

**OVERVIEW OF RESEARCH AND DEVELOPMENT
RELATED TO MARITIME DECARBONIZATION -
GLOBAL PERSPECTIVES**

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MARITIME AND SUSTAINABILITY

IMO
World Maritime Theme for 2022
New Technologies For Greener Shipping

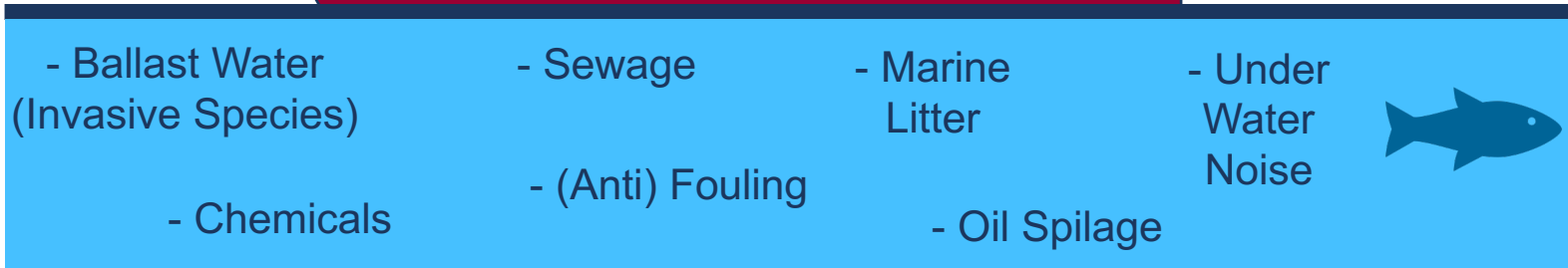


IMO
World Maritime Theme for 2023
MARPOL at 50 – Our commitment goes on

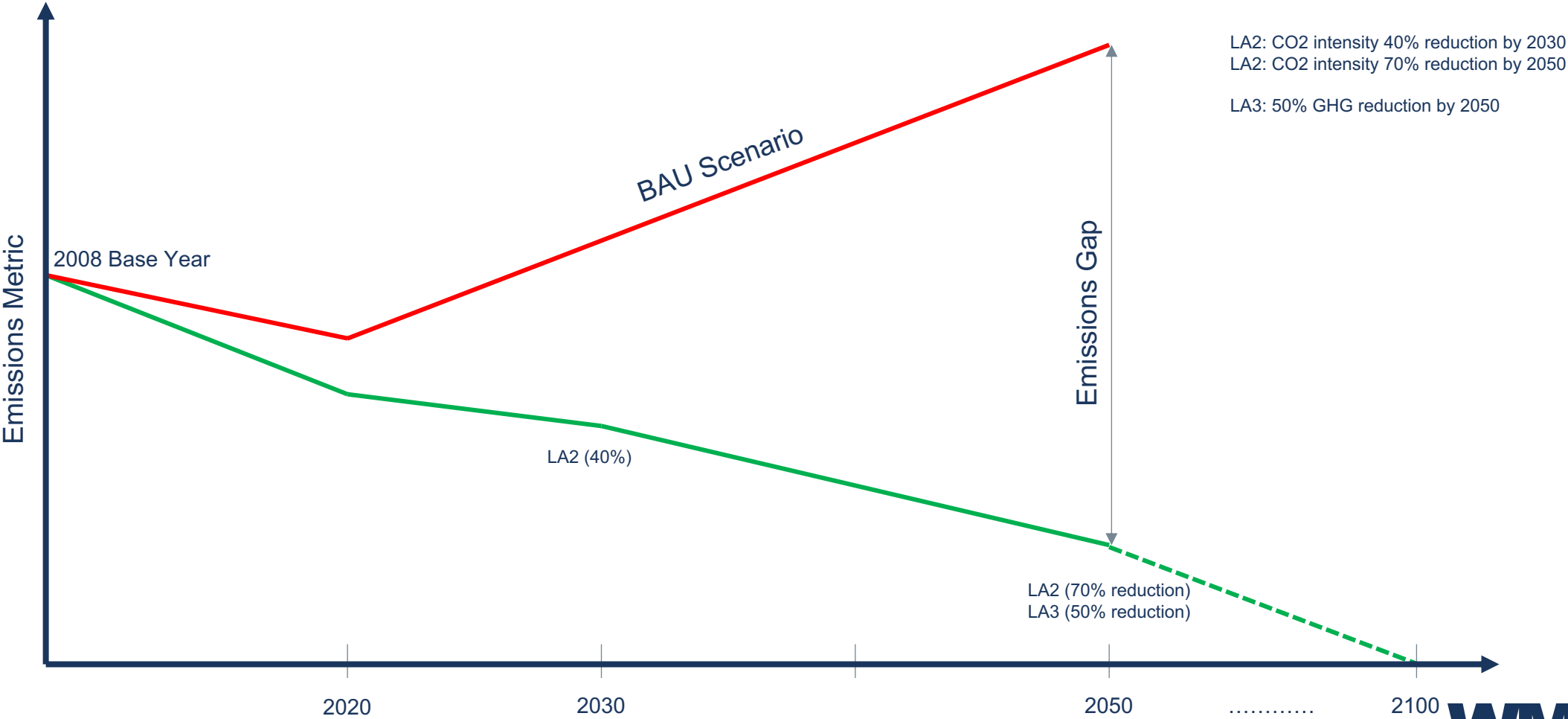


MARPOL AT 50
OUR COMMITMENT GOES ON

IMO
World Maritime Theme for 2020
Sustainable Shipping for a Sustainable Planet



IMO AMBITIOUS TARGETS AND EMISSIONS GAP



THE NECESSITY OF INNOVATION & RESEARCH

- ❑ No single existing or emerging “silver bullet” technology
- ❑ Ambitious decarbonisation targets, therefore it requires a game changer (*innovation and thereby relevant research and development*)
- ❑ Clean energy innovation pipeline
 - ❑ Prototype
 - ❑ Demonstration
 - ❑ Early adoption
 - ❑ Mature
- ❑ Cost barrier: Commercially viable new technologies
- ❑ Non-cost related barriers

