European Hydrogen Week

GRASSHOPPER Project Overview

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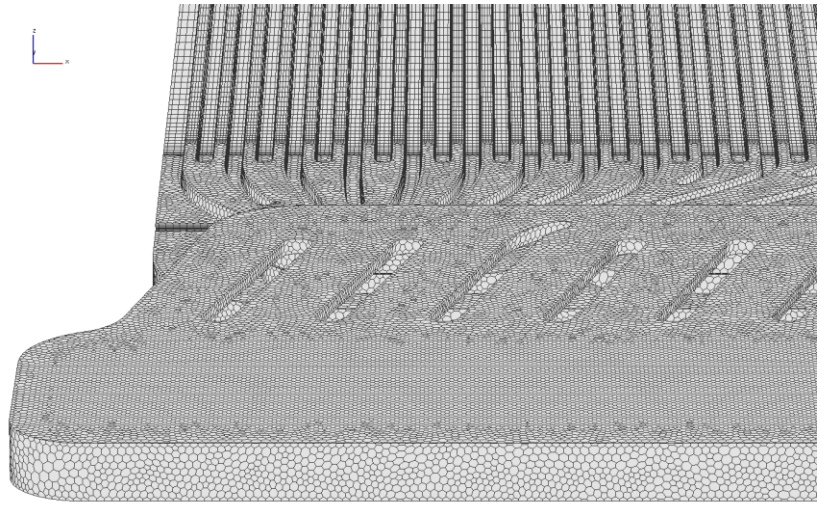
http://www.grasshopperproject.eu/

GRASSHOPPER Project
Objectives

- Development and demonstration of next-generation modular MW-size FCPP unit
- Improvements in fuel cell technology: MEAs, FC stacks, system:
  - **Substantial cost reduction of MEAs, FC stacks and system (BoP): stacks 450 €/kWe, system 1500 €/kWe**
  - **High stack power density and output, efficiency >55%**
  - **Durability requirements: lifetime >20,000 h**
  - **Simulation based improvements: system efficiency >50% and availability >95%**
- Improve the MEA and the stack manufacturing process
- Flexible demand driven operation with steep ramp rates : grid support and flexibility trading
- Demonstration of 100 kW submodule unit; validation period 8 months
- Dissemination activities: 2 scientific publications, 2 workshops, business case development, lateral project networking.

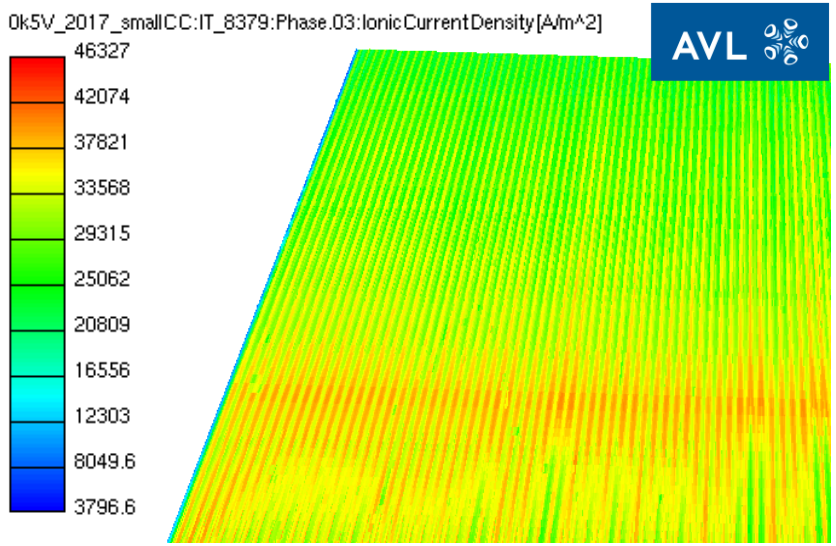
WP -2 Flow field modelling and experimental validation



