FLAGSHIPS

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FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Introduction of existing hydrogen projects in Europe

London – 08/11/2019

An innovation action under the FCH 2 JU, 2019, grant n:o 826215

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Marine applications must go green

Even more so, after 2020. With 30 year ship ownership actions towards reducing CO_2 emissions should start now!

SOx

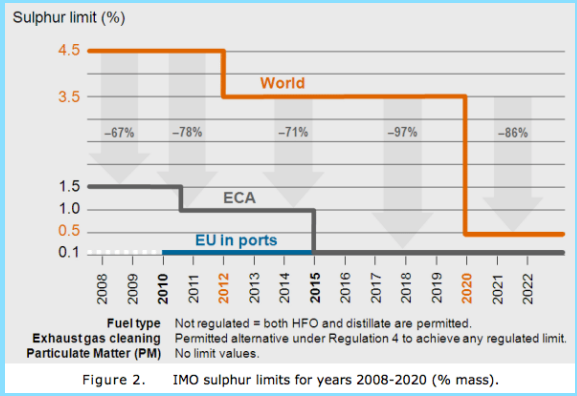
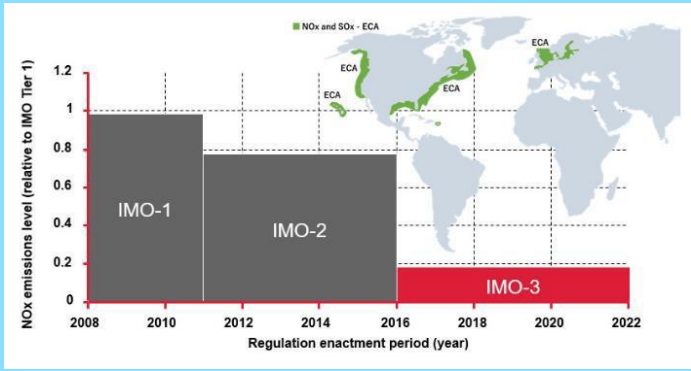


Figure 2. IMO sulphur limits for years 2008-2020 (% mass).

NOx



ECAs

Applies to new keels

CO_2

Regional level

Reduction of the total annual GHG emissions by **at least 70% in 2050** compared to 2008

