



La nuova frontiera della navigazione a idrogeno

Con particolare attenzione alla navigazione su fiumi e laghi!

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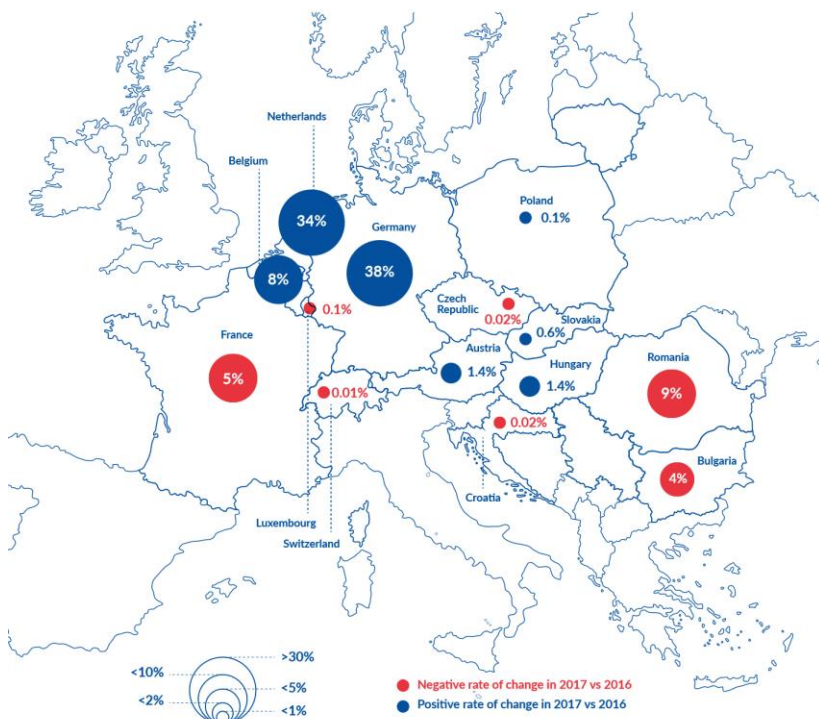
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Hydrogen Joint Research Platform by Politecnico di Milano

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State of the art of inland water transport

SHARE OF THE COUNTRIES' TKM IN TOTAL TRANSPORT PERFORMANCE IN EUROPE
(SHARE IN %)



CCNR Annual report 2019

Europe green policy is pushing the inland water transport in respect to the road transport

Some European countries have already a very good share for inland transport

In Italy the share of the inland water transport for good and people is minimal

Today the vast majority of vessels for transportation operates on fossil fuels

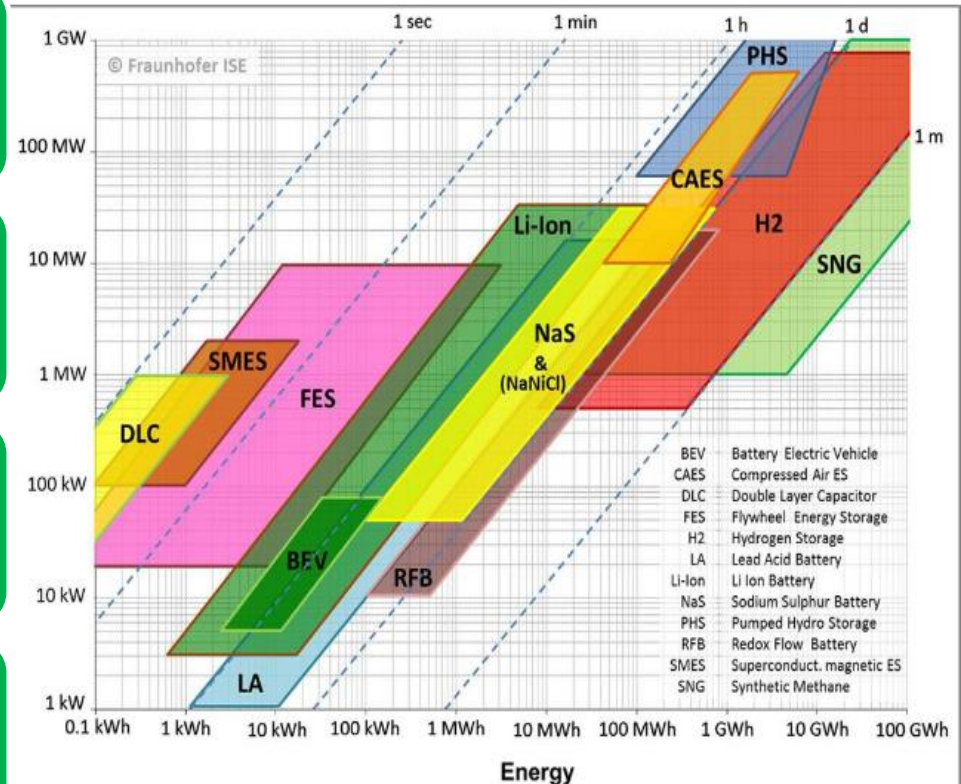
Competitive advantages of hydrogen

Hydrogen offers a way to have carbon dioxide and pollutant zero emission at the point of use

