HYDROGEN FUEL CELL ELECTRIC NON-ROAD MOBILE MACHINERY FOR MINING AND CONSTRUCTION: AN INNOVATIVE, EFFICIENT, SCALABLE, SILENT AND MODULAR POWER-TRAIN CONCEPT

Clean Hydrogen Partnership

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

H2MAC
Hydrogen fuel cell electric non-road mobile machinery

Outline

1. The Project Boundaries
2. The Consortium
3. The Concept
4. The Methodology
5. Contact

Clean Hydrogen Partnership
Co-funded by the European Union
The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

01

The Project Boundaries

Clean Hydrogen Partnership
Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

The Project Boundaries

- **Call:** HORIZON-JTI-CLEANH2-2023-03-01

  Real environment demonstration of Non-Road Mobile Machinery (NRMM)

  Knowledge generation by means of the development and demonstration (real environment – 1000h) of two mature prototypes of hydrogen FC propelled machinery (construction & mining or agricultural & farming sectors), which are currently running with an ICE utilising conventional fuels.

- **Action:** Innovation Action (IA): TRL 4-5 to TRL 7
- **Funding:** Maximum grant by the Clean Hydrogen Partnership: 5 M€
- **Budget:** 6 278 930.00 € (Grant amount: 4 990 769.76 €)
- **Duration:** 1 January 2024 – 31 December 2027

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

02

The Consortium

Clean Hydrogen Partnership
Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

8 Partners (5 Countries)

ita Instituto Tecnológico de Aragón

Tampere University
Tampere University of Applied Sciences

ANMOPYC
ASOCIACIÓN ESPAÑOLA DE FABRICANTES DE MAQUINARIA DE CONSTRUCCIÓN, OBRAS PÚBLICAS Y MINERÍA

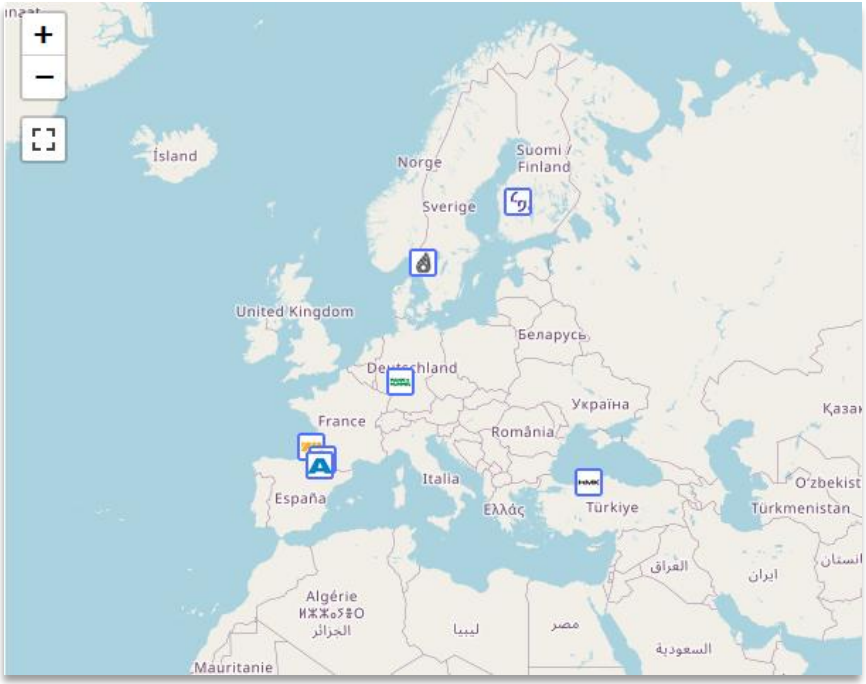
Ha FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

ZB GROUP

HIDROMEK

PowerCell Group

MANN+HUMMEL



Clean Hydrogen Partnership

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

Role Balance

ita Instituto Tecnológico de Aragón
Tampere University
Tampere University of Applied Sciences

R&D

- Power electronics
- Mechatronics
- Noise & vibration
- Electrification
- Control
- Thermo-Fluid dynamics

ANMOPYC
ASOCIACIÓN ESPAÑOLA DE FABRICANTES DE MAQUINARIA DE CONSTRUCCIÓN, OBRAS PÚBLICAS Y MINERÍA

Ha FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

Cluster

- Civil & mining machines manufacturers
- Hydrogen

ZB GROUP
HIDROMEK

OEM

- Excavator (120kW)
- Shredder (240kW)

