

An overview of hydrogen & fuel cell technology in transport

Bart Biebuyck
Executive Director

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Clean Hydrogen Joint Undertaking

EU Institutional Public-Private Partnership (IPPP)



Industry
More than 350 members



Research community
over 103 members

To facilitate the transition to a greener EU society through the development of hydrogen technologies

Clean Hydrogen JU Objectives


Support a sustainable hydrogen economy, contributing to EU's climate goals




Support the implementation of the Commission's Hydrogen Strategy



Stimulate research and innovation on clean hydrogen production, distribution, storage and end use applications



Strengthen the competitiveness of the EU clean hydrogen value chain



Contribute to the EU ambitious 2030 and 2050 climate ambition

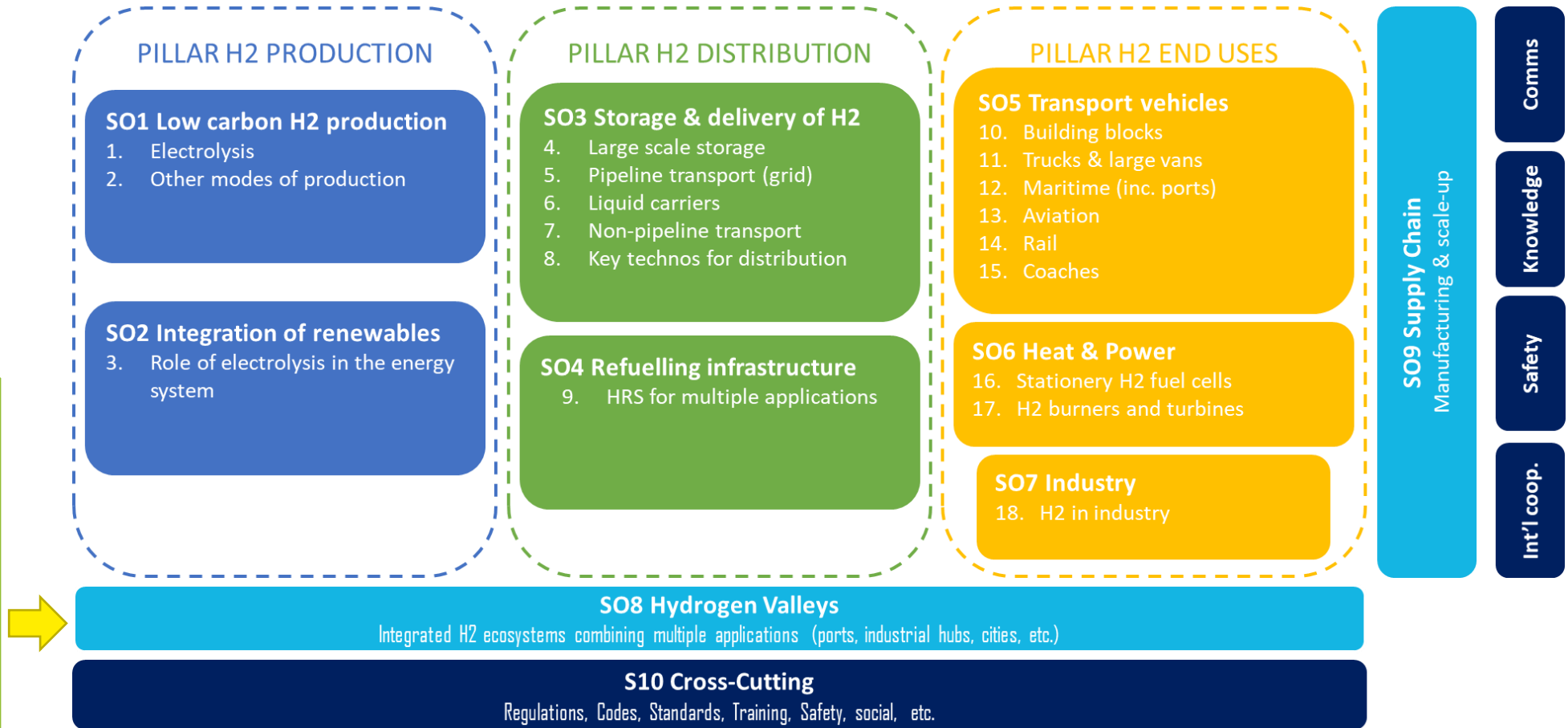
Research and Innovation priorities in Clean Hydrogen JU

