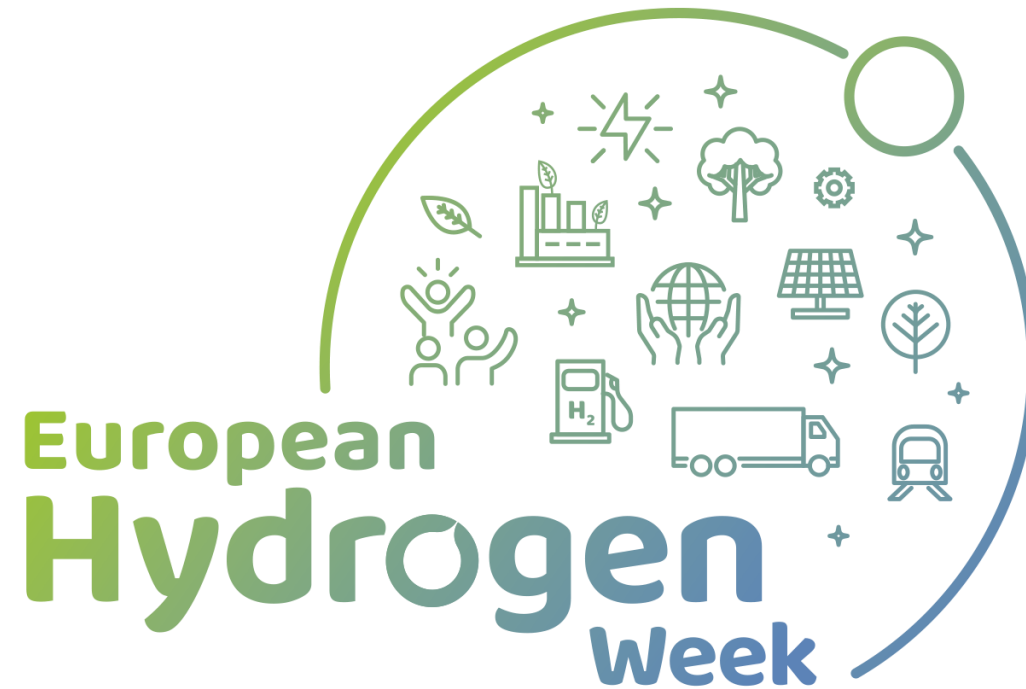


INN-BALANCE

INNovative Cost Improvements for
BALANCE of Plant Components of
Automotive PEMFC Systems



INN·BALANCE
AUTOMOTIVE FUEL CELL



Jose M. Garcia Campos

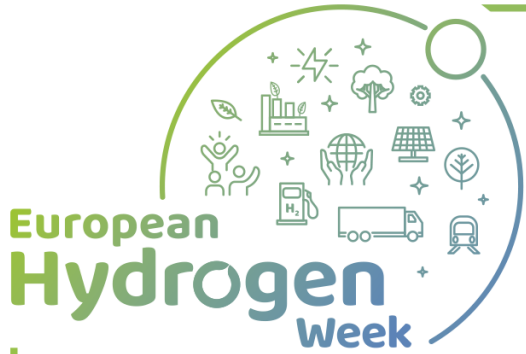
Fundación Ayesa

[https://www.innbalance-fch-
project.eu/](https://www.innbalance-fch-project.eu/)

cmorag@ayesa.com

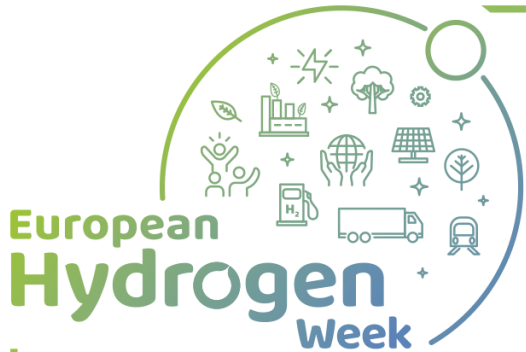
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Project Overview

- Call year: 2016
- Call topic: FCH-01-4-2016 Development of industrialization-ready PEMFC systems and system components
- Project dates: 01/01/17 - 31/10/21
- % stage of implementation 02/12/2021: 100 %
- Total project budget: 6.158.288,75 €
- FCH JU max. contribution: 4.999.538,75 €