Hydrogen usage for vehicles is more convenient, in respect to batteries, for higher the payload of the vehicle

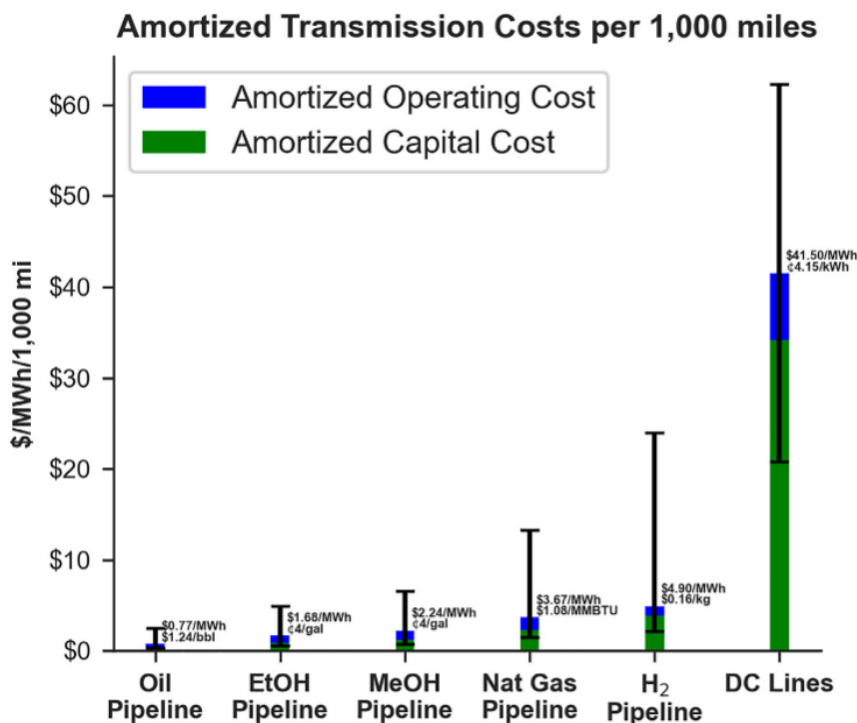
Hydrogen vehicles have ranges comparable with conventional fossil fuels vehicles

Hydrogen is suitable for long term storage



Shivakuma *et al*, 2021

Competitive advantages of hydrogen



DeSantis *et al*, 2021

Transmission and refuelling infrastructure have to be taken in account:

- Moving energy in the form of hydrogen is cheaper and easier compared to electric lines
- Refuelling hydrogen vehicles takes minutes, compared to the hours of the battery electric vehicles
- One hydrogen refuelling station can satisfy the needs of more vehicles

Competitive advantages of hydrogen



Picture: Yacht daily

EXAMPLE:

The refuelling of 10 battery electric vehicles over night can take up to 2 MW from the grid, while the same fleet powered by hydrogen would take less than 1 hour to refuel

In short, hydrogen is extremely competitive when managing big fleets with high utilization factors and low depot time



Hydrogen: A small molecule with big potential

Most abundant element on the planet, but extremely reactive

To obtain hydrogen there are a series of well established processes:

- Reforming from fossil fuels
- Water electrolysis
- Waste to gas (biochemical)

Hydrogen can be converted into thermal and mechanical/electric power via:

- Thermal process: flame- and catalytic burner
- Thermomechanical process: Internal combustion engine
- Electrochemical process: Fuel cell

Hydrogen can be used as decarbonized feedstock to produce e-fuels, such as ammonia or methanol



Hydrogen water transport ongoing projects

TITLE

FLAGSHIP – Clean waterborne transport in Europe

TIMELINE

2019-2023 (Ongoing)

OBJECTIVE

The FLAGSHIPS project will take zero-emission waterborne transport to an entirely new level by deploying two commercially operated hydrogen fuel cell vessels by 2023

