the replicability of pilots and the possibilities for scaling up of greening from single vessels to fleets is limited. The potentials of retrofit are still largely untapped, considering that most of the pilots are realized on newbuilds. This is particularly important for inland vessels which have much longer lives than seagoing ships. This gap confirms the importance of SYNERGETICS which focuses on potential of greening of ships by means of retrofit. The Pilot database does not quantify the level of greening attained, e.g., in terms of achieved emissions reduction. A more elaborate assessment would require more sophisticated data, e.g., the information on production of the alternative fuels and the sources of electricity. Therefore, the database registers greening efforts and identifies main directions but does not aim at assessing the achieved environmental performance. This remains the task for the future work of SYNERGETICS.

The study **"Greening of inland and coastal ships in Europe by means of retrofitting: state of the art and scenarios"** authored by Igor Bačkalov, Friederike Dahlke-Wallat, Elimar Frank, Benjamin Friedhoff, Alex Grasman, Justin Jasa, Niels Kreukniet, Martin Quispel, and Florin Thalmann was published in the special issue of the Sustainability journal, dedicated to Sustainable Marine Engineering and Efficient Marine Transportation of Energy. The study explores the trends in greening of shipping (established by using the Pilot database) and analyses what can be achieved in terms of emission reductions (greenhouse gases, nitrogen oxides, and particulate matter) and what would be the corresponding costs of retrofit if the observed trends are scaled up to the fleet level. The following trends are evaluated:

- electrification of small inland passenger ships and seagoing ferries,
- utilization of hydrogen in fuel cells on inland dry cargo vessels of length 110 m and longer,
- utilization of methanol in internal combustion engines of offshore supply vessels.

The analysis has been done both on the well-to-wake and tank-to-wake bases. Furthermore, the analysis was conducted using the values for emissions and costs which applied in 2020, as well as the values estimated for 2050.

The main conclusions are that the "greening" may have many different "shades of green" depending on the choice of technology, assessment basis (well-to-wake or tank-to-wake), and retrofit timeline. Overall, some greening trends were found to be worth following (electrification of ferries and small inland passenger ships), while others may be too cost-intensive and not satisfactorily efficient in terms of emissions reduction (e.g. retrofit of offshore supply vessels with dual-fuel methanol



2| Global warming potential of the green energy supply paths (well-to-tank perspective)

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engines). However, an adequate metrics is needed to properly evaluate the success of greening. Looking into emission reduction only without taking the costs into account may lead to ineffective policies and discourage greening efforts

The paper titled **"Multi-objective CFD optimization to demonstrate the potential of aft-ship replacement as an extreme retrofitting option in IWT"** by Jan Kaufmann, Simon Hauschulz, Benjamin Friedhoff, has been accepted for presentation at IMAM 2025 – The 20th International Congress of the International Maritime Association of the Mediterranean. IMAM 2025 will take place in Crete, from 28 September to 3 October 2025.

The paper elaborates on the potential for reducing the power demand by improved hydrodynamics as part of an aft-ship replacement, which was demonstrated for a typical 50-year-old inland waterway vessel. Utilizing high-fidelity RANS CFD simulations coupled with a parametric model in a fully automated optimization environment allowed for modelling accurately the complex flow resulting from the hull-propeller-duct interaction under shallow water conditions. By using a tailored actuator disk model suited for ducted propellers and carefully selecting model simplifications an efficient simulation setup was employed which finally led to an improvement between 15% and almost 30% compared to the baseline model for the selected representative operating conditions. In the context of reducing dependence on fossil fuels, hydrodynamic optimization can make a significant contribution. In addition to the reduced energy consumption and corresponding cost savings, the investment costs for energy converters and storage systems for low-emission drives are also reduced. Further potential exists if a reduction in the block coefficient is permitted as part of the optimization.

Finally, improving resilience to low water periods through measures against propeller ventilation or other major changes to the ship design are also possible as part of the aft-ship replacement, being, however, out of scope of the research carried out.

