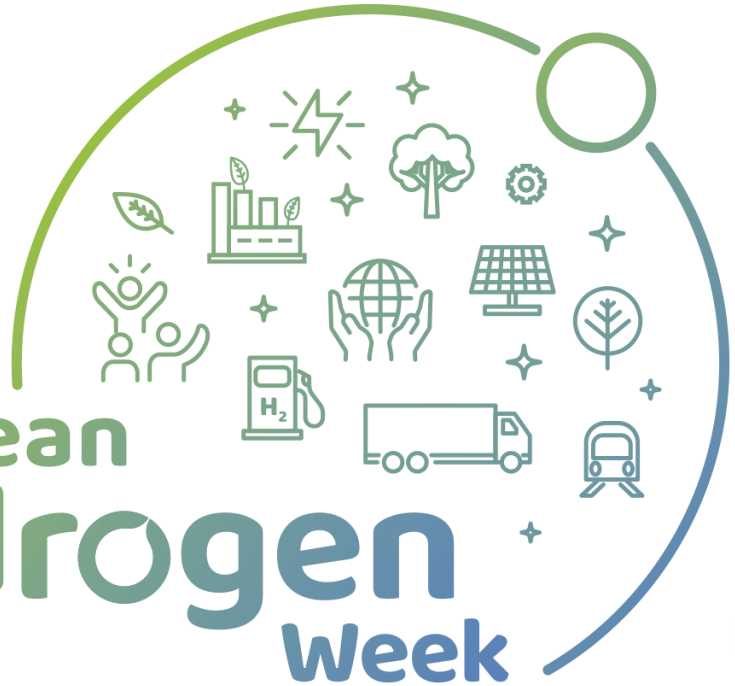
INN-BALANCE

INNovative Cost Improvements for

BALANCE of Plant Components of

Automotive PEMFC Systems

INN·BALANCE
AUTOMOTIVE FUEL CELL



EU Research Days

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#CleanHydrogen

Clean Hydrogen Partnership

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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 €

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European Hydrogen Week

Partners

CEVT

Integration of the overall system in powertrain and vehicle tests

STEINBEIS 2i

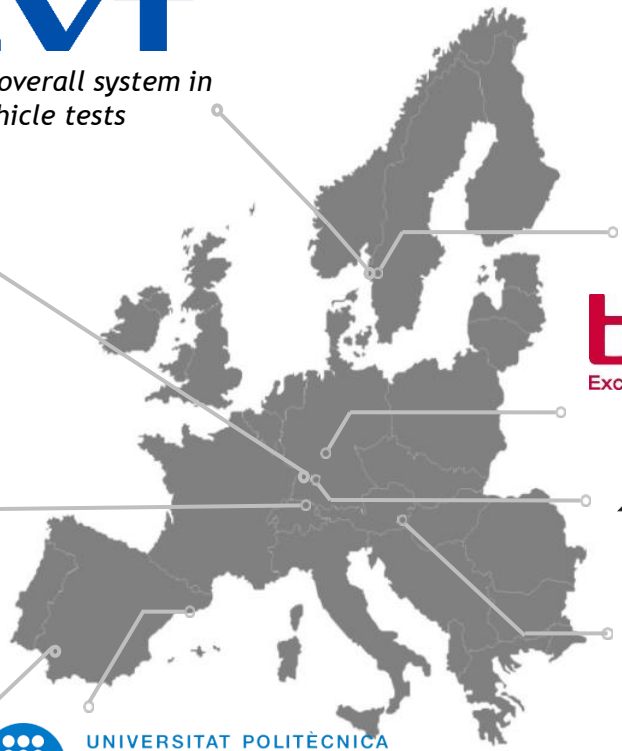
Dissemination and exploitation of results

Celeroton

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

fundación ayesa

Coordination and manufacturing-oriented design optimization



UPC UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Advanced control algorithms

POWERCELL

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

brose Excellence in Mechatronics

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

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.