Partners

CEVT

Integration of the overall system in powertrain and vehicle tests



Dissemination and exploitation of results

Celeroton

Design, building and testing of a turbo compressor for FC applications



Coordination and manufacturing-oriented design optimization



UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Advanced control algorithms



POWERCELL

Optimized layout of the FC stack and testing of the entire system in the laboratory



Design, building and testing of the cathode module



DLR

Design, building and testing of the thermal management system

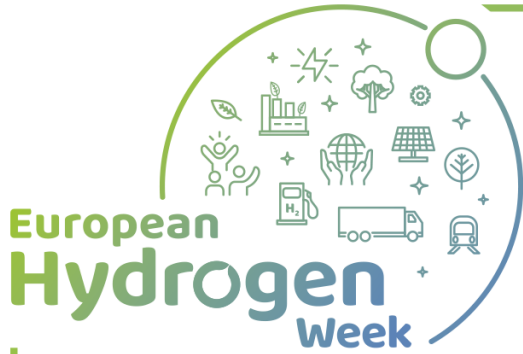


AVL

Design, building and testing of the anode module and the control system

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Project Summary

Main Objectives

- **Objective A:** To scale up and enhance an innovative fuel cell system layout.
- **Objective B:** To develop a cost-effective and improved automotive control unit.
- **Objective C:** To design and develop a new cathode module.
- **Objective D:** To develop a highly efficient thermal management system.
- **Objective E:** To integrate, test and evaluate the newly developed BoP components.
- **Objective F:** To optimize the design of the BoP components.
- **Objective G:** To develop a reliable technology plan and implement exploitation strategies and activities.

Project Summary

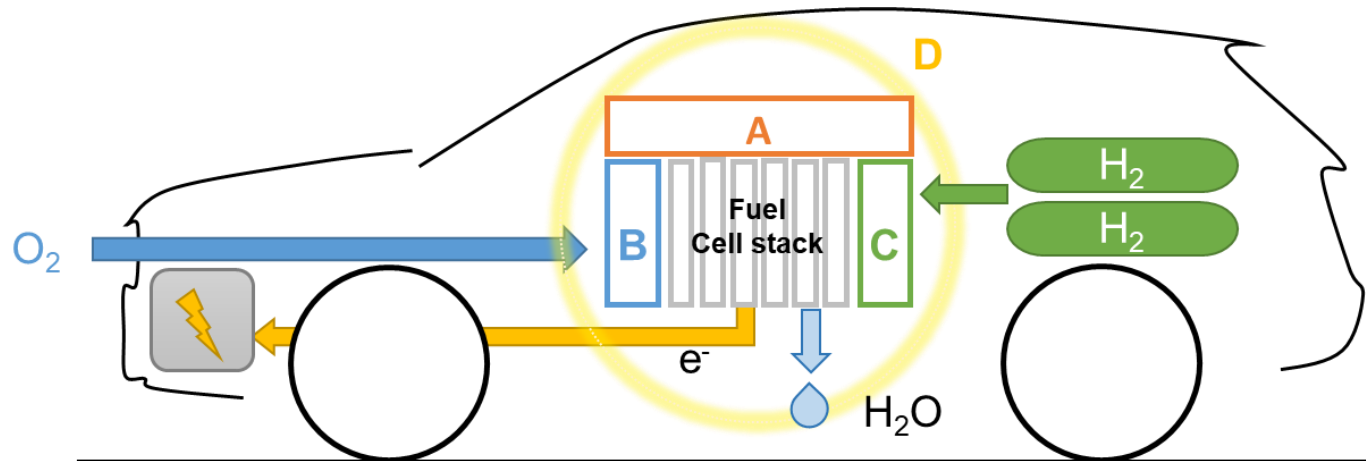
4 INN-BALANCE modules were defined based on their functions

A Thermal management system

Keeps all components at a desired temperature and enables cold starts

B Cathode module

Supplies a desired air mass flow with a specific reference humidity to the fuel cell stack

