

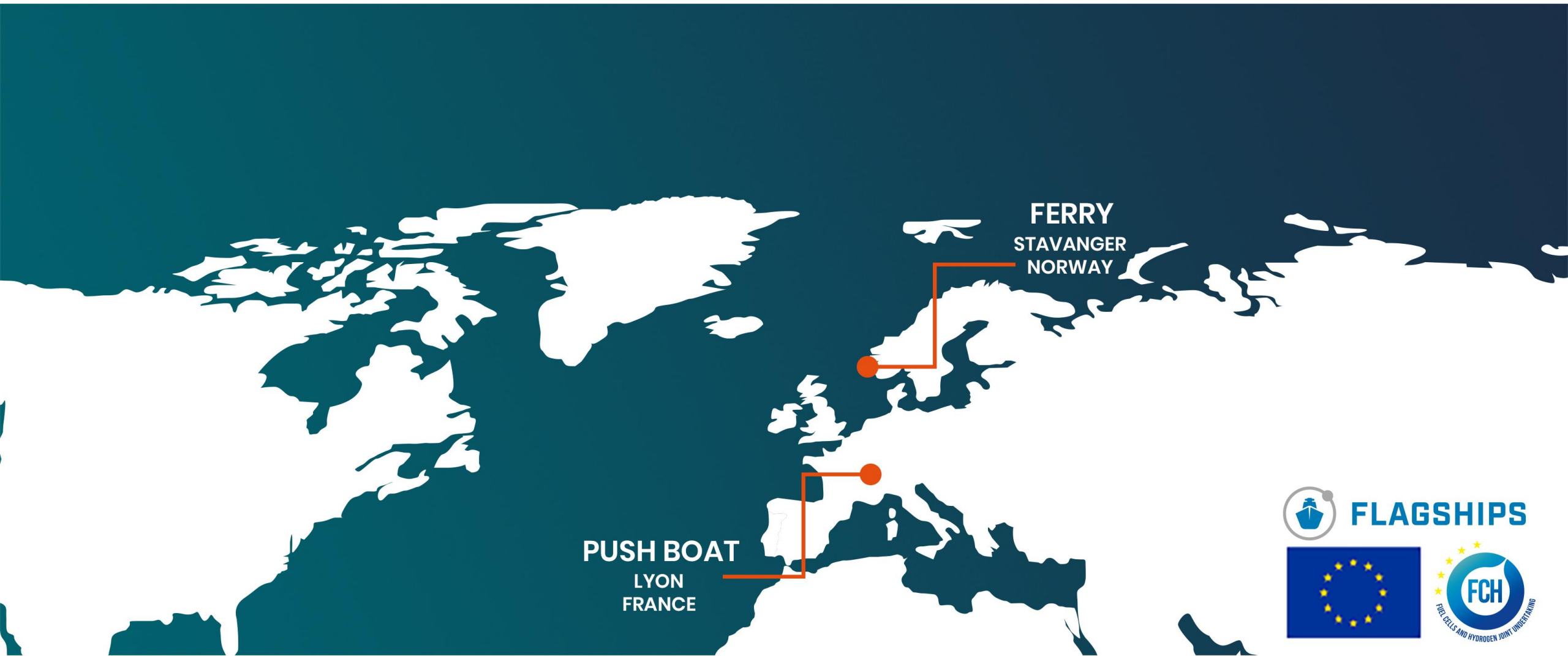
# FLAGSHIPS

## Clean waterborne transport in Europe

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Making Marine Applications Greener Online Seminar  
24th of September 2020