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Project Summary

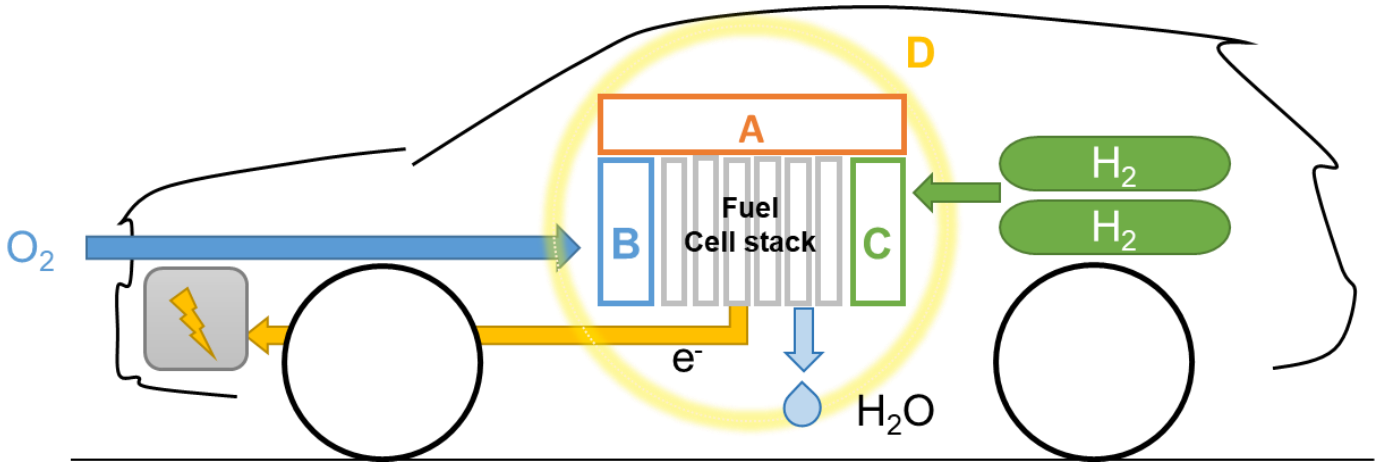
4 INN-BALANCE modules were defined based on their functions

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

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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.

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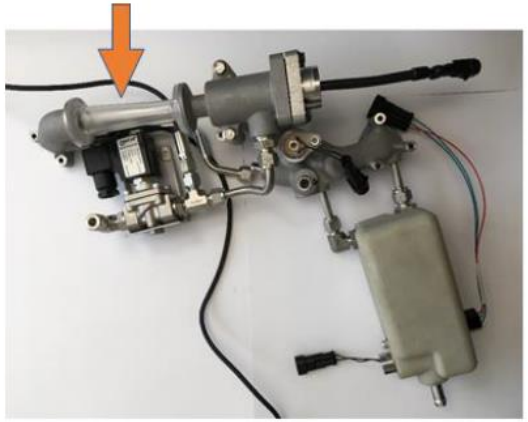
Some innovations

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.

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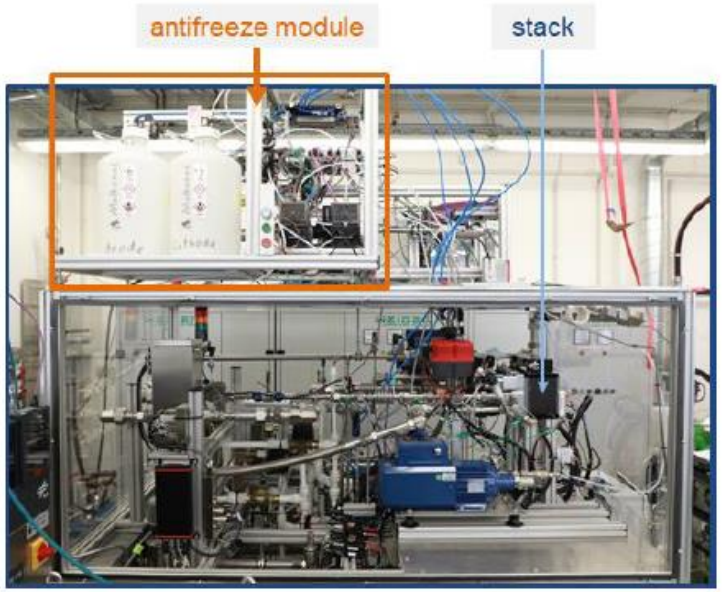
Some innovations

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.