}
Research
&
Policy Making

RESEARCH HISTORY ON MARITIME DECARBONISATION

- ❑ 2000 – 2004 Initial stage
- ❑ 2005 – 2008 Interest in decarbonisation and emission reduction
- ❑ 2009 – 2012 Growing research
- ❑ 2013 – 2016 Greater diversity from ship's operations to alternative fuels to policy amendments
- ❑ 2017 – Peak

HYSEAS III

- To look into the theory of **hydrogen powered vessels** (HySeas I), followed by a detailed technical and commercial study to design a **hydrogen fuel cell powered vessel** (Hyseas II 2014-2015).
- To build on the first two parts by aiming to demonstrate that fuel cells may be successfully integrated with a proven marine hybrid electric drive system (electric propulsion, control gear, batteries, etc), along with the associated hydrogen storage and bunkering arrangements.
- To build a zero emission car ferry to serve the island of Shapinsay in Orkney



Start date

1 July 2018

End date

30 June 2022

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 10 818 910,83

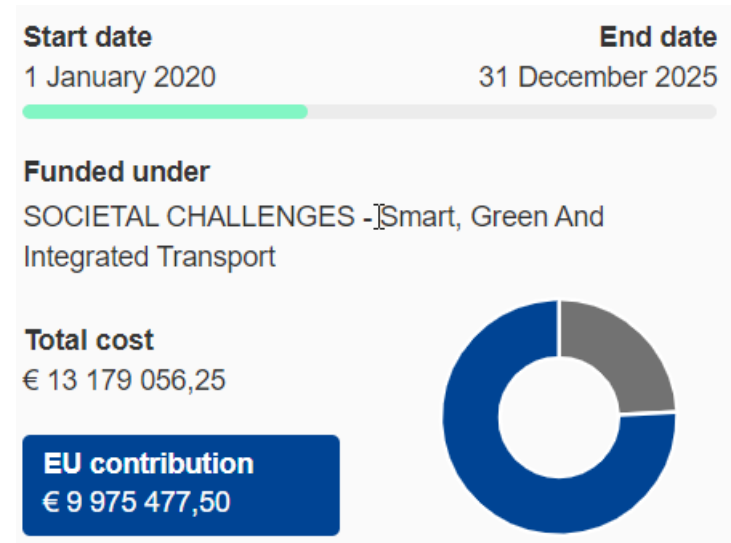
EU contribution

€ 7 886 390,14



SHIPFC - PILOTING MULTI MW AMMONIA SHIP FUEL CELLS

- To demonstrate that long-range zero-emission voyages with high power on larger ships is possible.
- Innovation areas
 - **Ammonia fuel cells** in shipping: The key to project impact is the demonstration of a high-power ammonia fuel cell onboard
 - **Green ammonia**: For the demonstrator vessel green ammonia will be used as fuel
 - The replicators: The ShipFC project will perform studies on three other vessel types and operational profiles, including 20+MW systems, to illustrate the ability to transfer the technology to other segments of the shipping industry.

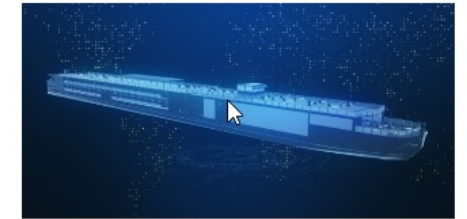


FASTWATER - FAST TRACK TO CLEAN AND CARBON-NEUTRAL WATERBORNE TRANSPORT

- Focus on **methanol as green alternative fuels**
- Objectives:
 - Demonstrate the overall feasibility under operational conditions, when our demo-cases test methanol in service
 - Develop and demonstrate universal, scalable retrofit kits for converting ships to methanol use for a wide power range (200 kW – 4 MW)
 - Develop the **next generation of methanol-fuelled engines** for further advances in efficiency, and further reductions in emissions and costs
 - Demonstrate the complete supply chain from renewable methanol producers to ship bunkering, including setting up bunkering procedures for safe and efficient bunkering
 - Develop a training programme for crews, gain experience with the FASTWATER Demo-cases and formulate best practices for use beyond FASTWATER
 - Life cycle performance assessment to analyse investment costs, CO2 savings and pollutant reductions