Marine Directive

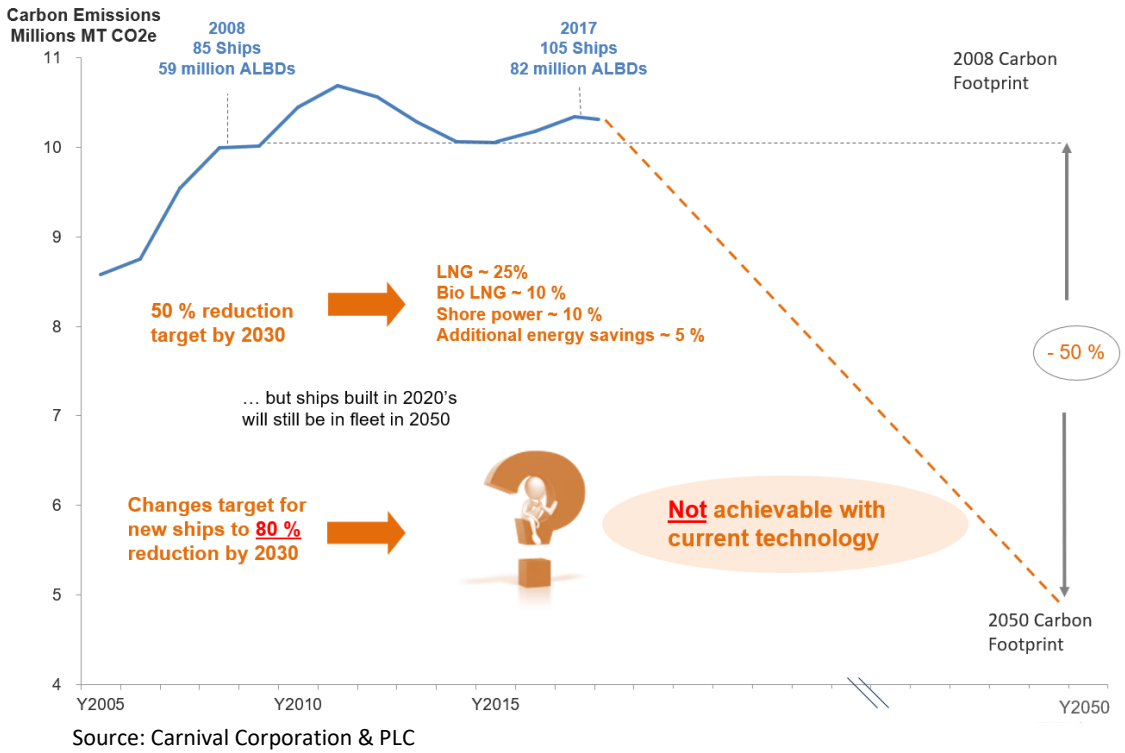
International level

Reduction of the total annual GHG emissions by **at least 50% in 2050** compared to 2008

Applies to the 'entire fleet'

Existing technologies, even combined, are not sufficient

LNG has proved efficient to address particulate emissions, but fails significantly contributing to CO_2 reductions



Source: Carnival Corporation & PLC

IMO targets are not achievable with current technologies, **converting the entire fleet to LNG will not be sufficient.**
Urgent need to regulate H_2 for ships

Until there are rules for H_2 as a marine fuel, H_2 ships must follow the "**Alternative design process**", which is:

- Lengthy
- Costly
- Unpredictable
- Subjective to individual interpretation

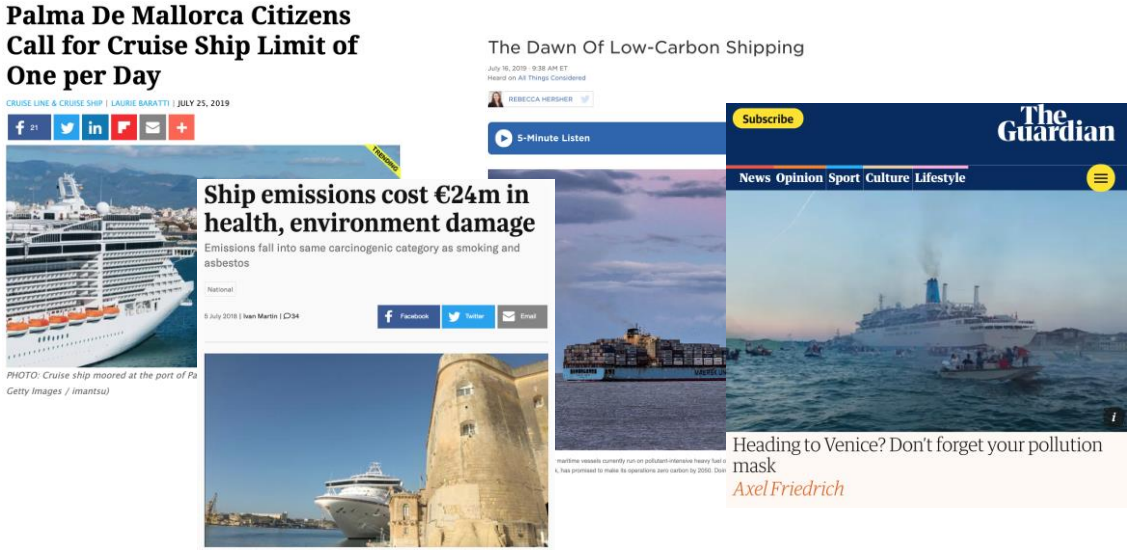
Perennial requests from the sector

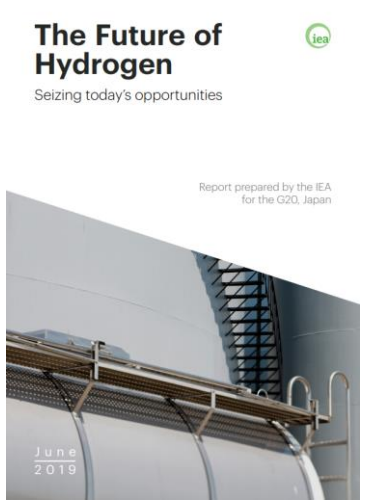
- Regulation
- International cooperation