Work Package 1 - D1.3: Report on scenarios

This report presents an inventory of policy strategies, scenarios, and legislative initiatives aimed at inland waterway transport (IWT) and coastal shipping concerning the emission reduction objectives set for 2050. It synthesizes insights derived from the SYNERGETICS project, particularly reflecting on the results from Tasks 1.1 and 1.2. In the following the key take-aways are presented:

A one solution fits all is not possible and several low-emission solutions need to be further developed in parallel to meet the EU Green deal targets. The reason is that there are severe uncertainties about the availability and prices of energy carriers, in combination with the variety in fuel characteristics. From the assessment it was concluded that HVO made from renewable feedstocks may not be sufficiently available. Therefore, other solutions will be needed as well, especially for the longer term. Moreover, the requirements and possibilities are rather diverse. For example, container vessels operating on fixed routes may well be positioned to use swappable battery containers as the infrastructure can be developed and containers can be swapped efficiently. However, dry cargo vessels operating on the spot market with varying destinations and sailing areas would probably benefit from energy carriers which have a higher energy intensity and thus provide a larger autonomy for the vessel. In such cases, usage of renewable diesel, bio- or e-methanol or e-hydrogen seem more appropriate.

Further work is needed to provide the full picture on the total cost of ownership, including the operational impacts and price scenarios. This concerns the additional time needed to replenish the energy and the possible loss of cargo space and payload. Furthermore, the risks of selecting one specific technology need to be taken into account. Seen the uncertainty in availability and prices, it is probably better to have some flexibility on board of the vessel to use different solutions in parallel. Dual fuel combustion engines as well as hybrid approaches on electrified vessels could be a smart way to mitigate these risks. The economics need to be further investigated.

A wide range of techniques for retrofit towards green shipping is more or less ready for

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deployment. There is also appropriate available funding from the EU and from some Member States (for example The Netherlands and Germany). However, there is still a gap in the business case. The main bottleneck is that policy regulations are lacking for the actual uptake of these solutions. This is a disadvantage compared to road transport modes and the larger seagoing vessels (>5000 GT) which have binding regulations in place in the EU. The bottleneck in the NRMM regulation regarding the gap in reference fuels (methanol and hydrogen are not recognized) needs to be solved as soon as possible. Furthermore, Member States, River Commissions and the European Commission together need to ensure a coordinated policy framework focussing on creating incentives and financial support for green vessels and retrofitting. It is crucial that external costs need to be internalized to close the gap in the business case and thus to reward and enable the deployment of zero-emission solutions. The Emissions Trading System (ETS) seems to be a suitable and available instrument to be applied for both coastal vessels below 5000 GT and to inland vessels via the fuel supply (ETS2). Revenues from ETS can effectively be used to feed a greening fund for IWT and coastal vessels. With the revised ETS, the legal framework is already in place at EU level. It is therefore now primarily a task for Member States to use this opportunity and to align their national implementation policies to create an effective legal framework synergetic to that of the EU. Moreover, deployment projects using the revenues from ETS need to focus on a holistic approach by including both economic incentives (addressing both CAPEX and OPEX), infrastructure and vessel retrofitting to ensure the competitivity of the IWT and coastal shipping sector. By addressing these bottlenecks, the incentives for the market uptake to green the IWT and coastal shipping fleet will increase, supporting the achievement of the desired energy transition rate.

Work Package 3 – Most recent developments

Demonstration of battery pack application on an inland vessel

Battery-electric drives offer a climate-friendly alternative for inland waterway transport – they improve air quality, reduce noise, and can be quickly implemented because the technology already has a high level of maturity (TRL).

ZESpacks are 20-foot containers with batteries that can be loaded onto ships. They provide energy via a Multipole Quick Power Connector (MQPC). Since 2021 the system has been successfully used on the inland vessel Alphenaar.

3| ZESpacks: placed on the Alphenaar (left) and stored next to a charging station ashore (right)

To facilitate application on more ships, the system is now being further developed: the next generation of ZESpacks. Improvements include, among other things, a more robust container design to prevent damage. The first-generation ZESpacks are designed with a flattened shape and a guiding frame, as well as innovations in the next generation are introduced: positioning on the top deck to enable better crane operation and reduce the risk of damage. In addition, safety measures are being introduced for