Harbour tug



River cruise ship



Pilot boat



Coast guard vessel

Start date

1 June 2020

End date

31 May 2024

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 6 357 962,50

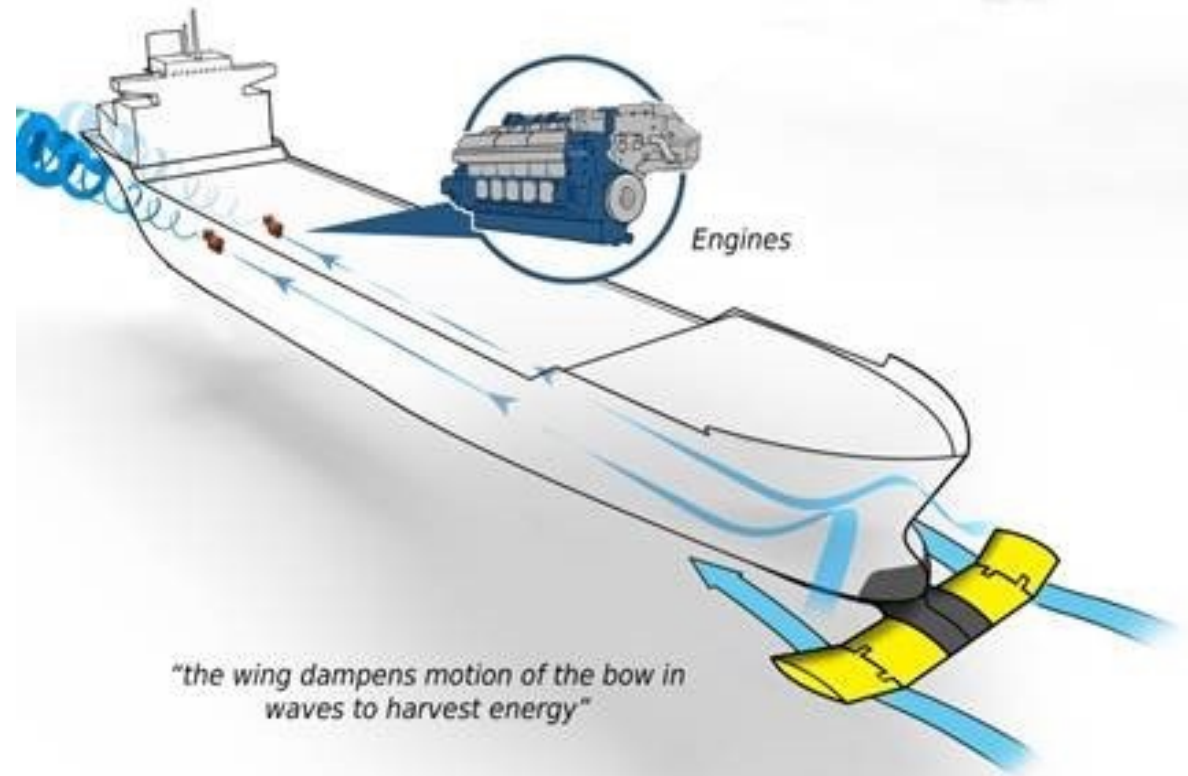
EU contribution

€ 4 999 217,51



SEATECH2020

- To aim at developing **two symbiotic ship engine and propulsion innovations** that when combined, could lead to a 30% reduction in fuel consumption.
- 99% reductions in emissions of sulphur oxides (SOx) and nitrogen oxides (NOx), a 46% reduction in CO2 emissions, and a 94% reduction in particulate matter emissions.
- To help reduce the emissions of the shipping industry through the symbiotic use of new engine technology and biomimetic flapping foils.



Start date

1 June 2020

End date

31 May 2023

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SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 6 478 472,25

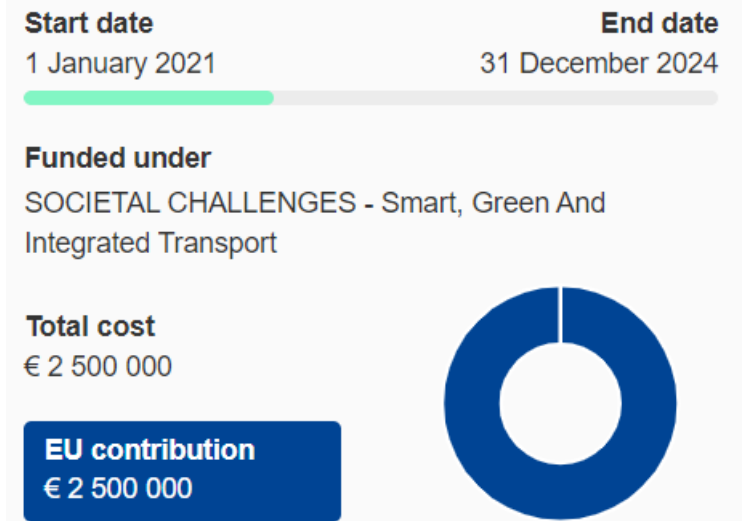
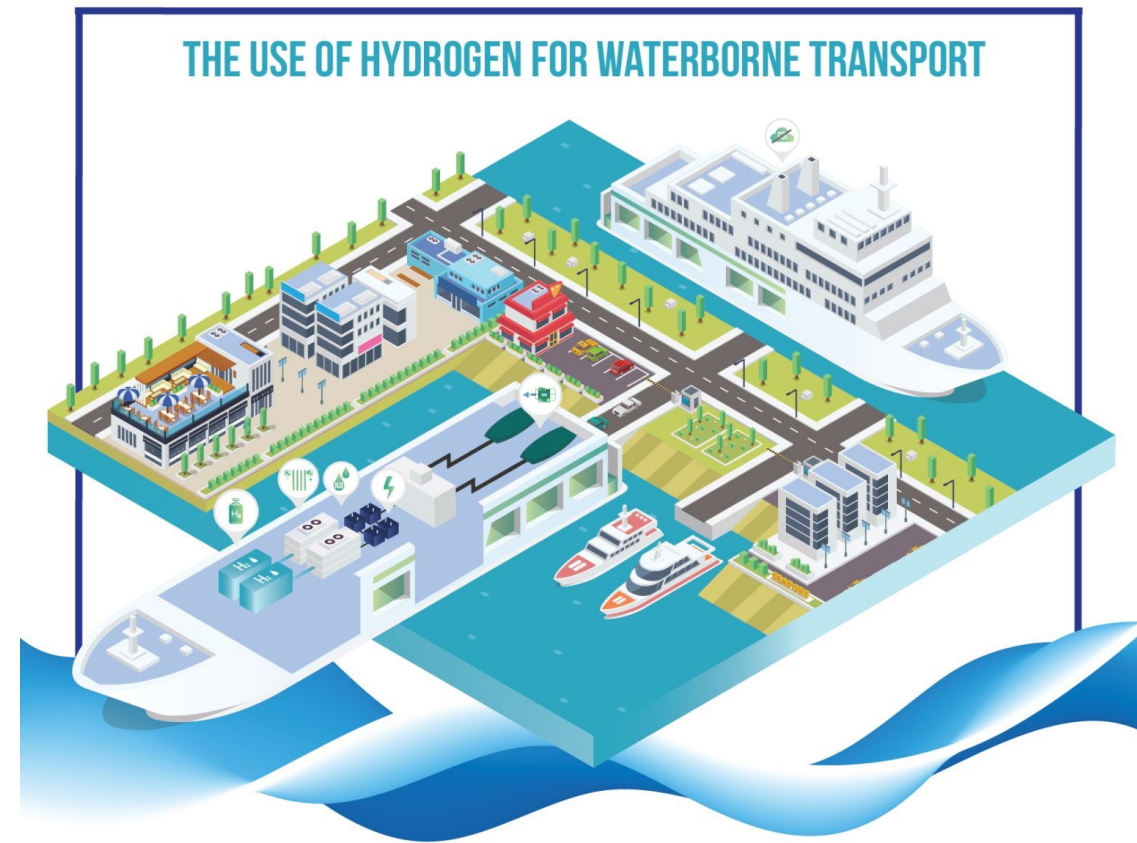
EU contribution

€ 4 999 243



E-SHYIPS - ECOSYSTEMIC KNOWLEDGE IN STANDARDS FOR HYDROGEN IMPLEMENTATION ON PASSENGER SHIP

- To define the new guidelines for an effective introduction of hydrogen in maritime passenger transport sector
- To boost its adoption within the global and EU strategy for a clean and sustainable environment, towards the accomplishment of a zero-emission navigation scenario



HYSHIP - DEMONSTRATING LIQUID HYDROGEN FOR THE MARITIME SECTOR

- To lower the development and operational cost of a wider move to **LH₂ for ship propulsion throughout Europe**. The EUR 8m funding from the EU's Research and Innovation programme Horizon 2020 under the Fuel Cells and Hydrogen Joint Undertaking (FCH2 JU) is subject to the signing of a grant agreement by the HyShip partners by the end of this year.
- To work on design and construction of **a new ro-ro demonstration vessel running on liquid green hydrogen (LH₂)**, as well as the establishment of a viable LH₂ supply chain and bunkering platform.