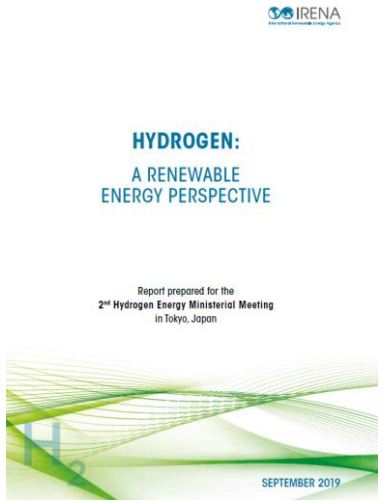
The **alternative design** is the process by which it must be demonstrated that safety, reliability and dependability of the systems is equivalent to that achieved with new and comparable conventional oil-fuelled main and auxiliary machinery

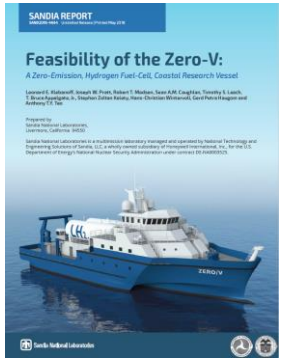
Anticipated role of hydrogen in the maritime sector

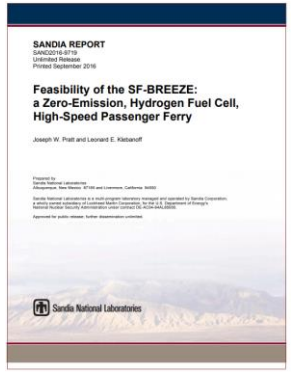
Increasing social pressure on the sector together with multiplying hydrogen related studies

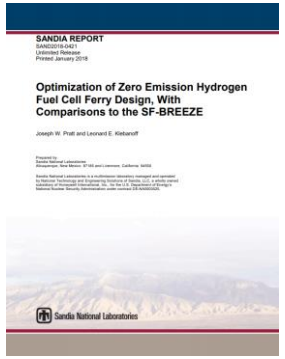








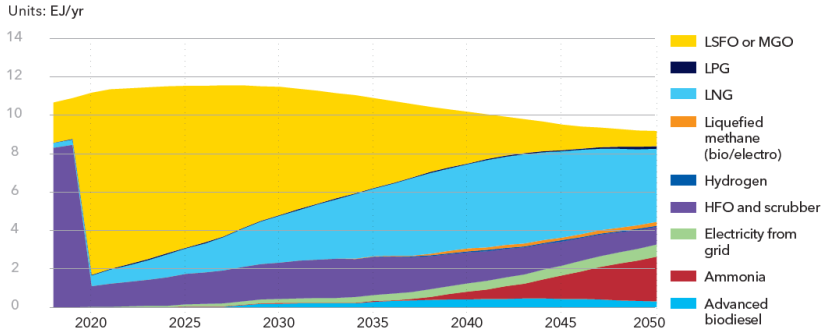




Anticipated role of hydrogen in the maritime sector

Different scenarios illustrate how H_2-based fuels will represent between 25% to 80% of maritime fuels by 2050

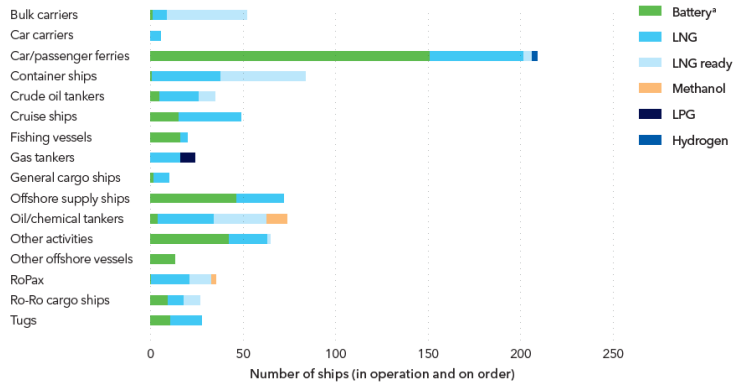
Energy use and projected fuel mix 2018-2050 for the simulated IMO ambitions pathway with main focus on design requirements