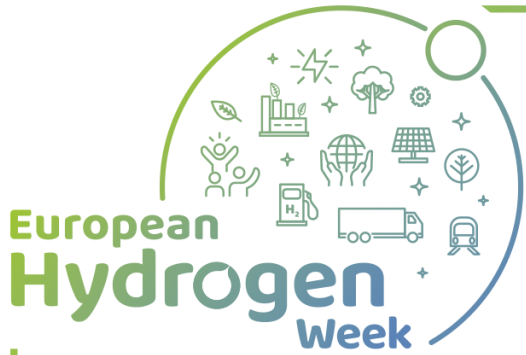


C Anode module

Supplies the required amount of hydrogen to the fuel cell stack and allows unused hydrogen to return

D Control system

Ensures smooth operation and detects errors at an early stage



Project Summary

Global positioning vs international state-of the art

- **Anode module:** The product improvement is achieved by reducing the number of components and using a model-based gas management.
- **Cathode module:** The high-speed turbo compressor is characterized by oil-free air supply, long lifetime, low weight, and high operating efficiency.
- **Thermal management system:** The anti-freeze module prevents ice formation during cold storage and reduces the shutdown procedure time.
- **Control system:** The innovative control system ensures longer life and lower operating costs of fuel cell systems.

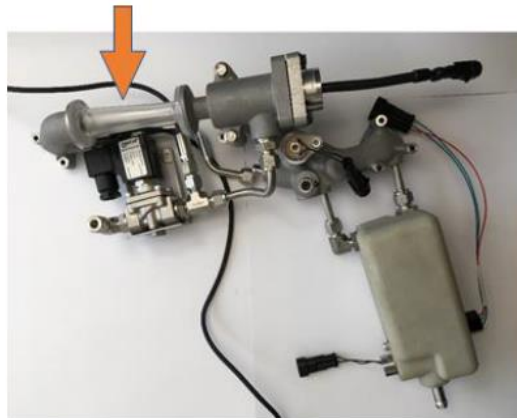
Application and market area

- **Anode module:** Commercial vehicles, marine applications, stationary fuel cell applications.
- **Cathode module:** The compressor can be used in various applications which need pressurized and clean air supply.
- **Thermal management system:** Suited for FC based heavy duty vehicles, hydrogen powered rail and maritime transport solutions.
- **Control system:** No other application foreseen for the moment.

Some innovations

Optimized ejector for automotive FC stack

The novel ejector is based on a Computational Fluid Dynamics (CFD) design, that leads to a better fuel supply and hydrogen recirculation as well as reduced parasitic losses, allowing for reduced fuel consumption and thus higher overall fuel cell system efficiency.



High speed air compressor for automotive FC

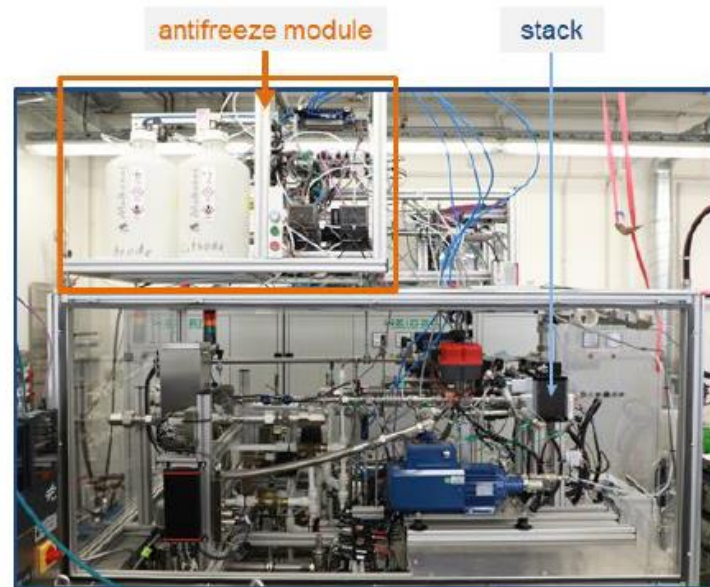
The high-speed turbo compressor is characterized by oil-free air supply, long lifetime, low weight, and high operating efficiency. Its high operation speeds make it suitable for various operating conditions and applications.