Start date

1 January 2021

End date

31 December 2025

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 10 796 560

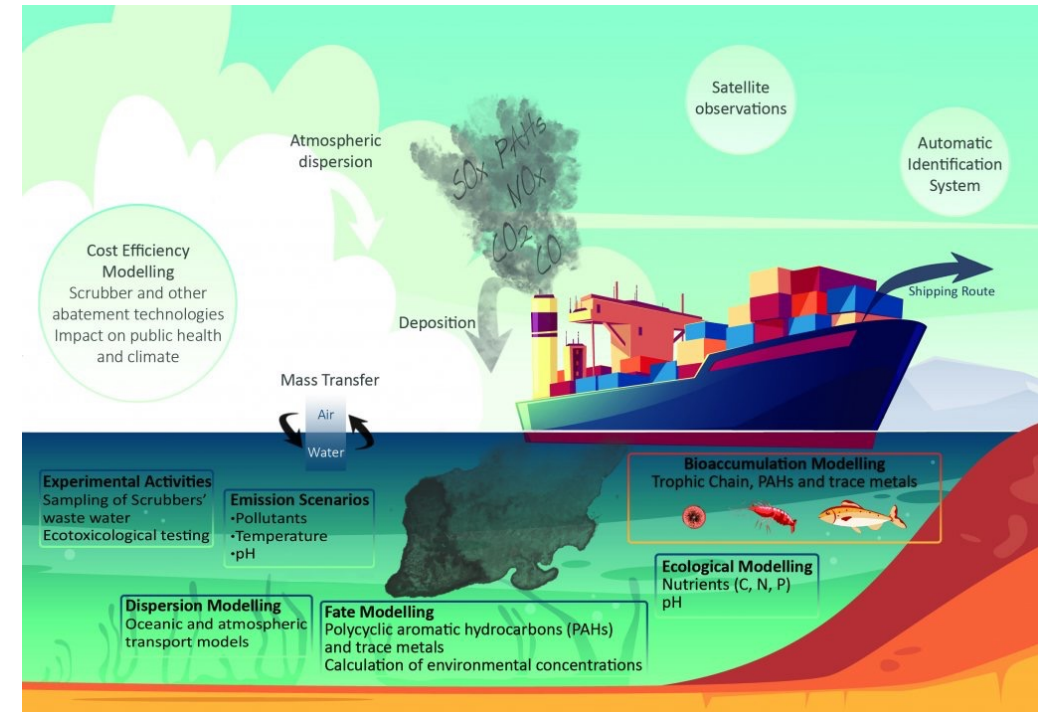
EU contribution

€ 7 993 942



EMERGE - EVALUATION, CONTROL AND MITIGATION OF THE ENVIRONMENTAL IMPACTS OF SHIPPING EMISSIONS

- To aim at quantifying and evaluating the effects of potential emission reduction solutions for shipping in Europe and developing effective strategies and measures to reduce the environmental impacts of shipping.
- To analyze the complex interactions between technological options, pollutant emissions and dispersion, and the environment



Start date

1 February 2020

End date

31 January 2024

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 7 493 885

EU contribution

€ 7 493 885



GATERS - GATE RUDDER SYSTEM AS A RETROFIT FOR THE NEXT GENERATION PROPULSION AND STEERING OF SHIPS

- To design, manufacture and install a retrofit **Gate Rudder System (GRS)** and demonstrate the effectiveness of the retrofit GRS through sea trials and voyage monitoring.
- The retrofit solution for GRS will directly improve the vessels performance in energy efficiency and CO2 emission.
- Impacts:
 - Reduction of noise and vibration: positive environmental impact of the GRS associated with improvements of the aft-end vibrations, cavitation and reduced underwater radiated noise.
 - Reduction in CO2, SOX, NOX, and PM emission figures proportionately based on the fuel consumption reduction figures.
 - Anticipated 10% fuel saving in calm weather conditions and up to 15% in-service conditions in comparison to conventional rudder systems.

GATERS



Start date

1 February 2021

End date

31 January 2024

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 5 878 364,25

EU contribution

€ 4 999 509,98



NAUTILUS - NAUTICAL INTEGRATED HYBRID ENERGY SYSTEM FOR LONG-HAUL CRUISE SHIPS

- The ultimate goal is to fully cover the power demand of cruise ships with the SOFC-battery technology, to fully power the ship on renewable fuels.
- To cut greenhouse gas (GHG) emissions by 50% and all other diesel engine exhaust gas emission components almost entirely.
- The concept consists of a Solid Oxide Fuel Cell (SOFC)-battery hybrid genset integrated with existing Internal Combustion Engine (ICE) generators.



Start date

1 July 2020

End date

30 June 2024

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 7 892 362,50

EU contribution

€ 7 892 362,50



AIRCOAT - AIR INDUCED FRICTION REDUCING SHIP COATING

- To reduce energy consumption and ship emissions, as defined by the EU Green Deal looking to reduce gas emission for the ship industry by 40% by 2030.
- To avoid the release of biocide substances of underlying coatings to the water and mitigate the radiation of ship noise
- The air barrier created by the AIRCOAT foil further will limit the attachment of fouling and consequent invasive species translocation.
- To help to understand and validate environmentally friendly initiatives within the maritime industry, paving the way for further marine research initiatives that reduce our footprint in the oceans.



Start date

1 May 2018

End date

30 April 2022

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 5 901 541,25

EU contribution

€ 5 299 097,38



MAGPIE - SMART GREEN PORTS AS INTEGRATED EFFICIENT MULTIMODAL HUBS

- To address the missing link between green energy supply and green energy use in port-related transport and the implementation of digitisation, automation, and autonomy to increase transport efficiency.
- To develop a **Masterplan for European Green Ports**; a roadmap thereto and a handbook to accelerate the development of sustainable maritime and inland European ports.