LSFO, low-sulphur fuel oil; MGO, marine gas oil; LPG, liquefied petroleum gas; LNG, liquefied natural gas; HFO, heavy fuel oil; Advanced biodiesel, produced by advanced processes from non-food feedstocks

Source: DNV GL

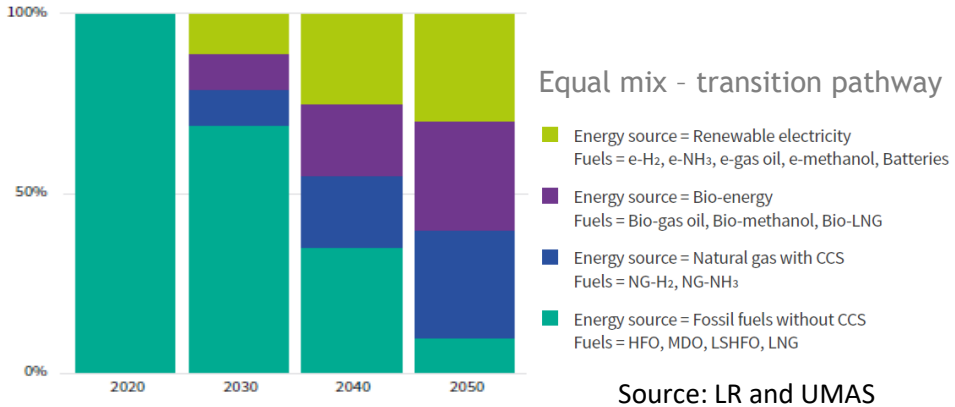
May 2019 status of uptake of alternative fuels by ships in operation and on order



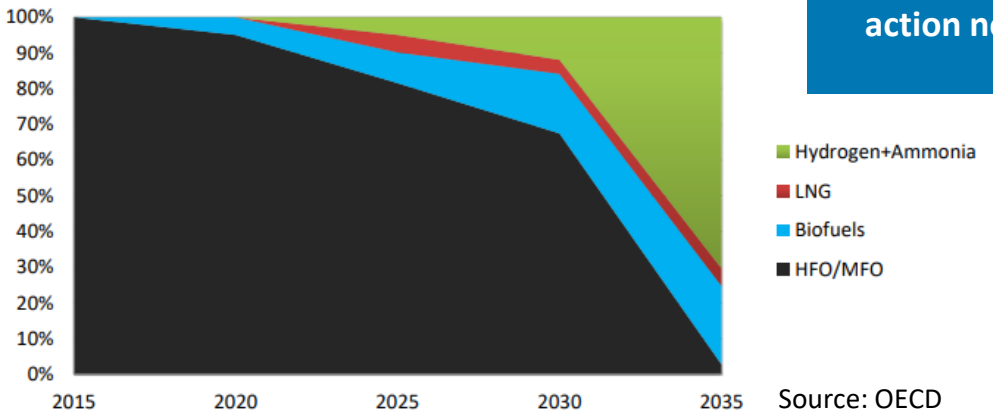
[a] Includes fully electric vessels, and chargeable and non-chargeable hybrids.

Source: DNV GL

This decade will be characterised by prototypes of ZEVs and deployment in niche areas. **The decade 2020 – 2030 is the most significant decade** in terms of research and development with the following decades based on scaling and commercialisation. Therefore this **stresses the urgency for action now**.