PowerCell Group
MANN+HUMMEL

Tier 1-2

- Fuel cell
- Filtering / conditioning components

Clean Hydrogen Partnership
Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

03

The Concept

Clean Hydrogen Partnership
Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

Scope

1. To identify the gaps between the state of the art and the **industry needs** to pave the way towards the decarbonization of NRMM for mining and construction, from different perspectives:
    i. Technology
    ii. Safety
    iii. Regulation and standards
2. To design and demonstrate an **innovative, efficient, scalable, silent and modular FCE-power-train concept** for non-road mobile machinery (**FCE-NRMM**) for construction and mining (harsh environment: dust, vibrations, etc).
3. To **design two new machines** for the construction and mining sector to host the new FCE-powertrain (This is not a retrofitting), probing their scalability:
    i. Excavator (120kW)
    ii. Shredder (240kW)
4. To **demonstrate (1000h) the viability** of the solution in a real environment (Quarry).

Clean Hydrogen Partnership

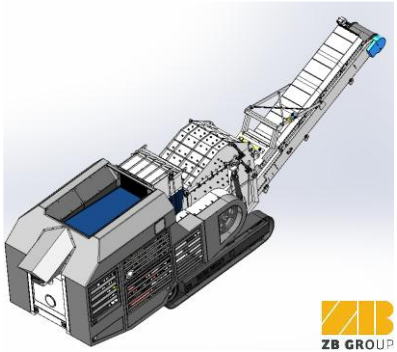
Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

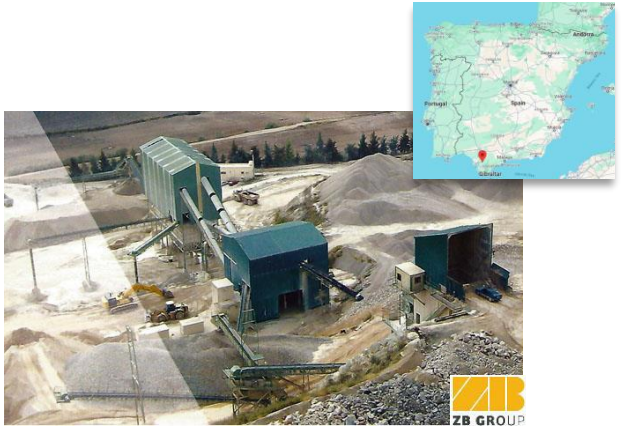
Strategic objective

Simultaneous **demonstration** during at least **1000 hours** in a real environment of **two** newly designed **NRMM** (excavator and shredder for the mining and construction sector) **hydrogen FC powered**.

Excavator (Current design for ICE)



Shredder (Current design for ICE)



Demo site (Arcos de la Frontera, Spain)

Clean Hydrogen Partnership

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

Specific technical objectives

O1. Enhanced system operation for the developed machinery in terms of emissions reduction, hydrogen consumption decrement, and external sound power level reduction.

O2. Improved Fuel Cell System characteristics, targeting 80% system lifetime of conventional power sources, a CAPEX <800 €/kW and 80% of NRMM availability.

O3. Improved component and system reliability under the specific working conditions.

O4. Compliance with regulations, codes and standards (RCS) in place and development of new standards for industrial development.

O5. Communication and dissemination of project results for a swifter adoption of the project innovations.

O6. Preparation of exploitation and business pathway to reach technology maturity.