Maintain and strengthen EU's global leadership role through a € 2.4 bn research program

18/05/22: REPowerEU
 The action plan includes an increase in the JU of 200m€ to double the number of EU H₂ valleys to 50 to accelerate:

↓

- in time
- in geography
- introduction of innovation



- 300.5m EUR call for 41 topics:
 - ✓ Renewable hydrogen production (10)
 - ✓ Hydrogen distribution & storage (11)
 - ✓ **Transport (8)**
 - ✓ **Min. 150 Hydrogen trucks**
 - ✓ **Liquid hydrogen tank for trucks**
 - ✓ **Min. 5 inland waterway ships**
 - ✓ **Heavy duty PEMFC research**
 - ✓ **MEA research**
 - ✓ **Dedicated fuel cell aviation**
 - ✓ **Liquid hydrogen tank for planes**
 - ✓ **Heat management for fuel cell in planes**
 - ✓ Heat and Power (4)
 - ✓ Cross-cutting (5)
 - ✓ Overarching: Two hydrogen valleys (2)
 - ✓ Strategic Research Challenge (1)

- Two cut-off dates: 31st May and 20th September

https://www.clean-hydrogen.europa.eu/apply-funding/call-proposals-2022/call-proposals-2022_en



CEF (Connecting Europe Facility) funding opportunities

Synergies with other EU funding instruments are envisioned

Call opening	16 September 2021				
	1 st cut-off date	2 ⁿ cut-off date	3 rd cut-off date	4 th cut-off date	5 th cut-off date
Deadline for submission:	19 Jan. 2022 17:00 CET (Brussels)	<u>7 June 2022</u> <u>17:00 CET</u> (Brussels)	<u>10 Nov. 2022</u> <u>17:00 CET</u> <u>(Brussels)</u>	13 April 2023 17:00 CET (Brussels)	19 Sept. 2023 17:00 CET (Brussels)
Evaluation:	Feb. – March 2022	July – Aug. 2022	Dec 2022 – Jan 2023	May – June 2023	Oct. – Nov. 2023
Information on evaluation results:	May 2022	Oct. 2022	March 2023	July 2023	Jan 2024
GA signature:	Sept – Oct. 2022	Feb. – March 2023	July – Aug. 2023	Dec. 2023 – Jan. 2024	May – June 2024

Consortia should submit for some topics another proposal to CEF for the Hydrogen Refueling stations

Hydrogen cars needed for intensive use or high performance

To meet all customer demands OEM's can not neglect hydrogen in their line-up

Hydrogen cars in production



Mass production from 2022~



Hypercars



Hydrogen cars can refill tank in 3-5 min. with a driving distances up to 1000km. The market needs hydrogen cars to meet customers specific needs (highly intensive use cases)

Hydrogen cars sees their entry in the world of racing

24Hrs of Le Mans is preparing for a competition using hydrogen



TU Delft students made a H2 racing car and won 2nd place in supercar challenge in Asse against gasoline cars



The 24 Hours of Le Mans will introduce a Hydrogen Class in 2025. In 2021 first test-drives took place