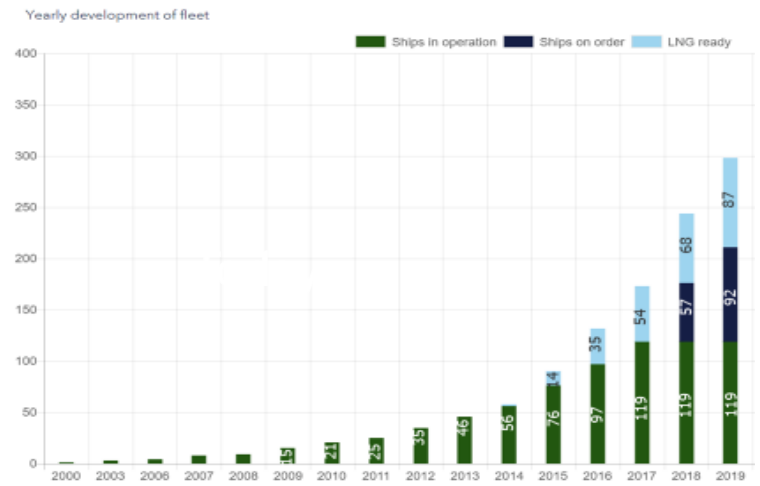


Source: LR and UMAS



Source: OECD

FCH vessels are accelerating



with respect to LNG development

CONCEPT BOATS

Energy Observer (2017)

Race for Water (2017)