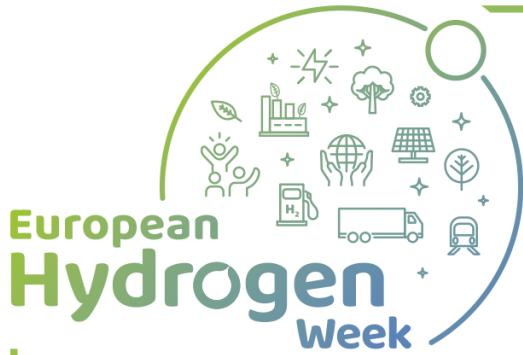


Some innovations

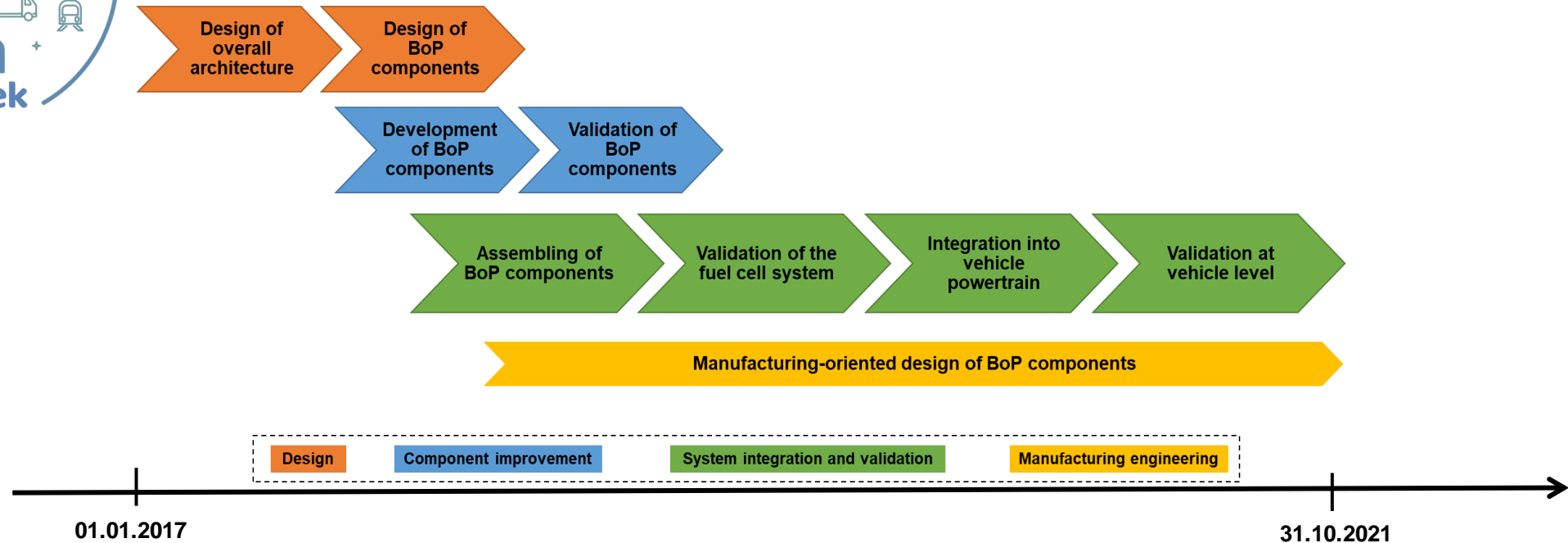
Anti-freeze module for automotive FC

The anti-freeze module prevents ice formation during cold storage and reduces the shutdown procedure time, which reduces the risk of FC degradation, improving the lifetime of the fuel cell system.

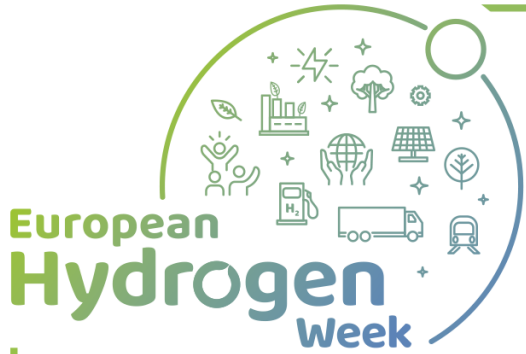




Project schedule



- **First step:** Definition of the most important parameters and overall architecture.
- **Second step:** Design of the anode, cathode, thermal management and control module, building of first prototypes and tests.
- **Third step:** Integration of all components in the FC system and subsequent integration of the FC system in vehicle powertrain. Test under real automotive conditions.