Clean Hydrogen Partnership

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

04

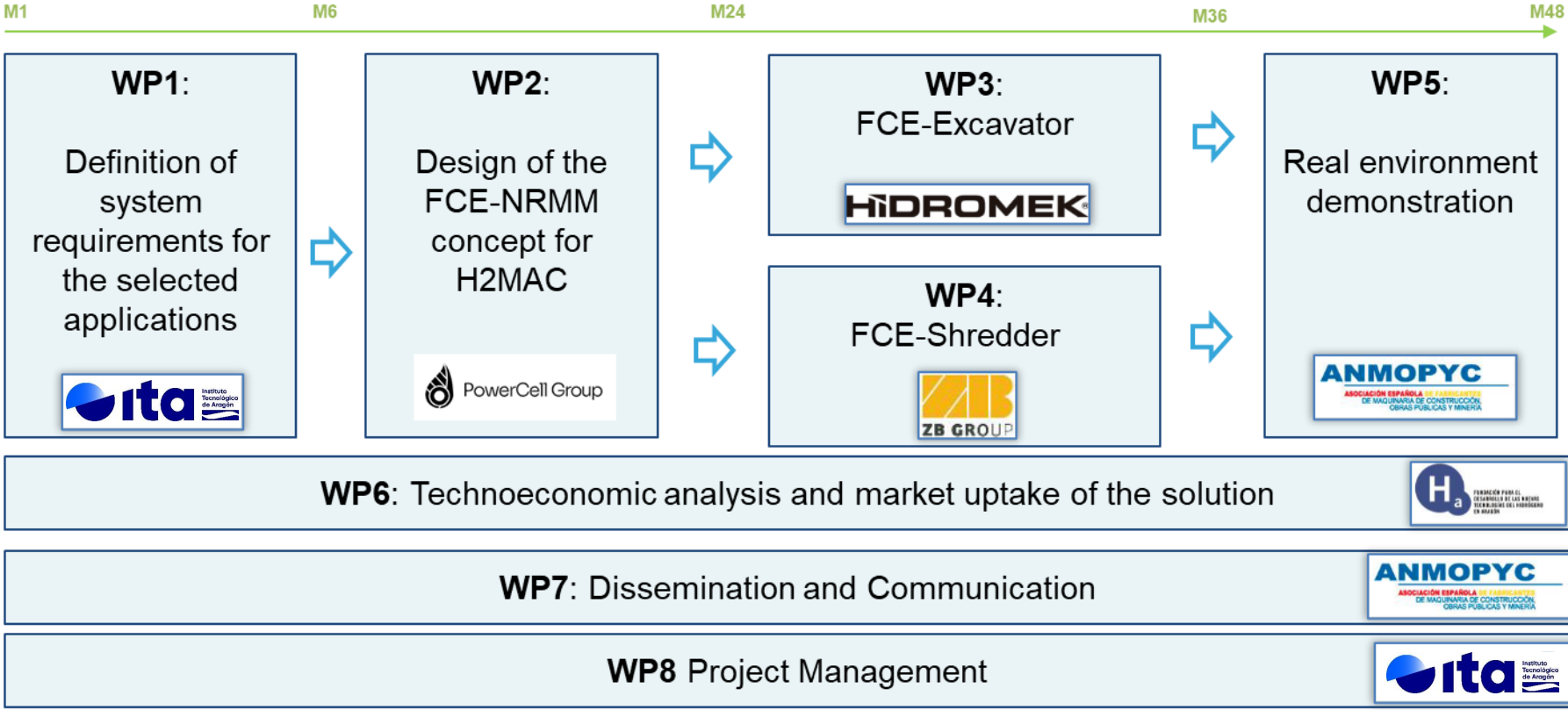
The Methodology

Clean Hydrogen Partnership
Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

The Work Plan

H2MAC
Hydrogen fuel cell electric non-road mobile machinery



Clean Hydrogen Partnership

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

The Gantt Chart

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
WP1	**Definition of system requirements for the selected applications**																																																
T1.1	FCE-excavator specifications and industry needs																																																
T1.2	FCE-shredder specifications and industry needs																																																
T1.3	Harmonization of FCE-NRMMs specifications					MS3																																										
T1.4	Real demonstration: Specifications and needs					MS4																																										
T1.5	Identification of any legal or standards requirement likely to prevent the success																																															
T1.6	Assessment of the safety plan																																															
WP2	**Design of the FCE-NRMM concept for H2MAC**																								MS10																								
T2.1	Modular powertrain hybrid design																																															
T2.2	Machine electrification study																																															
T2.3	Design of Thermal Management System																																															
T2.4	Fuel cell design																																															
T2.5	Air management system design (Balance of Plant)																																															
T2.6	Hydrogen and water storage system																																															
T2.7	Noise mitigation systems																																															
T2.8	Vibration mitigation systems																																															
T2.9	Integrated digital twin																								MS9																								
WP3	**FCE-Excavator**																																															
T3.1	Machine design																										MS12																						
T3.2	Sensors for data gathering																																															
T3.3	Construction and assembly of the prototype																																															
T3.4	Testing and verification of machine functionalities																																			MS16												
WP4	**FCE-Shredder**																																															
T4.1	Mechanic design																										MS13																						
T4.2	Electric design																										MS13																						
T4.3	Sensor for data																																															
T4.4	Manufacture of the prototype																																															
T4.5	Testing and verification of machine functionalities																																			MS17												
WP5	**Real environment demonstration**																																															
T5.1	Safety Plan																																															
T5.2	Site conditioning for demonstration																																			MS19												
T5.3	FCE-Excavator demonstration and data gathering																																													MS21			
T5.4	FCE-Shredder demonstration and data gathering																																												MS21			
T5.5	Data analysis and KPI assessment																																															MS23
T5.6	LCA study assessing the sustainability of the solution																																															
WP6	**Technoeconomic analysis, market uptake of the solution and exploitation results**																																															
T6.1	Assessing the TCO of the solution results																																															
T6.2	Paving the way to FCE-NRMMs: Legal Standards																																													MS22		
T6.3	Develop of new business models based on H2MAC activities																																															
T6.4	Developments of an exploitation strategy for commercialization of key exploitable results																																															
T6.5	Implementation of the exploitation strategy for commercialization of key exploitable results																																															
T6.6	IPR Protection, Patent Planning																																															
WP7	**Dissemination and Communication**																																															
T7.1	Dissemination strategy & communication plan																																															
T7.2	Dissemination and Communication activities			MS2																																													
T7.3	Clustering activities					MS6																																										MS25
T7.4	Advisory Board																																															
WP8	**Project Management**																																															
T8.1	Project Coordination	MS1				MS5				MS7				MS8				MS11				MS14				MS18				MS20				MS24												
T8.2	Reporting to EC																																															
T8.3	Technical and Risk Management																																															
T8.4	Quality Management																																															
T8.5	Data Management Plan (DMP)																																															
T8.6	Annual reporting for the CleanHydrogen JU																																															
T8.7	Assessment of the KPI progress																																															