HYSEAS III

Fiskerstrand car and passenger ferry

KHI LH_2 carrier

Havila Coastal Route

Today

2019

2020

2021

2022

2023

Water-Go-Round

Maranda

Elektra

Hydrogen Viking

NPRA

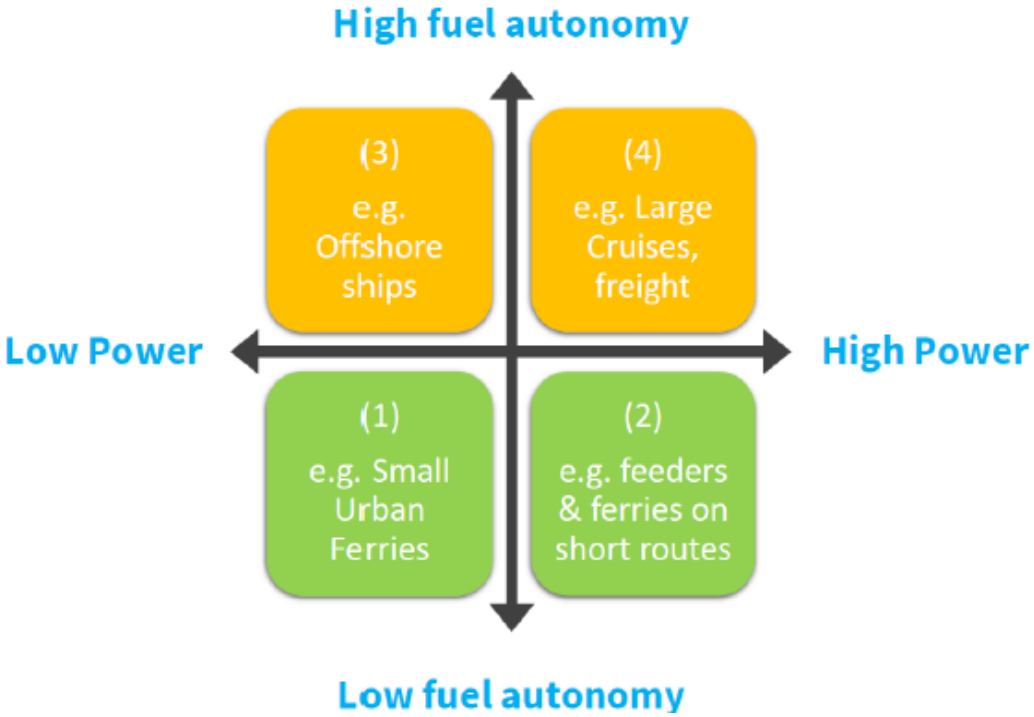
Norled car and passenger ferry

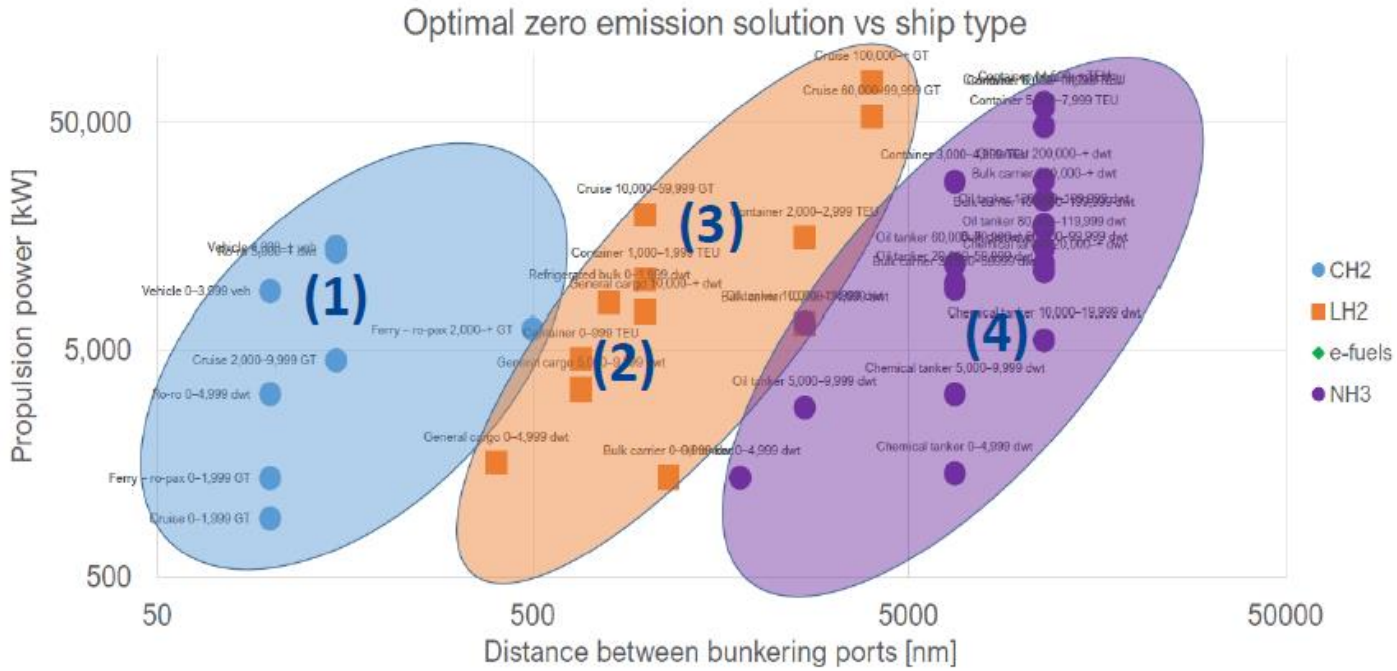
Flagships

Hydrogen fast ferries Sogn & Fjordane County

One size will not fit all

Preliminary results, analysis done by Hydrogen Europe





IMO role, what is the support needed to make it happen

Institutional support for convergence of actions

Context

- Experience is built from the industry and demo projects to support an establishment of rules
- FCH ships are multiplying and approval processes are taking place in an ad hoc and isolated manner
- Some guidelines from the IGF code lead to unsafe designs when applied to hydrogen (e.g. double-wall piping)

What needs to come next?

- Capitalise on the experience gathered through the various designs and approval processes
- Enable a better convergence between class agencies, for example on risk-based design methodology
- Highlight the IGF related guidelines which do not apply to hydrogen
- Establish specific must-have safety assessments and guidelines

What is the support needed to make it happen?

- A coordinated process, superseding the individual interests from the different project/stakeholders
- A forum to exploit experience and exchange safety assessments, regular meetings, etc.
- Pre-normative research focusing on must-have safety assessments

Would IMO be willing to take over the coordinator role this would help drive progress at the international level

And now, more details on...