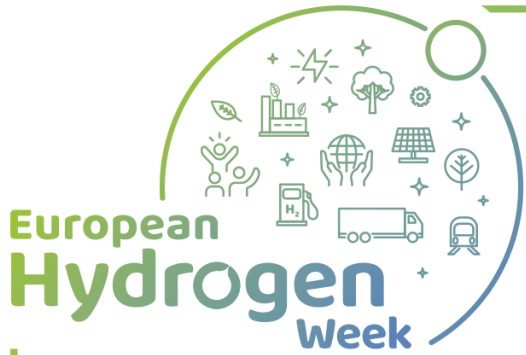
Risks and Lessons Learned

Risks

- INN-BALANCE occurred during the years of the global COVID-19 pandemic, and since the project consortium consists of partners from several European countries, who are working close to and dependent on each other, the project suffered from major unavoidable delays. Some partners offices were shut down for a period of time, production lines were stopped, which caused shortage for certain components, and sending parts across borders was more difficult and time consuming than usual.

Some Lessons Learned

- The cost optimization conducted on the identified potential for significant cost reduction in a potential series production. Specially ,in the compressor, which is the most expensive component.
- The extensive testing allowed to identify potential for improvement to be tackled in a next design iteration.



Communication and dissemination activities

Activities

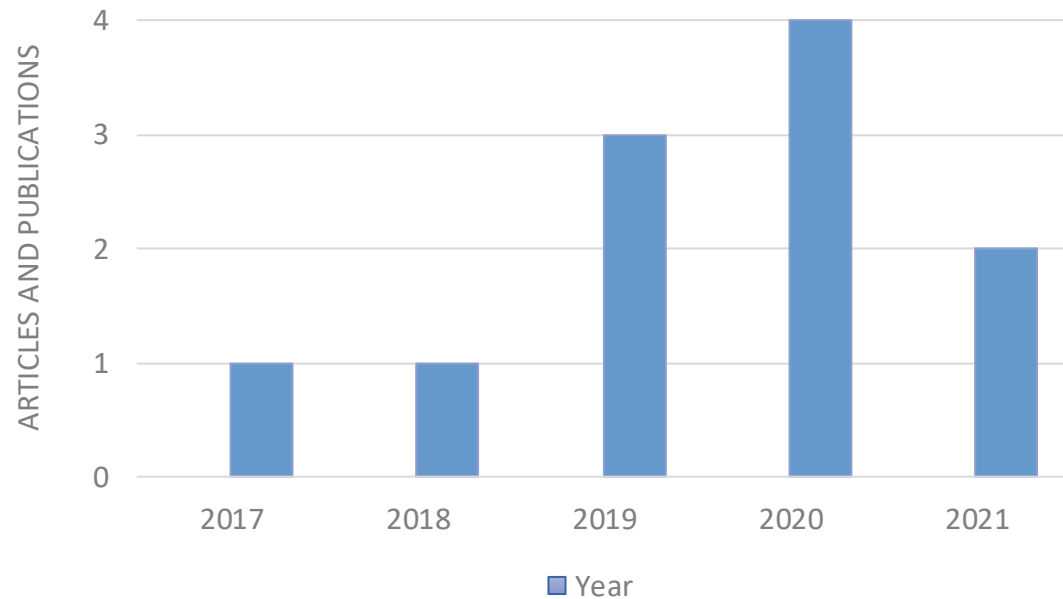
- Newsletters
- Press release
- Flyers
- YouTube channel
- Posts on social media channels and project webpage (innbalance-fch-project.eu)