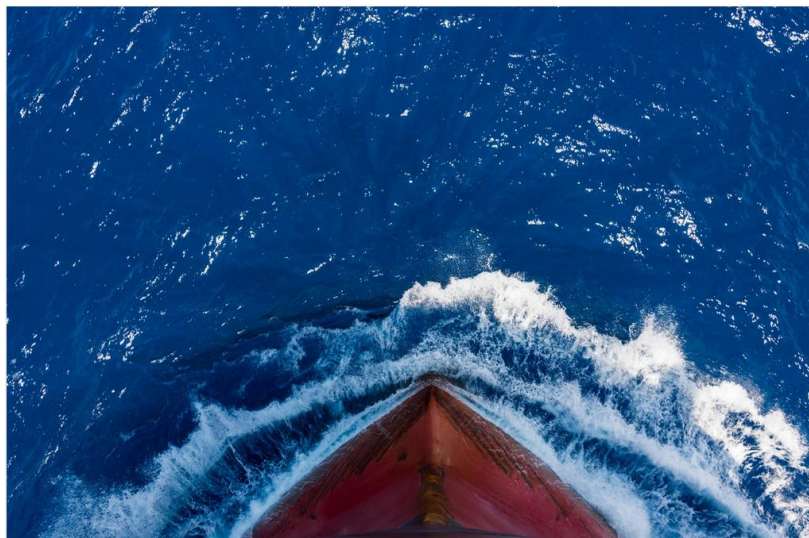


METHODOLOGY

Construction and deployment of shipping vessels powered by hydrogen



Hydrogen water transport ongoing projects



BUDGET AND FUNDING

The FLAGSHIP project has received funding from Clean Hydrogen Partnership, gathering 11 partner with a budget of 7 million €

RESULTS OBTAINED – EXPECTED IMPACT

Deployment of two shipping vessels:

- Zulu 06, compressed hydrogen cargo vessel – in operation since Feb 2022
- FPS Waal, cargo vessel to be deployed in Belgium by Summer 2023



Hydrogen water transport ongoing projects

TITLE

HyShip

TIMELINE

2021-2024 (ongoing)

OBJECTIVE

The project aims to lower the development and operational cost of hydrogen supply chain to push the usage of LH2 for ship propulsion throughout Europe



METHODOLOGY

Design and construction of a new ro-ro demonstration vessel running on liquid green hydrogen, as well as establishment of viable supply chain and bunkering platform



Hydrogen water transport ongoing projects

BUDGET AND FUNDING

The HyShip project involves 14 European partners and was granted a budget of 8 million € from the EU's Research and innovation programme Horizon 2020

RESULTS OBTAINED – EXPECTED IMPACT

Deployment of the Topeka vessel, a zero-emission vessel powered by a 1 MWh battery and 3 MWh PEM Electrolyzer. Conduction of three replicator studies:

- 1 MW tanker barge for use on inland waterways
- 3 MW fast ferry
- 20 MW energy system for deep-sea vessels



Hydrogen water transport ongoing projects

TITLE

HySeas III

TIMELINE

2013-2022 (ongoing)

OBJECTIVE

HySeas III builds on the projects HySeas I and II, by aiming to demonstrate that fuel cells may be successfully integrated with a proven marine hybrid electric drive system along with the associated hydrogen storage and bunkering arrangements



METHODOLOGY

The project will do this by developing, constructing, testing and validating a full-sized drive train on land. The testing is intended to test safety, load response, transient response, and emergency situations of the system.

Hydrogen water transport ongoing projects



BUDGET AND FUNDING

The project HySeas III has received funding from the European Union's Horizon 2020 research and innovation programme

RESULTS OBTAINED – EXPECTED IMPACT

HySeas III, following the theoretical work of HySeas I and II, expected results is to deploy a fully functional hydrogen fuel cell ferry and to demonstrate its safety and reliability



Hydrogen water transport ongoing projects

TITLE

H2SHIPS - System-Based Solutions for H₂-Fuelled Water Transport in North-West Europe

TIMELINE

2019-2022

OBJECTIVE

Demonstrate the technical and economic feasibility of hydrogen bunkering and propulsion for shipping and identification the conditions for successful market entry

On course for circular, emission-free shipping



METHODOLOGY

Implementation of two pilots projects, one in Amsterdam, regarding a hydrogen fuelled vessel, and one in Belgium regarding ancillary equipment. Implementation of an action plan for the deployment of a H2SHIPS Pilot in the river Saine in Paris

Hydrogen water transport ongoing projects



BUDGET AND FUNDING

H2Ships is a interregional project in the North-West Europe proposed by the European Union, gathering 13 partners from 5 countries. The project was awarded with a total of 6.33 million €

RESULTS OBTAINED – EXPECTED IMPACT

By the end of the project H2SHIPS expects to have created the necessary conditions for uptake of its technologies by 2% of the fleet renewal (retrofit or new) with positive impact on cross-sector industry uptake. This will lead to the creation of several jobs every year.