Funded by
the European Union

This project has received funding from the European Union's Horizon 2020 (MFF 2014-2020) research and innovation programme under Grant Agreement 101036594

Start date

1 October 2021

End date

30 September 2026

Funded under

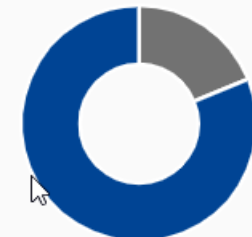
SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 30 764 358,84

EU contribution

€ 24 964 564,23

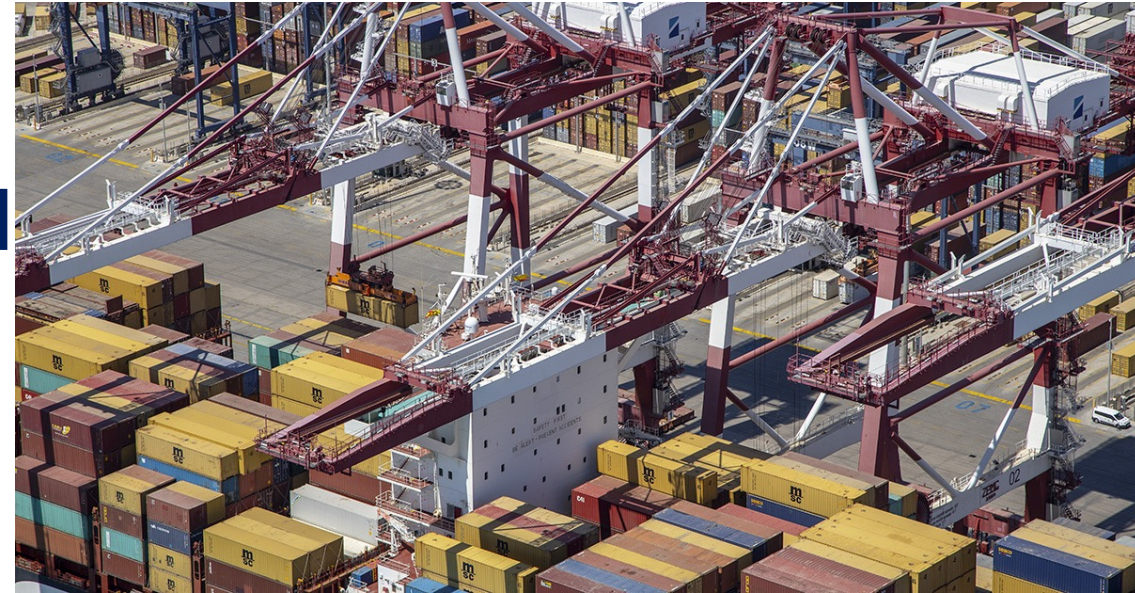


PIONEERS - PORTABLE INNOVATION OPEN NETWORK FOR EFFICIENCY AND EMISSION REDUCTION SOLUTIONS

- To address the challenges faced by European ports to reduce their environmental impact while remaining competitive in a sector characterised by continuous growth.

• OBJECTIVES

- Reduce the port's total environmental footprint
- Deploy sustainable port infrastructure beyond energy supply and demand
- Introduce eco-friendly improvements relying on digitalisation and new methods of operation
- Co-define and transfer pioneers's demonstrations to fellow ports
- Deliver and disseminate a Port Master Plan for the transition towards GHG-neutral shipping and wider multimodal mobility by 2050



Start date

1 October 2021

End date

30 September 2026

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 33 465 726,63

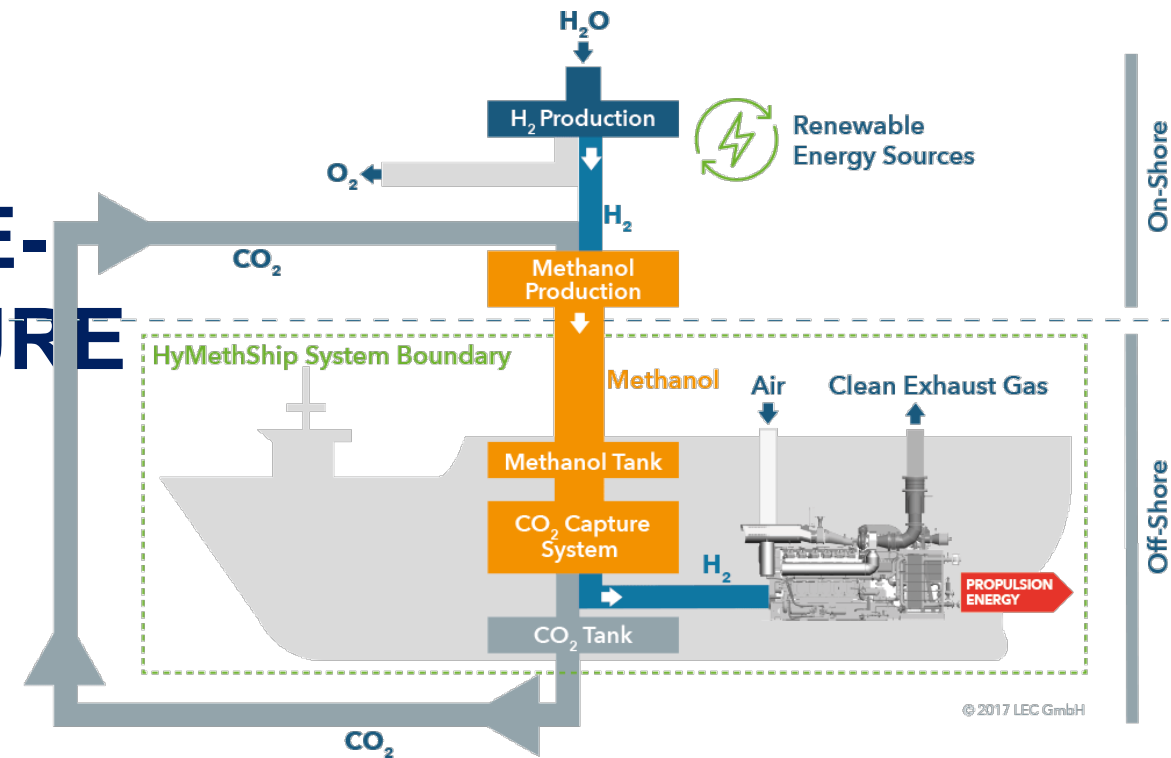
EU contribution

€ 24 999 997,26



HYMETHSHIP - HYDROGEN-METHANOL SHIP PROPULSION SYSTEM USING ONBOARD PRE-COMBUSTION CARBON CAPTURE

- To drastically reduce emissions and improve the efficiency of waterborne transport at the same time
- Combining a membrane reactor, a CO₂ capture system, a storage system for CO₂ and methanol as well as a hydrogen-fueled combustion engine into one system. The proposed solution reforms methanol to hydrogen, which is then burned in a conventional reciprocating engine that has been upgraded to burn multiple fuel types and specially optimized for hydrogen use.