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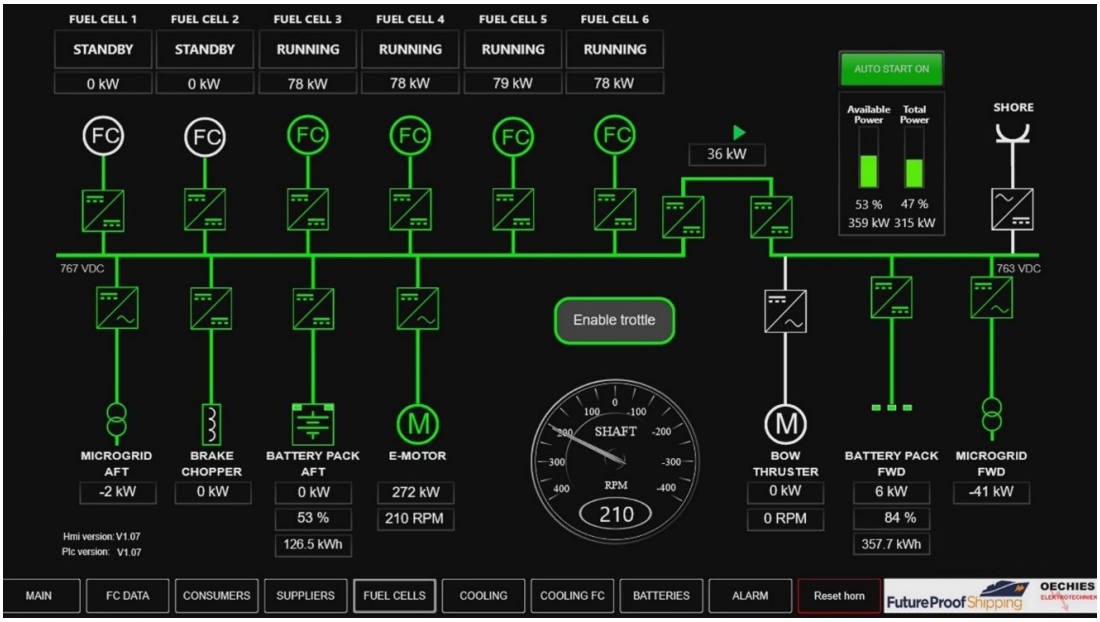
terminal handling, including visual instructions, a lighting system, and an alarm system to prevent incorrect removal. Finally, the MQPC system is being replaced by the Megawatt Charging System (MCS), which has established itself as a global standard, increasing its interoperability with third parties.

Evaluation of Power Management System (PMS)

The Power Management System (PMS) was implemented on two hydrogen-powered inland vessels, H2B1 and H2B2. Both vessels, operated by the SYNERGETICS partner Future Proof Shipping, were converted from conventional diesel propulsion to fully electric systems powered by hydrogen fuel cells. H2B1 served as the test platform for the first version of the PMS, while H2B2 benefited from the subsequent improvements.

The first version of the PMS, installed on H2B1, revealed several challenges in integrating fuel cells and battery systems in a maritime environment. These included limitations in the control software, inefficient battery charging practices, and high manual operation demands, which negatively affected energy efficiency and crew workload. In response, a second version of the PMS was developed and implemented on H2B2. Key improvements included optimized battery charging logic, improved state of charge (SoC) management, automated start-up and shutdown of the fuel cells, and the ability to deactivate non-essential systems while idle. These adjustments led to a significant reduction in energy consumption, improved temperature control, and extended fuel cell lifespan.

Operational experience from both vessels highlights the importance of peak shaving algorithms and predictive control to ensure efficient energy distribution between batteries and fuel cells. Future upgrades are planned to further enhance automation, reduce crew workload, and integrate AI-based predictive algorithms to enable more adaptive and anticipatory energy management.



4| Main page of the PMS human machine interface (HMI) onboard

Final concept design of viadonau pusher

Using HVO100 and Stage V-NRE engines, viadonau has already implemented a very clean and effective measure for greening its fleet. Anticipating a departure from the usage of fossil fuels, a similarly effective solution close to zero emissions was looked at within SYNERGETICS. The analyses performed in this project resulted in the choice of methanol as the only reasonable energy carrier, fulfilling most of the requested design prescriptions, in particular with respect to the bunker independent operation after a severe flood event and the main dimensions.