European H2 stations network

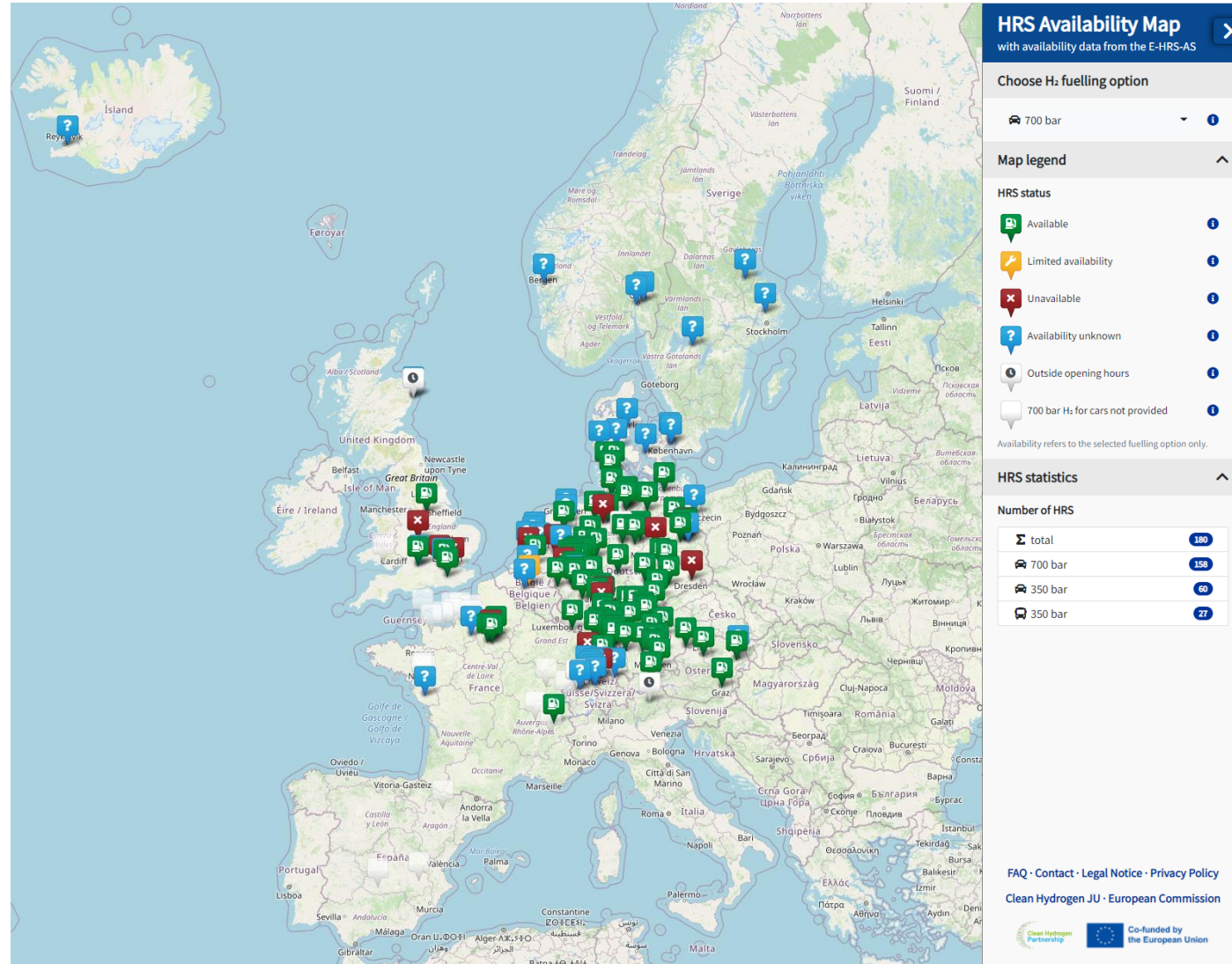
The Clean Hydrogen Partnership Hydrogen Refuelling Station Availability system.

www.H2map.eu

Nearly all HRS in EU are connected to this tool and gives every minute an update on its status (open, closed, maintenance...)

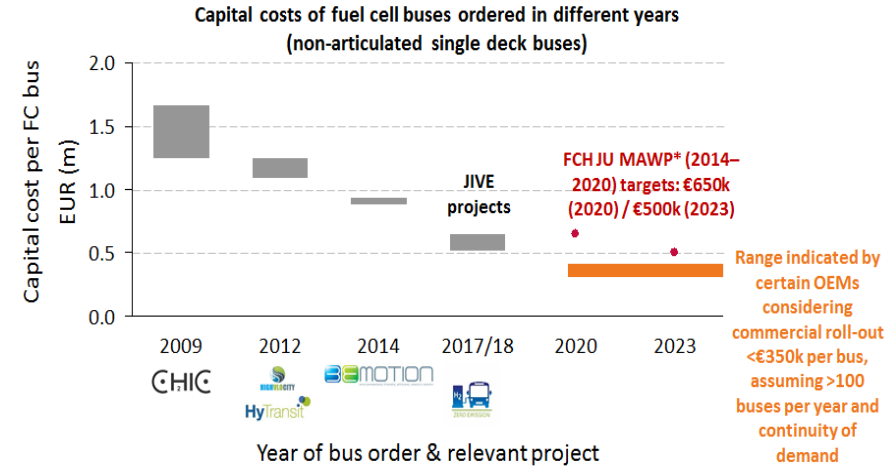
The Alternative Fuel Infrastructure Regulation (AFIR) is under discussion and proposal requires to build a basic network along TEN-T & comprehensive networks by 2030