Start date
1 July 2018

End date
31 December 2021

Funded under
SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost
€ 9 288 310

EU contribution
€ 8 438 110



CHEK - DECARBONISING SHIPPING BY ENABLING KEY TECHNOLOGY SYMBIOSIS ON REAL VESSEL CONCEPT DESIGNS

- CHEK develops and demonstrate two vessel designs, equipped with an interdisciplinary combination of innovative technologies working in symbiosis
 - a wind energy optimised bulk carrier
 - hydrogen powered cruise ship –
- To reduce greenhouse gas emissions by 99% and achieve at least 50% energy savings.



Start date

1 June 2021

End date

31 May 2024

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 9 999 996,25

EU contribution

€ 9 999 996,25



ENGIMMONIA - SUSTAINABLE TECHNOLOGIES FOR FUTURE LONG DISTANCE SHIPPING TOWARDS COMPLETE DECARBONISATION

- Proving the capabilities and the key role of ammonia as the most promising clean fuel for the future of the shipping sector, demonstrating clean energy solutions for on-board electricity and HVAC, fostering replicability at business, regulatory, policy and naval classification
- Three pillars in ENGIMMONIA:
 - Development of **Ammonia Engine with low GWP**
 - Clean Energy technologies integrated on-board
 - Technology replication at the regulatory and business level



Start date

1 May 2021

End date

30 April 2025

Funded under

SOCIETAL CHALLENGES - Smart, Green And Integrated Transport

Total cost

€ 9 500 000

EU contribution

€ 9 500 000



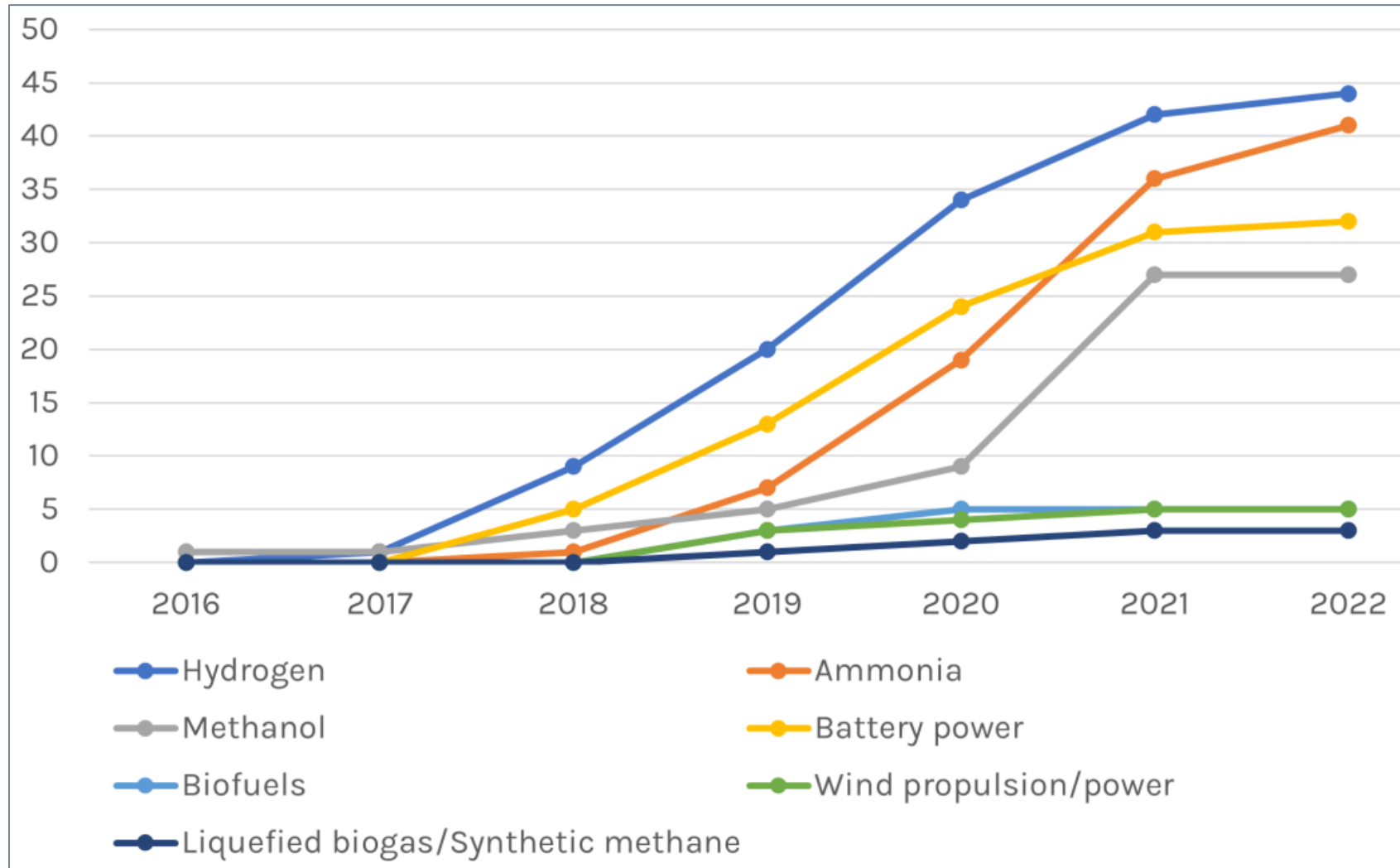
NORDIC MARITIME TRANSPORT AND ENERGY RESEARCH PROGRAMME

- HOPE - Hydrogen fuel cells solutions in shipping in relation to other low carbon options – a Nordic perspective
 - Assess the potential role for hydrogen and fuel cell solutions for decarbonizing the Nordic shipping sector in relation to other low or zero carbon fuel solutions by including technology evaluation and impact assessment covering potential, environmental, economic and policy aspects.
- AEGIR - Ammonia electric marine power for GHG emission reduction
 - Establish a design concept for a fully electric ammonia-fueled ship powertrain without CO₂-emissions and having a tank-to-electricity efficiency > 60%