FLAGSHIPS

FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Two hydrogen flagships deployed in this project illustrate the business viability and promote social acceptability of zero-emission shipping based on hydrogen and fuel cells

OVERARCHING

Persee smarter energies

VTT

BALLARD

Norwegian Centres of Expertise NCE Maritime CleanTech

TEAM STAVANGER

NORLED

JOINING SOON

WESTCON POWER & AUTOMATION

LMG MARIN

TEAM LYON

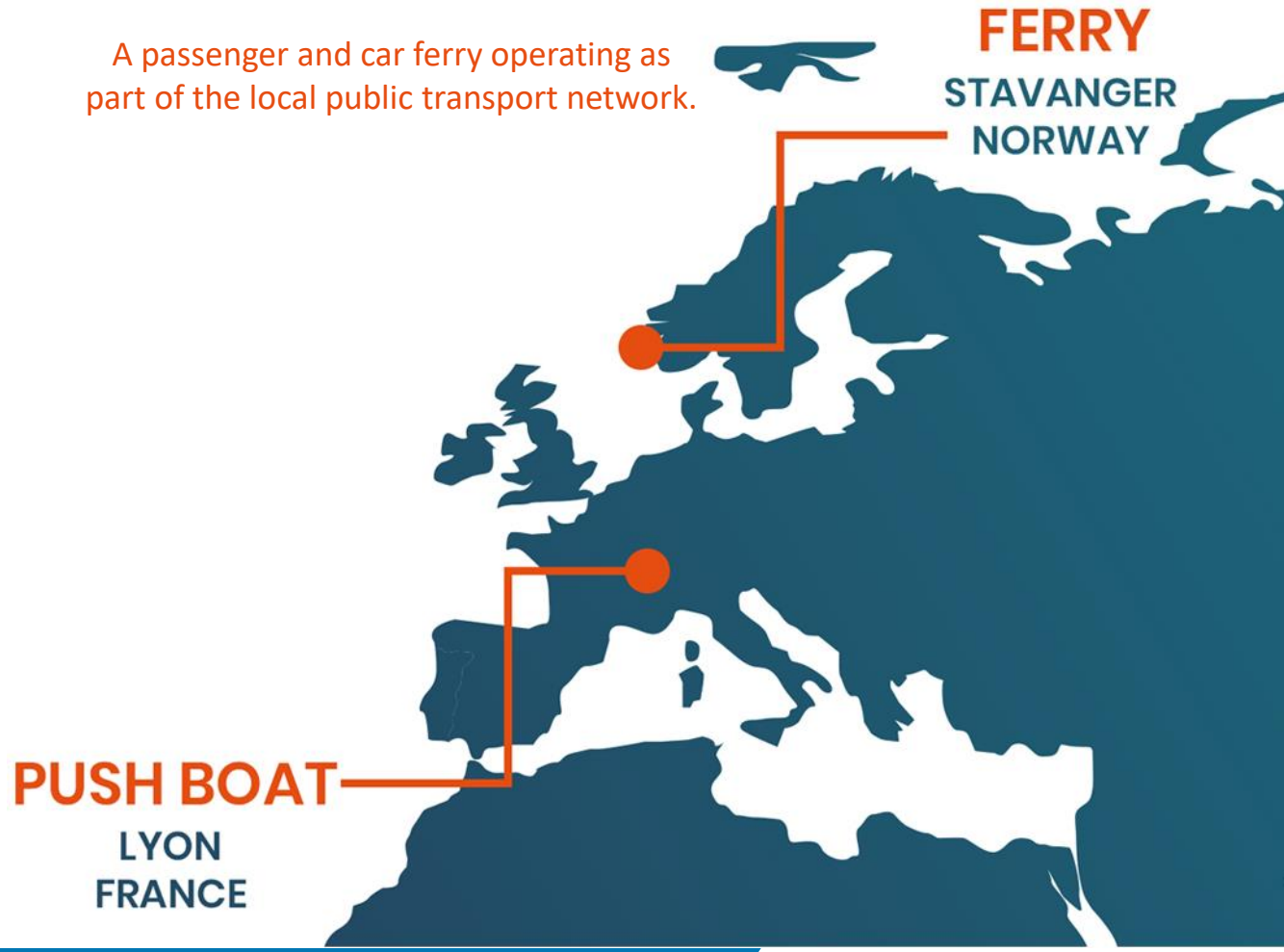
CFT COMPAGNIE FLUVIALE DE TRANSPORT

SOGESTRAN GROUP

ABB

LMG MARIN

A passenger and car ferry operating as part of the local public transport network.