- HRS (gas) every 150km and an HRS (liquid) every 450km
- Refuelling capacity for HDV and LCV
- Storage capacity of at least 1000kg H2
- 1 payment system (with credit cards) across EU



Activity	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
CUTE & HyFLEET: CUTE (2001-09)											
CHIC											
High V.Lo.City											
HyTransit											
3Emotion											
JIVE											
JIVE 2											

Van Hool hydrogen bus for PAU (France) crowned as best bus of the world 2019!



JIVE/JIVE2

- All orders placed for 295 buses (100%) with 6 suppliers Van Hool (84), Solaris (67), Wrightbus (85), SAFRA (10), Caetano (18) and Optare (12)
- Delivery of 211 busses (72%)
All buses on the road by end 2022
- Increased interest from other European OEMs, with JIVE-compliant offers received from: Rampini, and SOL and continued interest from ADL, Daimler, VDL and interest from 2 other major European OEMs.

NEXT:

City buses have advanced a lot, next is to work on coaches. The project "CoachHyfied" will demonstrate 6 Fuel Cell Coaches in the two coach segments (inter-city and long-distance passenger transport)



Heavy duty trucks demonstration projects to validate the technology

Long haul and urban applications, 30 trucks demonstrations in 13 sites and 7 countries



23/11/2020: Industry commitment for 100.000 trucks and 1500 HRS by 2030 in the EU

15 Long haul trucks



- At least 400 km autonomy;
- Tractor and rigid configurations;
- Integration in the daily operations of end users with different operations (Air Liquide, BMW, Carrefour, Colruyt)
- Deployment of the trucks in 2022



Iveco - Nicola



VDL (Colruyt, AbInBev)

15 Refuse trucks



- Daily back-to-base missions;
- Standardization of the design towards mass production;
- Fleet operation: 120.000 hours;
- First truck already deployed in Breda;



Protocol for heavy-duty refueling using hydrogen

- Develop refueling protocol(s) for vehicles with Compressed H2 Storage System >250L & >10kg;
- Identify factors limiting the refueling rate (120g/s) and propose solutions for larger flow rates;
- Findings and recommendations should be shared with relevant sectors and standardization committees;
- International cooperation;



Hydrogen trains in Europe

Market demand is accelerating fast

Fuel Cell Hybrid PowerPack for Rail Applications

Demonstrate the system in a bi-mode train to be homologated in three MS



In the EU project FCH2RAIL, the consortium is developing and testing a new type of train prototype with partners from Belgium, Germany, Spain and Portugal. The main objective of the FCH2RAIL project is to develop, build, test, demonstrate and homologate a scalable, modular and multi-purpose Fuel Cell Hybrid PowerPack (FCHPP) applicable for different rail applications (multiple unit, mainline and shunting locomotives) also suitable to retrofit existing electric and diesel trains, to reach TRL7.



Pesa to unveil hydrogen locomotive by year end

The Polish manufacturer has been working on the vehicle since December 2019.



A Pesa Gama locomotive



Europe funds hydrogen train in the Netherlands with 25 million

Published on 26-04-2021 at 10:38

The European Investment Bank (EIB) will fund 25 million euros for the purchase of four hydrogen trains and the construction of a hydrogen filling station in Groningen in the Netherlands. The amount is part of a 3.4 billion euro investment package in sustainable development. Of this, 700 million euros are spent on sustainable mobility.

Alstom to supply Italy's first hydrogen trains

The board of FNM, Lombardy's leading public transport group, approves major investment in green railway transportation



Coradia Stream for FNM. For illustrative purposes only. © Alstom / Design & Styling

26 November 2020 – Alstom will supply six hydrogen fuel cell trains, with the option for eight more, to FNM (Ferrovie Nord Milano), the main transport and mobility group in the Italian region of Lombardy, for a total amount of approximately €160 million. The first train delivery is expected within 36 months of the date of the order.