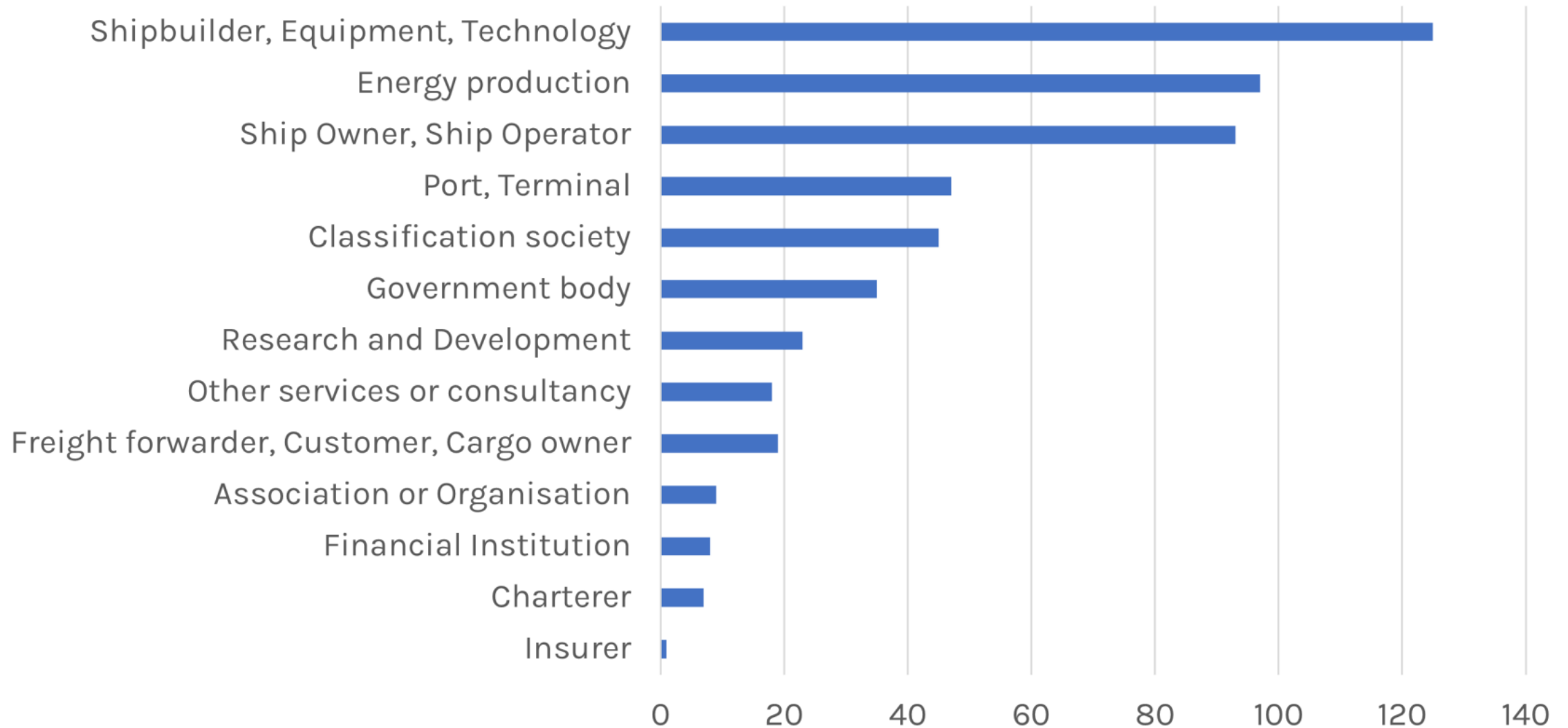


- CAHEMA - Concepts of NH₃/H₂ engines for marine application
 - Investigate innovative injection and combustion strategies using ammonia and hydrogen in combination, to achieve Reactivity Controlled Compression Ignition (RCCI) and Direct-injection dual fuel stratification (DDFS) with these fuels.