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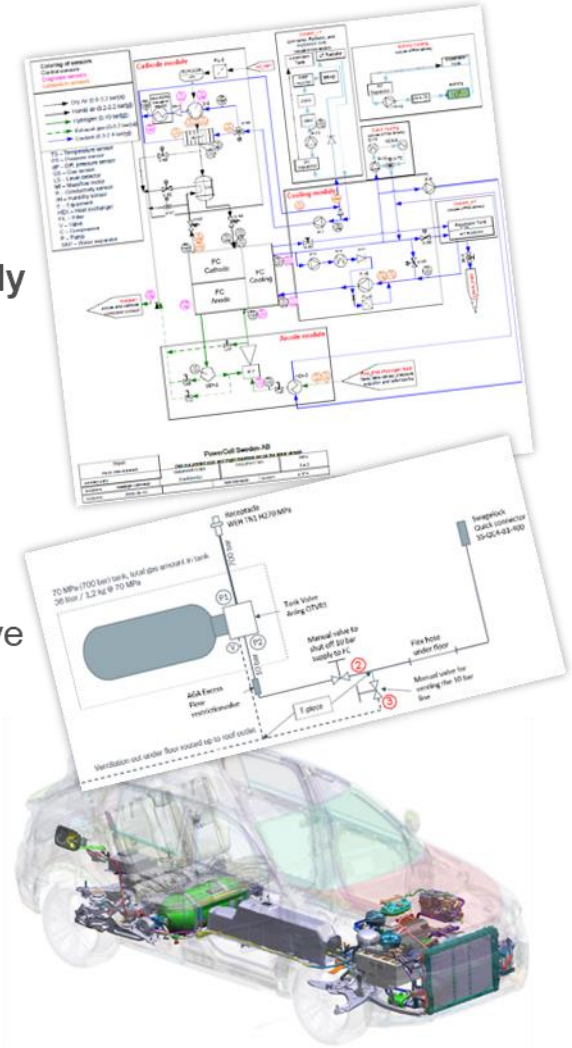
Challenge

Challenges:

- To integrate a complete fuel cell system, including **vehicle control software, thermal management, high voltage** and **hydrogen supply systems**, in a vehicle.
- Perform controlled and repeatable tests with a hydrogen powered vehicle.

Motivation:

- Build competence in fuel cell technology for vehicle applications.
- Influence fuel cell system design to benefit the needs of the automotive industry.
- Contribute to the transition towards zero emissions in the automotive industry.



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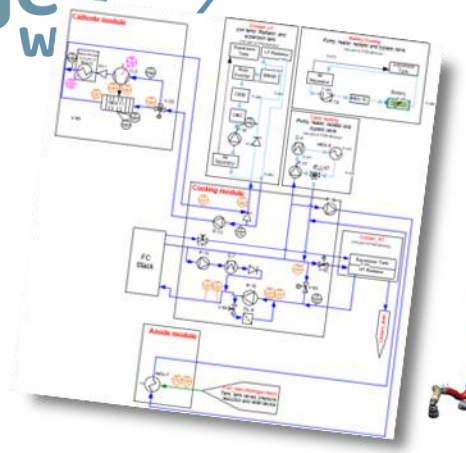
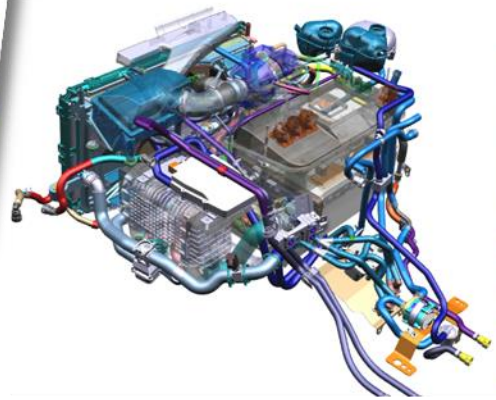
Manufacturing approach