FOLLOW US

 @INNBALANCE_FCH

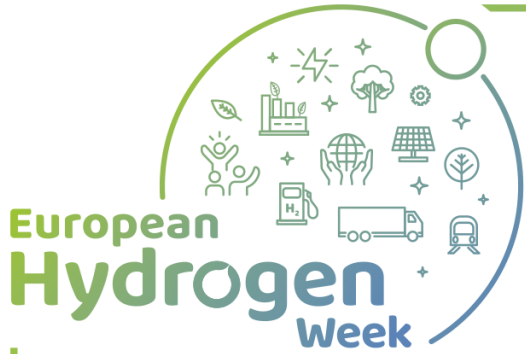
 INN - BALANCE Automotive Fuel Cells

Articles and publications



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Dissemination material - the inn-balance guidebook

This guidebook presents the main project activities and results generated during the project. It also contains an overview of the current market for hydrogen vehicles in Europe and provides an outlook to future challenges in this field.

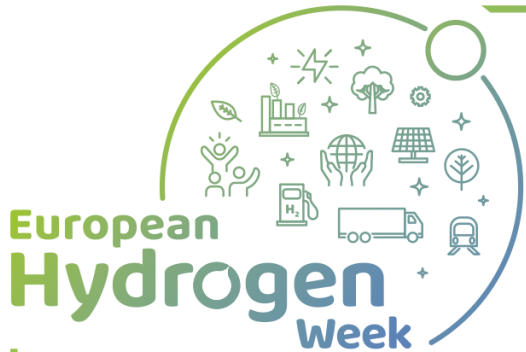
The main target groups of this document are vehicles OEMs and their suppliers, fuel cell integrators and manufacturers, BoP manufacturers, research institutions, and public authorities.



Paul Haering (Lead author), Jose M. G. Campos, Consuelo M. González, Markus Kogler, Ali Molavi, Juan S. Monreal, Emelie Nordqvist, Georg Oberholzer, Demetrius Ramette, Gema M. Ríos, Alexander Schenk

INN-BALANCE Guidebook

Improvement of Balance of Plant Components
for PEM based automotive fuel cell systems

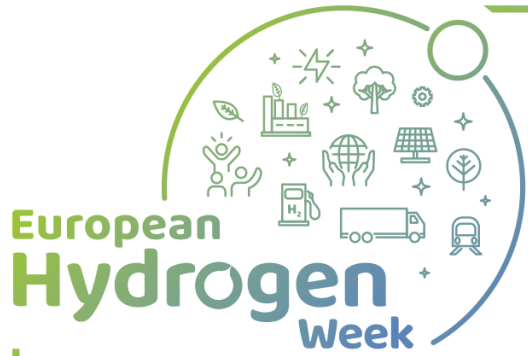


Achievement



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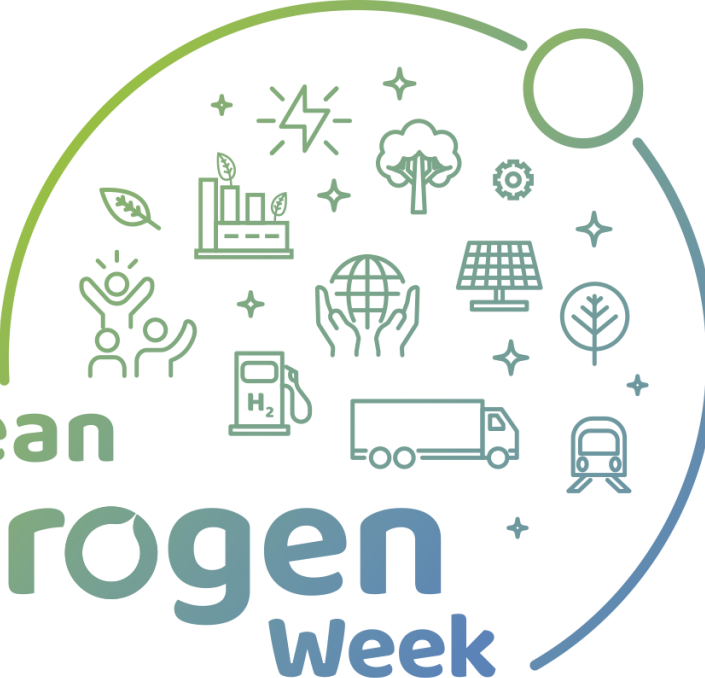




**Thank you for your
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**European
Hydrogen
Week**

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