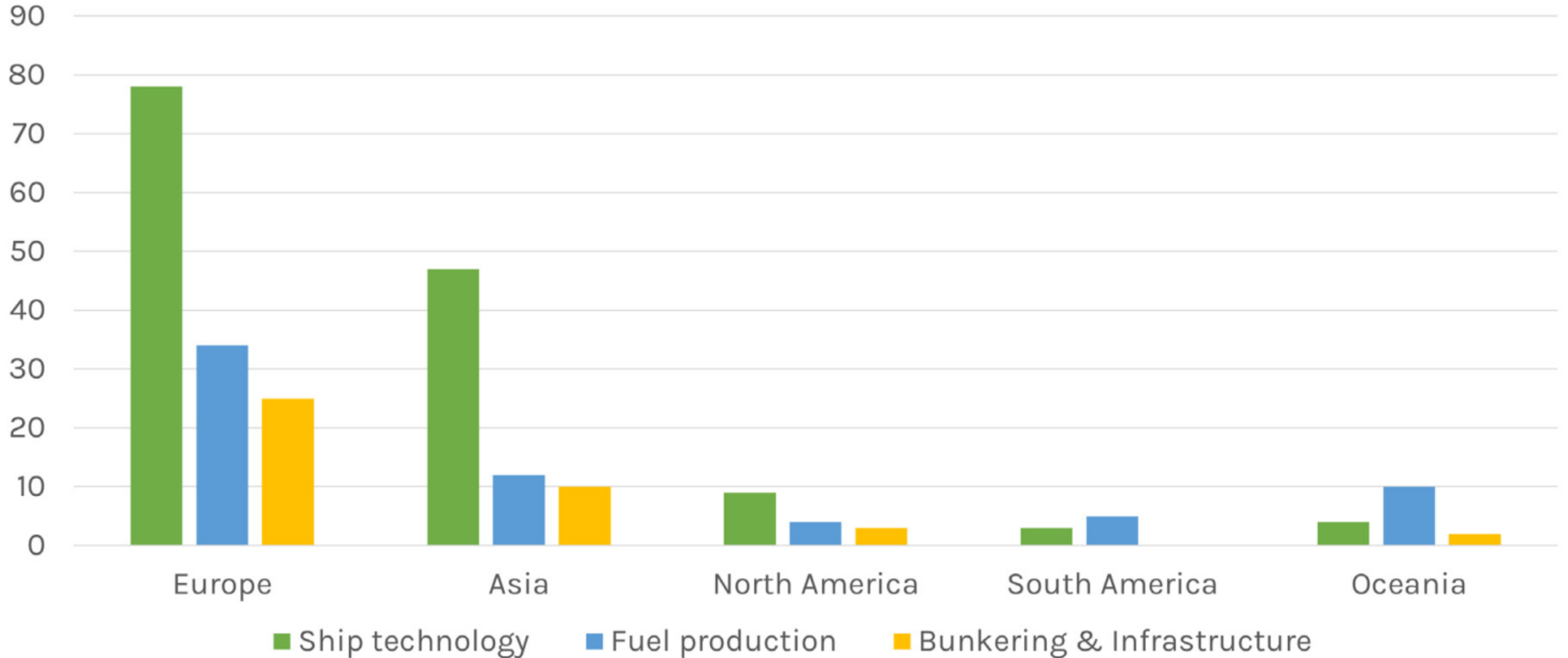
PROJECTS BY ENERGY SOURCE FOCUS



PROJECTS BY THE VALUE CHAIN

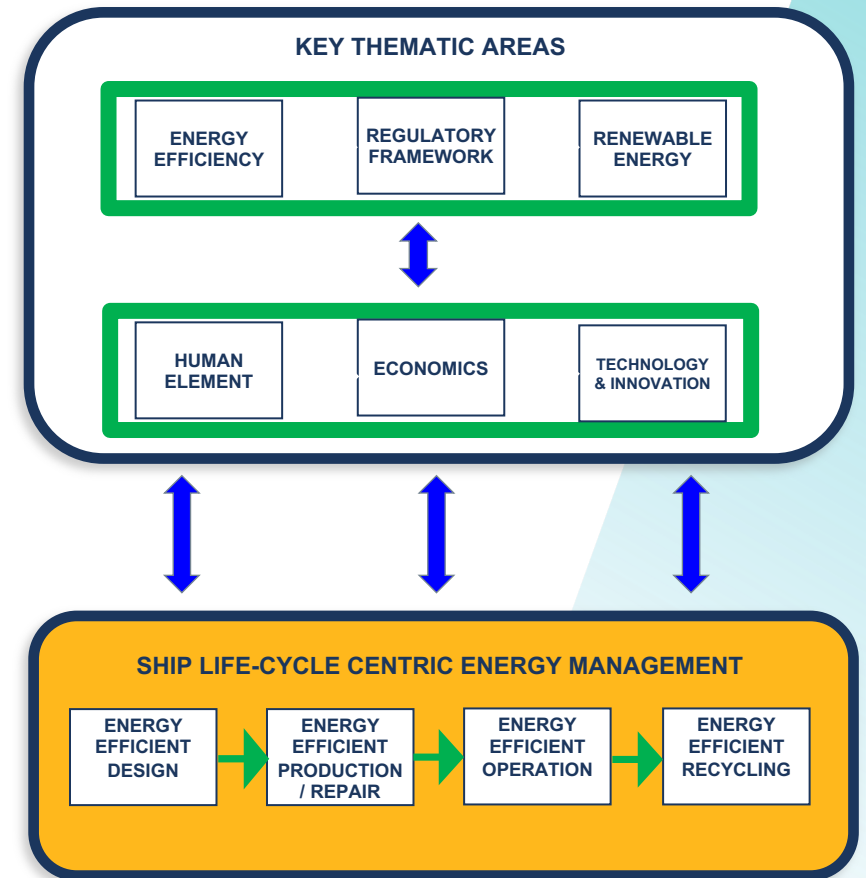


PROJECTS BY REGION

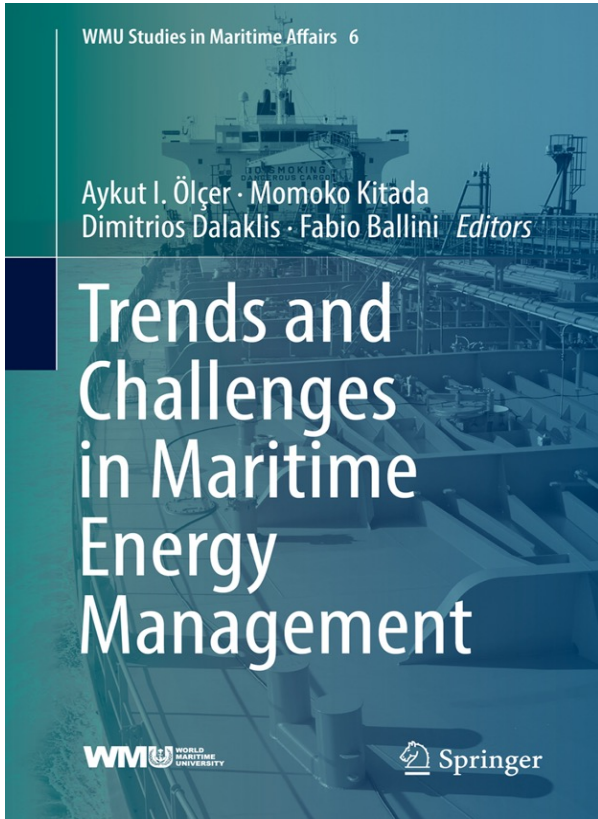


RESEARCH GAPS & TRENDS

- ❑ Holistic and transdisciplinary centric research inc. Global Collaboration amongst all stakeholders and capacity building
- ❑ Alternative Fuels, Electrification and renewable energy
- ❑ Financing of decarbonisation
- ❑ Life-cycle cost/environmental analysis of the measures
 - ❑ Impact assessments of the measures on LDCs and SIDS
- ❑ More on economic measures inc. ETS, MBM etc.
- ❑ Life-cycle perspective within energy and maritime supply chain
- ❑ Trade-off between smarter, safer and greener



- ❑ Empowering women in the maritime industry and
- ❑ Building resilience for disruptions such as COVID-19



THANK YOU

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