The new hydrogen trains will be based on Alstom's Coradia Stream regional train platform, which is dedicated to the European market and already being produced for Italy by Alstom's main Italian sites. The hydrogen powered Coradia Stream for FNM, will be equipped with the same fuel cell propulsion technology that was introduced to the world by the Coradia iLint. The hydrogen Coradia Stream will maintain the high standards of comfort already appreciated by passengers of its electric version. The hydrogen version will match the operational performance of diesel trains, including their range.



The first Portuguese hydrogen train will replace Vouguinha

23/01/2021

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Railway-News

Four French regions have signed an order for dual mode electric-hydrogen trains, making this the first order for hydrogen trains Alstom has received in France.



Alstom's hydrogen train successfully completes three months of testing in Austria

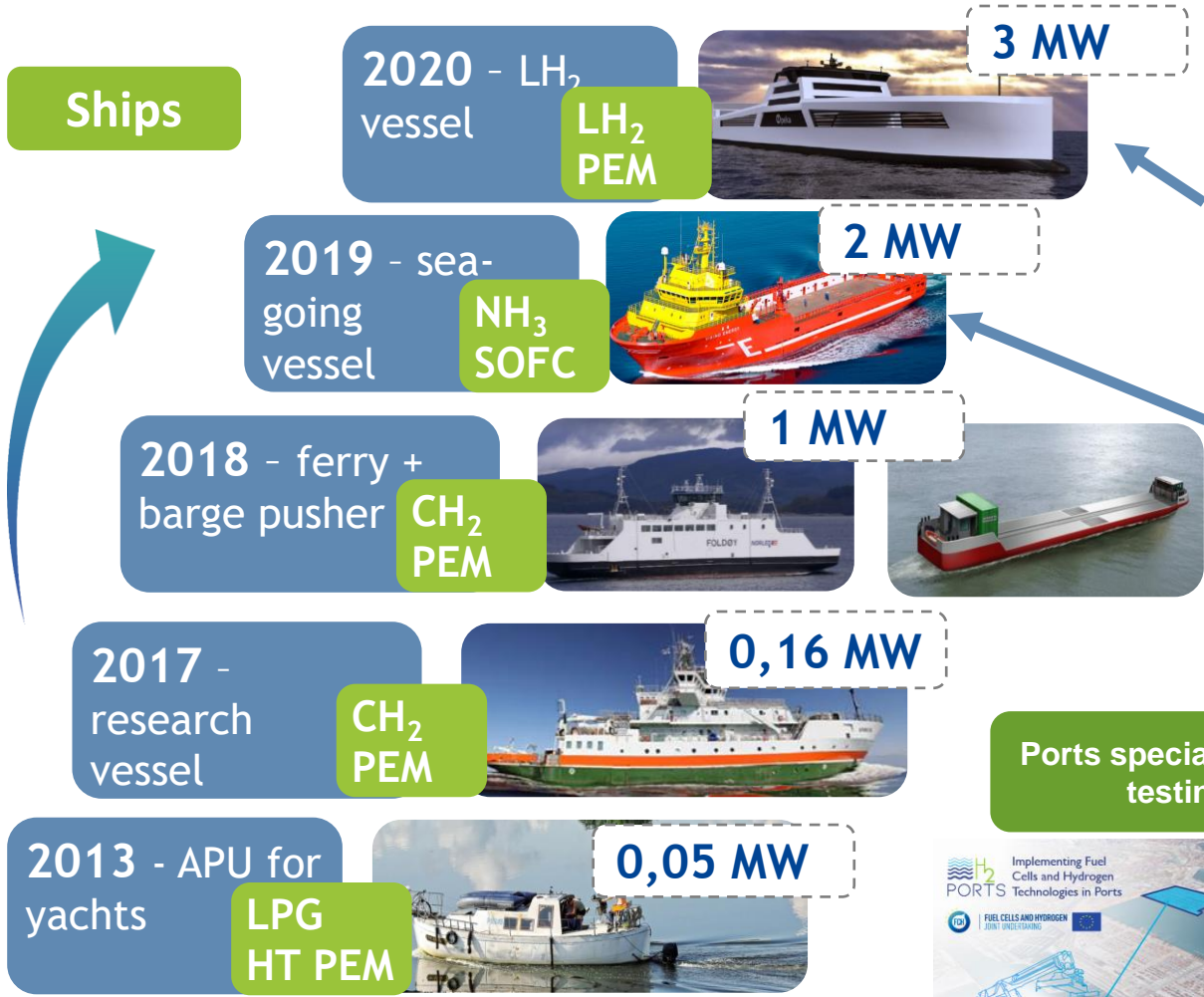
The Coradia iLint is fully approved for the Austrian network and has successfully completed passenger operation tests with ÖBB