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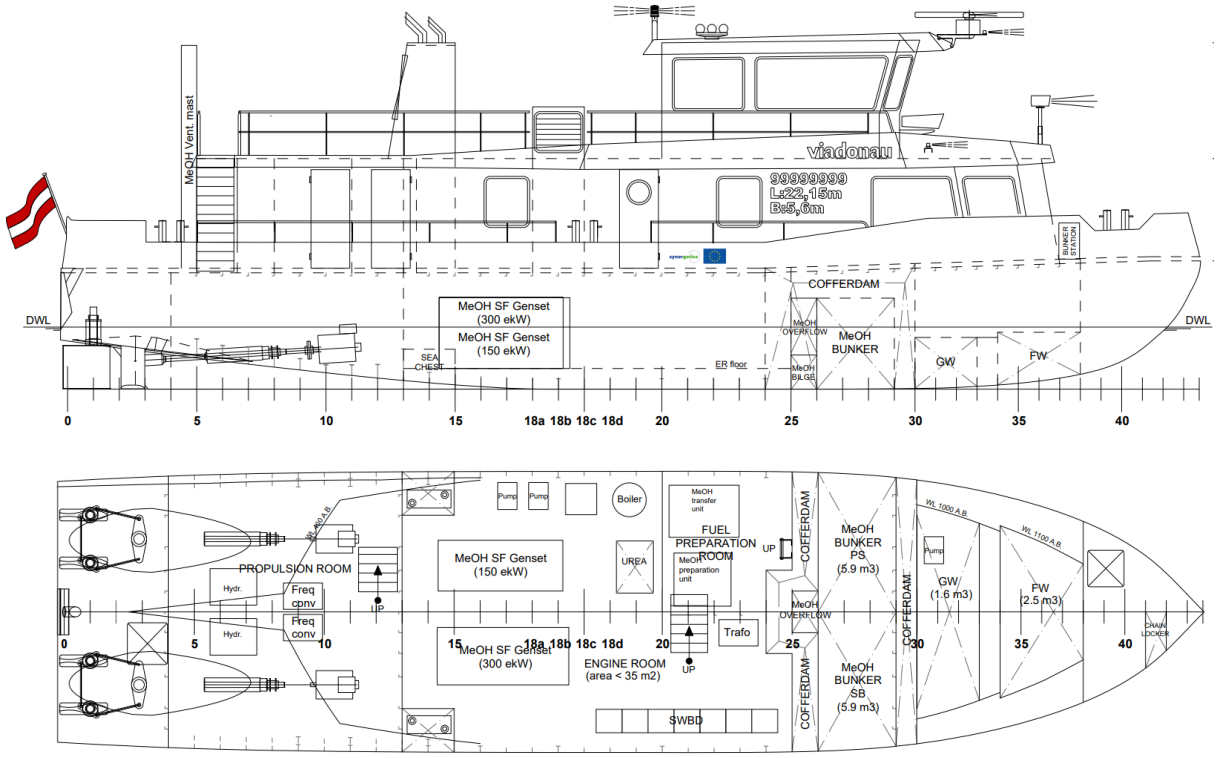
The usage of dual-fuel gensets was considered in the initial stage, however not pursued further as diesel would have been necessary still, and diesel-like alternatives e.g. HVO100 and e-fuels are already or will become available in the future what for the ship technology already exists. Therefore, a pure methanol configuration with two differently sized generators (single fuel, 150 kW, 350 kW) and a battery pack for peak shaving (100 kWh) was chosen.

The concept design was completed with an overall satisfactory result. It was found that only a limited amount of additional superstructure volume is required – not enough to necessitate changes to the vessel's main dimensions when using methanol as fuel. However, it became evident that the use of methanol creates hazardous areas along nearly the entire length of the vessel, making it very difficult to adequately arrange ventilation and access to non-hazardous spaces. Additionally, the increased weight of the methanol-based concept results in a deeper draught, which may require larger scantlings if the design draught is exceeded. The equilibrium trim under the given loading conditions remains within an acceptable range. Initial intact stability (based on the GM value) is sufficient; however, stability at larger heeling angles demands more careful consideration.



5| Final design of the viadonau pusher with methanol-electric propulsion and battery for peak shaving

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Activities – Events

Danube Ports Days 2025

With great pleasure, we are excited to announce that registration is now OPEN for the Danube Ports Days 2025, taking place on 16 to 17 September in Constanta, Romania – a strategic hub at the crossroads of Danube and maritime logistics.

This year's edition will dive into greening technologies and innovative logistics trends, offering two days packed with expert panels, engaging discussions, and networking with key players in the inland waterway transport (IWT) sector.