Hydrogen water transport ongoing projects

TITLE

Energy Observer

TIMELINE

2013 – 2022 (Ongoing)

OBJECTIVE

Demonstration of the readiness technology of zero-emission propulsion to power a sailing boat and exploring practical solutions whilst developing new technologies to accelerate ecological transition



METHODOLOGY

A net zero vessel powered by solar panels and hydrogen is cruising around the world demonstrating the readiness of the net-0 technology



Hydrogen water transport ongoing projects



BUDGET AND FUNDING

The project is carried out by more than 50 partners with the support of the European Union, UNESCO committee and hydrogen council.

RESULTS OBTAINED – EXPECTED IMPACT

Demonstration of the maturity of the net zero technology applied to the maritime sector and deployment of net zero boats. The first sailing boat is already operating and cruising all over the world, while a second vessel running on liquid hydrogen is scheduled to be deployed in the next years.



SLOWMOVE

Hydrogen water transport ongoing projects

TITLE

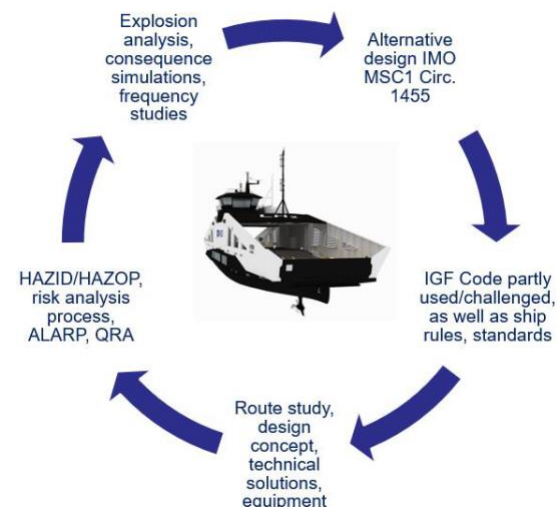
MF Hydra

TIMELINE

2022 (On going)

OBJECTIVE

Deploy the first world's liquid hydrogen driven ship and prove the maturity of the technology



METHODOLOGY

Construction of a liquid hydrogen powered boat fuelled with green hydrogen, considering bunkering arrangements.

Hydrogen water transport ongoing projects



BUDGET AND FUNDING

The project was financed privately by NORLED, a major ferry operator in Norway

RESULTS OBTAINED – EXPECTED IMPACT

Deploy the first liquid hydrogen powered vessel to enlighten the barriers to a wider hydrogen adoption in the maritime sector, such as the lack of adequate regulatory framework, bunkering hubs and hydrogen supply chain



Hydrogen water transport ongoing projects

TITLE

H2Ports

TIMELINE

2019-2022 (ongoing)

OBJECTIVE

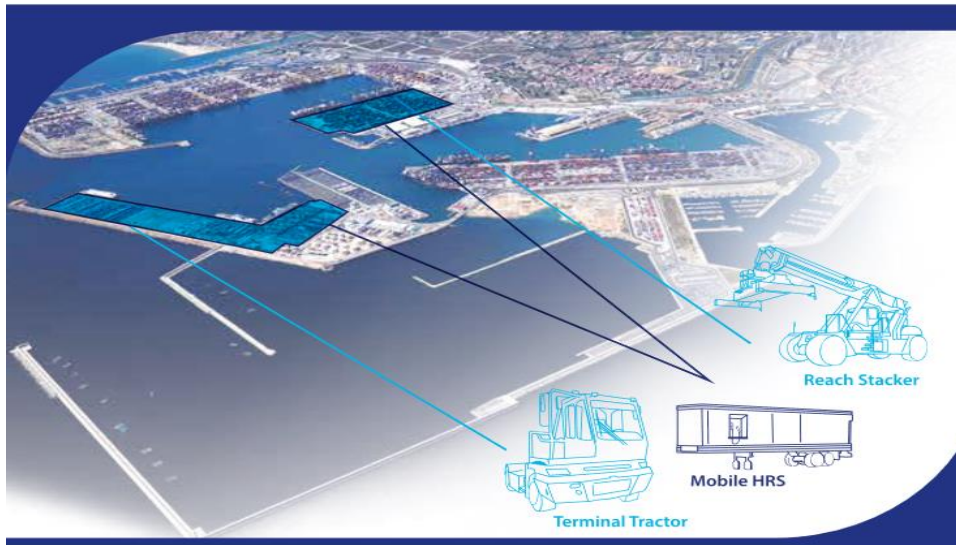
Demonstrate at the Port of Valencia in real port operations two innovative solutions based on fuel cell technologies and a hydrogen mobile supply station specifically designed for the project