FERRY  
STAVANGER  
NORWAY

PUSH BOAT  
LYON  
FRANCE



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

## VESSEL 1: LYON

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

### FEATURES

Total Budget: 6.8 M€  
FCH 2 JU funding: 5.0 M€  
Duration: 4 years, 2019-2022



## VESSEL 2: STAVANGER

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



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



Hydrogen production with electrolysis powered by renewable electricity



FUEL CELLS AND HYDROGEN  
JOINT UNDERTAKING



# Hydrogen vessels



## Pusher

- Lyon, France
- 400 kW FC power



NORWESTED

## Passenger & car ferry

- Stavanger area, Norway
- 600 kW FC power



# Project consortium

## OVERARCHING



## TEAM STAVANGER

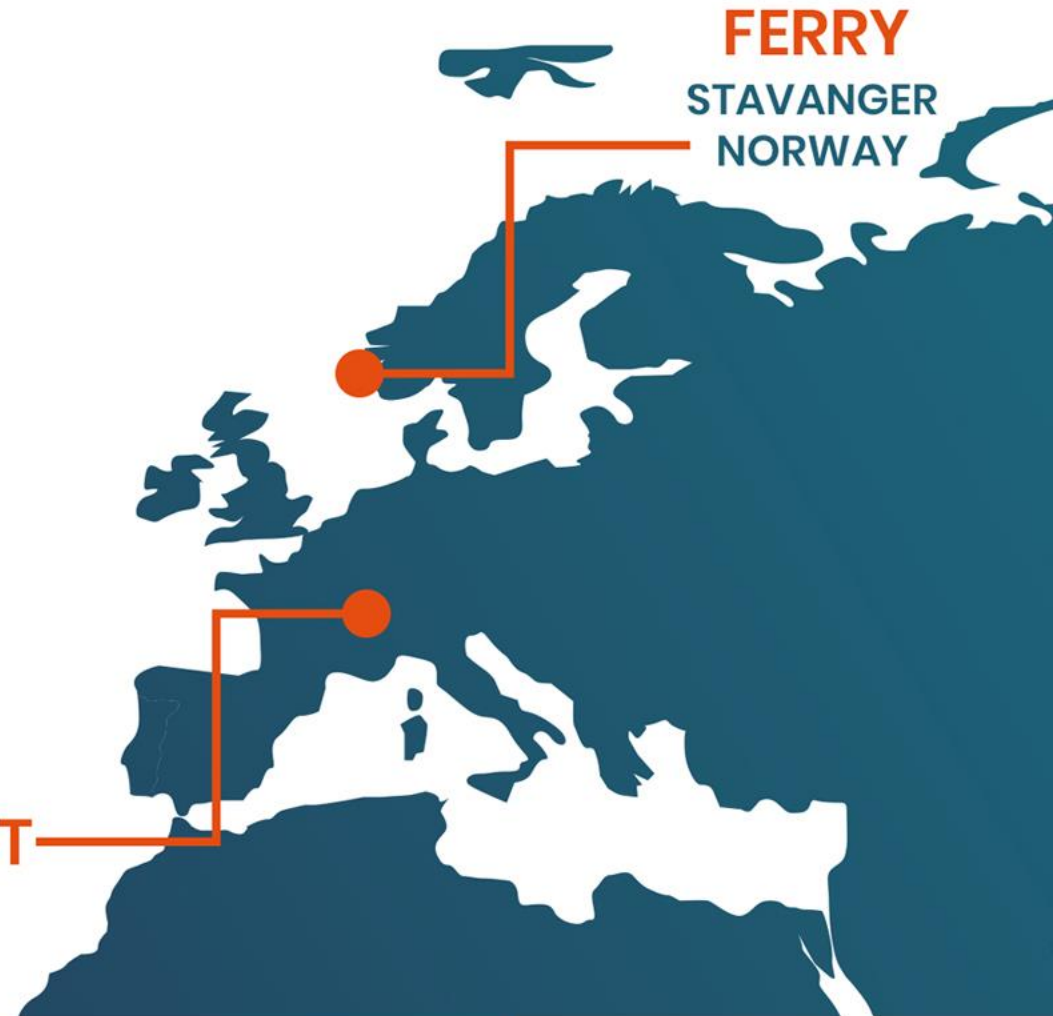


## TEAM LYON

**PUSH BOAT**

LYON  
FRANCE

**FERRY**  
STAVANGER  
NORWAY





# Lyon case data

- Route: Port area for local work + Port of Lyon – Docks of Fulchiron
- H2 storage (250 – 350 bars / 300 – 350kg H2)
- Refueling by swapping H2 storage rack
- Power system
  - 2 x 200 kW PEM FC modules
  - Batteries
- Navigation authorization granted by local authorities through a derogation process



# Stavanger case data

- Route: Judaberg-Helgøy with 6 stops (route changes through the day)
- Daily operation: 140 nm (270 km), 19 hours (6 a.m. – 1 a.m.)
- H<sub>2</sub> fuel consumption: 500 kg / day (to be confirmed)
  - Comparable to ca. 1900 litres / day of (bio)diesel
- H<sub>2</sub> 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 336 kWh
- Class and flag: approval by DNV-GL, under Norwegian flag (NMA)

# Ballard FCwave

- Marine-tailored FC module
- Rated power: 200 kW - scalable
- Size WxDxH: 788x1220x2200 mm
- Weight: 875kg
- LCS stacks durability: 30.000+ hours
- Nominal design efficiency: 50%
- Type approval by DNV-GL
- Easy integration
- Easy serviceability



## FC gen® – LCS fuel cell stack

-  Power density designed for Heavy Duty requirements
-  Freeze start capability
-  Extended durability
-  Low product total cost of ownership
-  Packaging flexibility for easier integration
-  Refurbishing process re-uses plates & recycles catalyst





# Project objectives

- Raise the global readiness level of hydrogen-powered zero-emission waterborne transport
  - Develop and deploy H<sub>2</sub>+FC vessels in two commercial applications
    - Reach runtime of at least 18 months in day-to-day operation
  - Drive the uptake of H<sub>2</sub> fueling infrastructure for hydrogen vessels
  - Develop and strengthen supply chains for the marine FC & H<sub>2</sub> technology
  - Clarify approval practices for hydrogen ships

# Timeline

**Specification**

**Design**

**Build**

**Test & approval**

**2019-2020**

**2021-2022**

**Operation in commercial service**



# Lessons learnt so far

- Availability of hydrogen – incentives, public support needed!
- Ecosystems
- Approval process still time consuming and long process
  - Early engagement of authorities is the key

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