The event is organized by Pro Danube in collaboration with the Port of Constanta and leading EU-funded projects (SYNERGETICS, PIONEERS Ports, Green Inland Ports), with the support of the Danube Ports Network.

Read more and register here: https://ec.europa.eu/eusurvey/runner/Danube-Ports-Days-2025

When & where:

16 to 17 September 2025

Constanta, Romania

Don't miss out – save the date and join us in shaping the future of Danube logistics!

The Danube Ports Days has become a tradition and is a highly anticipated event for professionals working in and around the Danube IWT sector. It brings together key players from across the industry from port authorities and logistics providers to policymakers, researchers, and innovators.

Waterborne Days 2025

SYNERGETICS was presented during the Waterborne Days 2025, which took place in Brussels on 4 and 5 February 2025.

The focus of the presntation was on the status of the main findings from the analysis of the Pilot database, demonstration of a dual fuel hydrogen combustion engine on a crew transfer vessel, hydrodynamic optimization of the aft-ship of a motor cargo vessel, comparison of different approaches to utilization of methanol in internal combustion engines: dual fuels vs. single fuel, and the Catalogues of Greening Retrofit Solutions and its derivatives, i.e. the Fact Sheets. During the Waterborne Days, SYNERGETICS used the unique chance to interact and exchange the experiences gained so far with its sister-project Green Marine, funded under the same call, and coordinated by the University of Strathclyde.

ECMAR

SYNERGETICS was also presented during the ECMAR (European Council for Maritime Applied Research) session dedicated to the thematic area "Energy transition: energy efficiency, low- and zero-emission fuels" of the new ECMAR Strategic Research Agenda.

PLATINA4Action – Third Technology Transfer Workshop

The third PLATINA4Action Technology Transfer Workshop took place in Duisburg on 26 May 2025, bringing together innovators, technical experts, and barge operators to share tangible progress towards the greening of the IWT fleet.

The workshop was organised and hosted by DST – Entwicklungszentrum für Schiffstechnik und Transportsysteme e. V., in collaboration with the German innovation project BinSmart and the Innovation Action SYNERGETICS.

With a focus on pilot applications, discussions covered: battery-electric propulsion and hybrid systems, alternative fuels, port infrastructure and fuel-efficient solutions.

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6| PLATINA4Action workshop in Duisburg

Once again, the PLATINA4Action workshop served as an engaging forum for exchanging lessons learned and reflecting on the state of the art, as well as the innovative solutions needed to accelerate the transition to low- and zero-emission inland navigation.

The presentations are available on the PLATINA4Action website: https://lnkd.in/eijjGi2G

The fourth Technology Transfer Workshop will take place in Budapest on 3 November 2025.

LSSTF 2025

The LSSTF2025 was successfully carried out on 26 June 2025, in Graz and online. It was dedicated to innovative, sustainable technologies in shipping, promoting climate-friendly propulsion solutions through collaboration between research, industry, and policy. While the former LSSTF events were dealing mainly with maritime shipping, the focus of this particular event was expanded to include also inland shipping. Seventeen expert presentations by international specialists highlighted current developments and projects. Increasing the visibility and reach of SYNERGETICS, Cristian Chirita (viadonau) and Gianluca Giurco (MARIN) gave a common presentation with the title: **SYNERGETICS: demonstration of the use of digital tools and virtual assets in finding the optimal greening solution for inland vessels.**

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Coordinator:

DST – Entwicklungszentrum für Schiffstechnik und Transportsysteme e. V. (DE)

Partners:

SPB – Stichting Projecten Binnenvaart (NL)
Scandinaos AB (SE)
MARIN – Maritime Research Institute Netherlands (NL)
viadonau – Österreichische Wasserstraßen-GmbH (AT)
TTS – Transport Trade Services GmbH (AT)
ZT Büro Anzböck Richard (AT)
EUFRAK – Euroconsults Berlin GmbH (DE)
CRS – Hrvatski Registar Brodova (HR)
OST – Ostschweizer Fachhochschule (CH)

Argo-Anleg GmbH (DE)
FPS – Future Proof Shipping (NL)
Mercurius Shipbuilding BV (NL)
ZES – Zero Emission Services (NL)
Compagnie Fluviale de Transport (FR)
Sogestran (FR)
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