A push-boat operating as a utility vessel on one of the most demanding rivers, the Rhône.

Project overview

AMBITION: Illustrate the business viability and promote social acceptability of zero-emission shipping based on hydrogen and fuel cells

FEATURES

Total Budget: 6.8 MEUR
Duration: 4 years, 2019-2023

A total of 1 MW installed on-board fuel cell power

On-site hydrogen production with electrolysis powered by renewable electricity

Specification

Design

Build

Test & approval

2019-2020

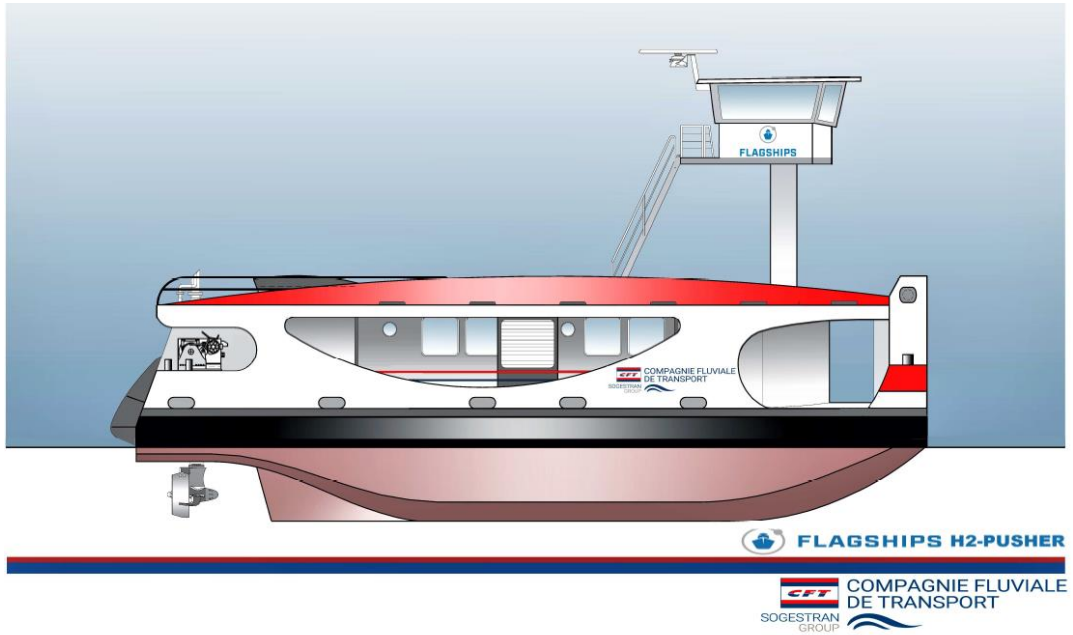
2021-2022

Operation in commercial service

Hydrogen vessels

Passenger & car ferry

- Stavanger area Norway
- 600 kW FC power



Pusher

- Lyon, France
- 400 kW FC power

Stavanger case data

- Route: Judaberg-Helgøy with 6 stops (route changes through the day)
- Daily operation: 140 nm (260 km), 19 hours (6 a.m. – 1 a.m.)
- H_2 fuel consumption: 460 kg / day (to be confirmed)
  - Comparable to ca. 1900 litres / day of (bio)diesel
- H_2 storage: 250 bar gaseous with 600 kg total capacity (TBC)
- Bunkering: every night, from shore to ship
- Power system
  - 3 x 200 kW PEM fuel cell modules
  - Battery capacity planned 0-500 kWh (need for batteries is under consideration)
  - Biodiesel generator back-up power
- Class and flag: approval by DNV-GL, under Norwegian flag (NMA)

Lyon case data

- Route: Port area for local work + Port of Lyon – Docks of Fulchiron
- H_2 fuel consumption (180 kg / week)
- H_2 storage (250 – 350 bars / 300 – 350 kg H_2)
- Refuelling by swapping H_2 storage rack.
- Power system
  - 2x PEM FC modules
  - Batteries
  - 2x diesel generators for back up power
- Class and flag: approval by Bureau Veritas, by French national authorities

Contact points

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European Commission

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