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

H2MAC
Hydrogen fuel cell electric non-road mobile machinery

05

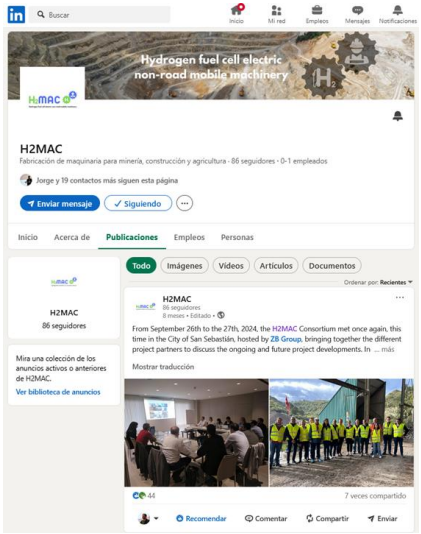
Contact

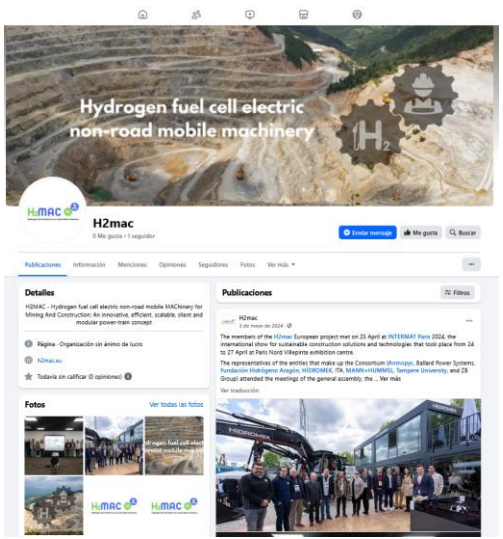
Clean Hydrogen Partnership
Co-funded by the European Union

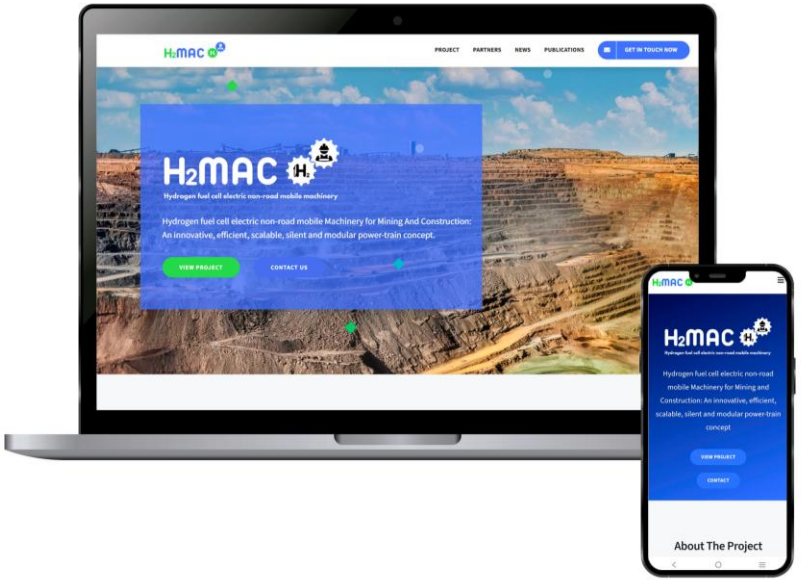
The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.

Contact

H2MAC
Hydrogen fuel cell electric non-road mobile machinery







#H2MAC
#NRMM
#construction
#mining
#fuelcellapplications

https://h2mac.eu

Follow us to keep updated on the project development!

@h2mac

@h2macproject

@H2macproject

@h2macproject

Clean Hydrogen Partnership

Co-funded by the European Union

The project is supported by the Clean Hydrogen Partnership and its members, under Grant Agreement No 101137786.