Clean Hydrogen JU support for FC and H2 in maritime applications

Moving towards larger sizes of vessels, no « size fits all »

Ships



HySHIP

- RoRo vessel, for coastal goods transport
- 3MW fuel cell system using LH₂ (>5t storage)
- Conceptual designs for a 20MW ship
- Develop a standardised bunkering system
- LH₂ distributed to a series of maritime bases in a containerized system

ShipFC

- Platform support vessel in North Sea (Norway)
- Length: 95m, Gross tonnage: 5073MT
- Operation: 2024
- Zero emission ammonia

Ports special equipment starts testing fuel cells



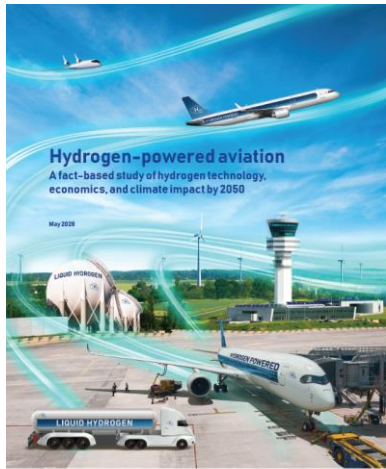
Maersk will start in 2023 with Methanol propelled ships



Hydrogen powered Aviation study

(joint study with Clean Sky2 JU)

Hydrogen propulsion has significant potential



Hydrogen-powered aviation
A fact-based study of hydrogen technology, economics, and climate impact by 2050

May 2020

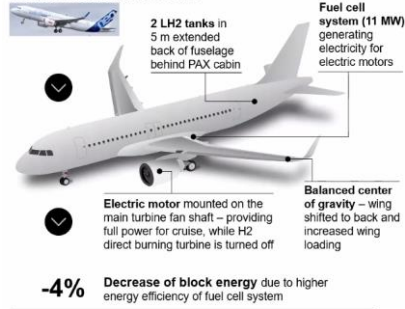


Example: Short-range aircraft with hybrid H2 propulsion

Exemplary pictures

Evolutionary aircraft design for short range

Reference aircraft: Airbus A320 neo



Source: DLR design study, expert input, project team

Key takeaways:

- Hydrogen is feasible to power aircraft with entry into service between 2030-2035 for short-range segments.
- Less than 17€ per PAX additional cost on a short range flight.
- Zero CO2 and 70% reduction of climate impact.
- First prototype by 2028, need for large R&D investments
- 40% of the fleet by 2050 on LH2 for short and partly medium range, others by SAF (eg. methanol)

<https://www.fch.europa.eu/news/new-study-hydrogen-powered-aviation-preparing-take>



Airbus presented 3 models on Liquid Hydrogen targeting 2035 to enter service

La France veut lancer un avion « zéro émission de CO2 » dès 2035

Au-delà des mesures d'urgence, le plan de soutien à l'aéronautique française du gouvernement, chiffré à 15 milliards d'euros par Bruno Le Maire, vise à placer l'aéronautique française en pointe dans la transition énergétique. Avec un objectif ambitieux : lancer un avion vert à l'hydrogène dès

2035.



H₂ Zeroavia: UK



H2fly: HY4 Germany



H2FLY - 2030



SKAI: passenger drone

Other hydrogen applications

For example, off-road applications



Our projects supported hundreds of forklifts in Carrefour (Paris) and Colruyt (Halle)



Snow groomers in Italy



Ford New Holland hydrogen



JCB hydrogen excavator



Snow scooters



Motorcycle by France H2 Motronics



Hydrogen bike Pragma industries



Bart Biebuyck
Executive Director

Bart.Biebuyck@clean-hydrogen.europa.eu

[@bart.biebuyck](https://twitter.com/bart.biebuyck)

[in](https://www.linkedin.com/in/BartBiebuyck) Bart Biebuyck



For further information

www.clean-hydrogen.europa.eu

www.hydrogeneurope.eu

www.hydrogeneurope.eu/research