METHODOLOGY

The project will run the equipment daily during two years of real operational activities and will analyze ways of improving the energy efficiency, performance and safety of operations with Fuel Cells port equipment

Hydrogen water transport ongoing projects



BUDGET AND FUNDING

The project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe research

RESULTS OBTAINED – EXPECTED IMPACT

H2Ports aims to boost the transition of the European port industry towards an effective low-carbon/zero-emission and safe operative model, piloting, evaluating and demonstrating new fuel cell technologies oriented to increase energy efficiency, decarbonization and safety of port terminals.



Hydrogen water transport ongoing projects

TITLE

e-SHyIPS – Eco-systemic knowledge in standards for Hydrogen Implementation on Passenger Ship

TIMELINE

2021-2022 (OnGoing)

OBJECTIVE

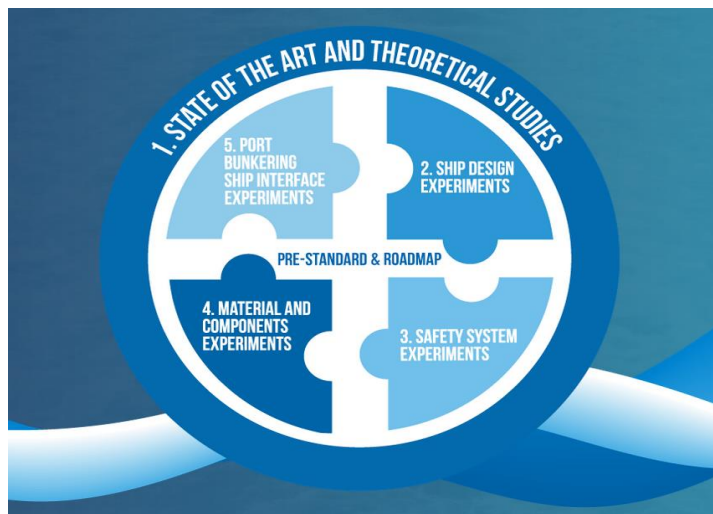
The e-SHyIPS project aims to define the new guidelines for an effective introduction of hydrogen in maritime passenger transport sector and to boost its adoption



METHODOLOGY

Integration of pre-normative research activities on standards with simulation and laboratory experiments, gathering knowledge from the main stakeholders in the maritime sector

Hydrogen water transport ongoing projects



BUDGET AND FUNDING

This research has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (JU) project e-SHyIPS. The JU receives support from the European Union's Horizon 2020 research and innovation programme and Italy, Finland, Germany, Greece, Spain, Cyprus, Netherlands.

RESULTS OBTAINED – EXPECTED IMPACT

The purpose of the project will be satisfied by defining a pre-standardization plan for the international code for ships using gas for hydrogen-based fuels passenger ships, creating a roadmap to boost the hydrogen economy in the maritime sector and providing appropriate tools for the ship designers and engineers



Hydrogen water transport ongoing projects

Fincantieri and MSC are developing the first two hydrogen-powered cruise ships

The ships will be operational in 2027 and 2028, running on liquid hydrogen



EXPLORA I, launched in Monfalcone on 30 May. Courtesy of Fincantieri



Open topics on hydrogen technology

Hydrogen, and green hydrogen in particular, still not widely and largely available on the market

Hydrogen value chain comprehend a number of technologies with different technology readiness level

Lack of a regulatory framework coming from governments, so at the moment the regulatory activity is left to groups of companies developing guidelines (e.g. Handbook for hydrogen fuelled Vessels by DNV)



The platform is complementary to individual agreements stipulated by companies with Politecnico and/or Fondazione Politecnico di Milano

It enables research on major transversal multicompany issues and supports the evolution of a hydrogen supply chain

It allows sharing interests, efforts and risks, increasing the value of the research and decreasing the impact of costs on the companies



The platform has supported a student-based team designing and constructing a boat for the Monaco Energy Boat Challenge

In 2022 the boat was powered by batteries and photovoltaic

In 2023 the boat will be also powered by hydrogen



Conclusions

Hydrogen is a valid candidate to boost the emission-free transportation

Hydrogen offers a way to renovate fleets without massive changes

Availability on the market is holding the penetration of hydrogen

Lack of regulatory framework for design and operation of vessels

The European Union is doing a huge effort to overcome the difficulties and promote the european hydrogen economy



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