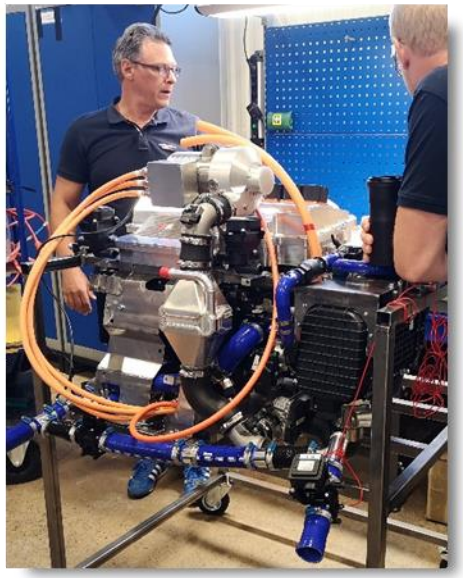
Assembly of the Fuel Cell System



System study



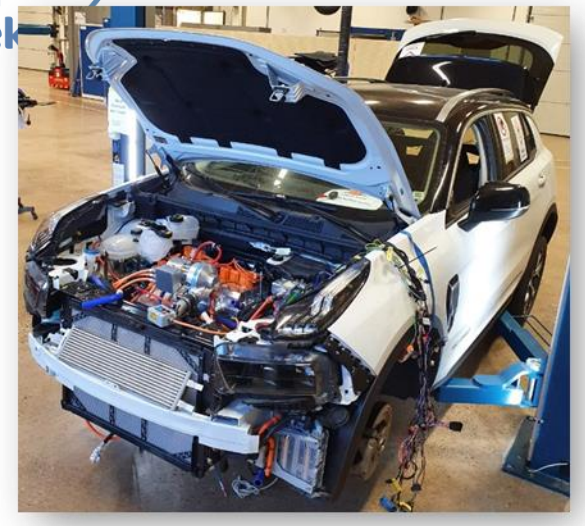
Packaging study



Assembly

Delivery

Vehicle assembly



Assembly of the fuel cell and hydrogen supply systems into the vehicle.

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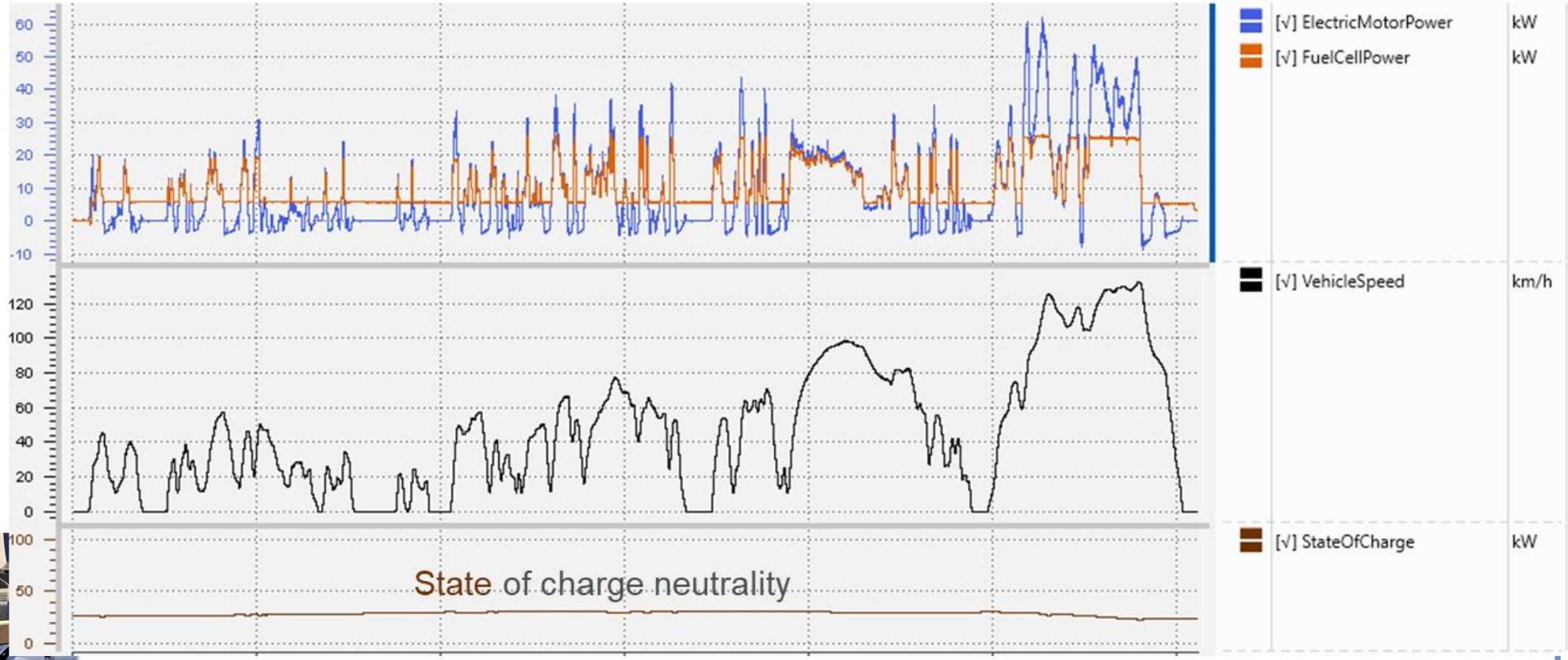
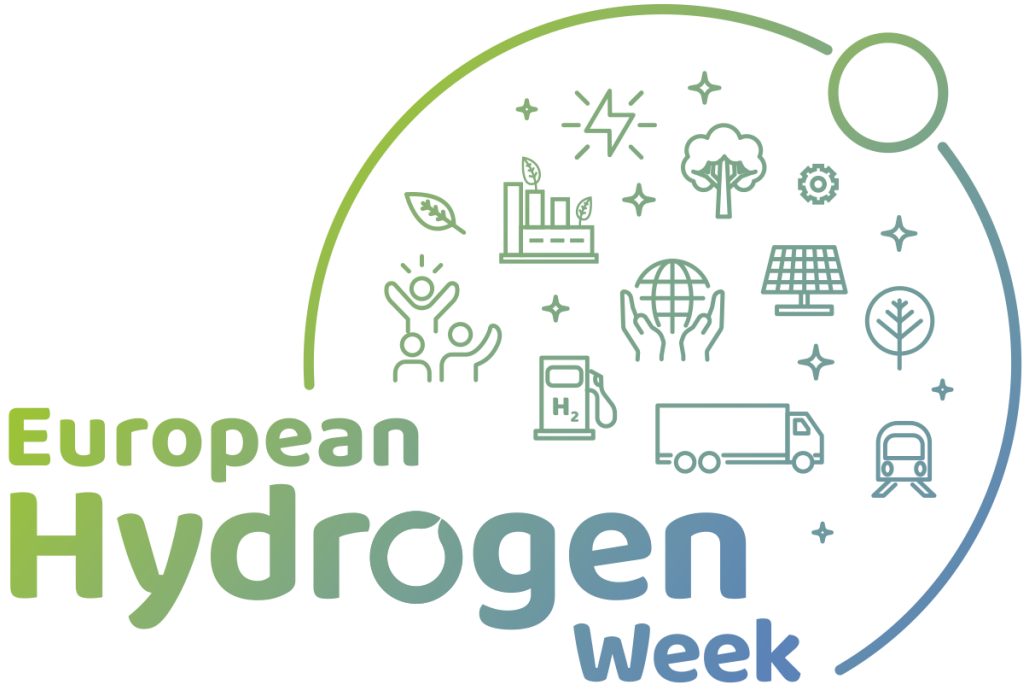
Final result

Project Summary

World Harmonized Light-duty Vehicle Test Cycle (WLTC)





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