Meshed cell plate

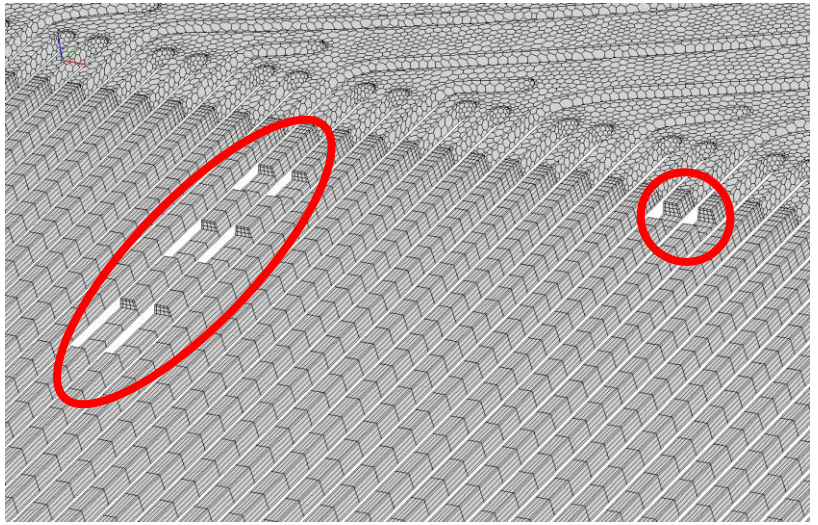
The development process of the new GRASSHOPPER fuel cell stack could be successfully completed

- Newly developed MEA and flow field combination are meeting the project targets
- CFD-simulation of the large area fuel cell could be performed successfully
- The simulation confirms a very good distribution of the media in the cell



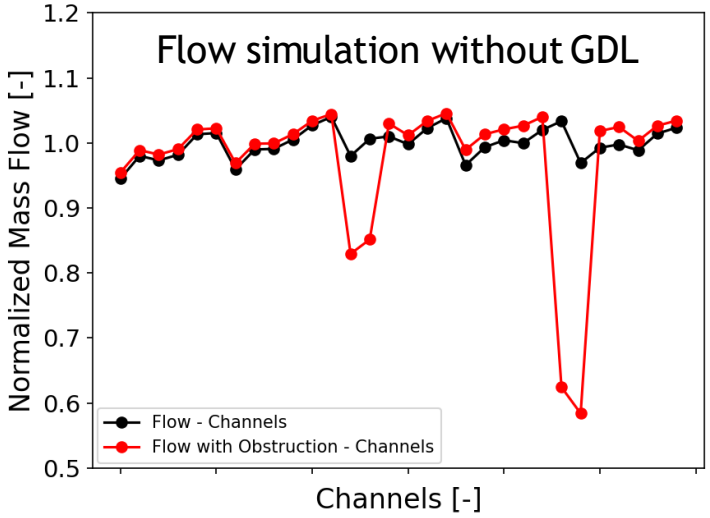
Uniform current density distribution

WP2 - Flow field modelling and experimental validation

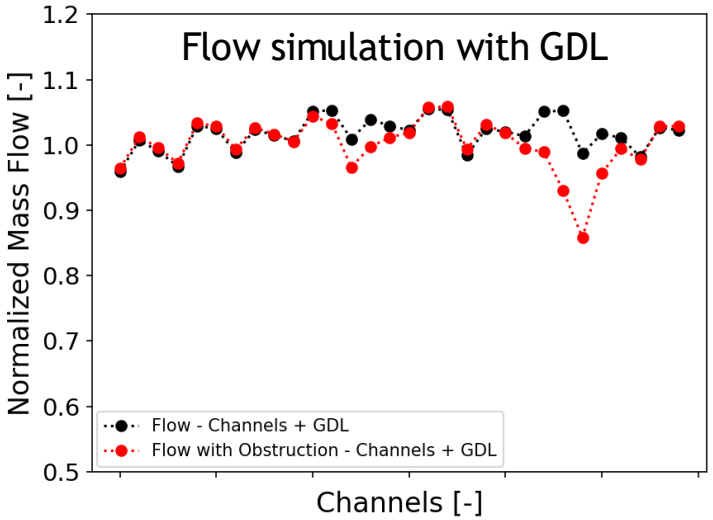


Meshed with artificially inserted obstructions

Further simulation-based studies even show a stable behaviour when individual channels are blocked by e.g. water droplets. The GDL enables compensating flows under the landings and can thus make an important contribution to a long durability of the stack.



Strong impact of obstructions in the case of pure channel simulations



Compensation of the flow differences by the GDL

WP3 - Develop durable stationary power MEA with CCM construction

Achievement to-date

SoA MEA used in eg DEMCOPEM-2MW

25% 50% 75%

Target
60% cost/unit power reduction,
76% mass Pt/unit power reduction

Membrane	Chemical stabilisation	Mechanical stabilisation	Catalyst Layers
Pre-project Stationary Power (30µm)	Standard	Standard	Stationary state of the art design
Automotive style (15µm)	Standard	Standard	86% Pt reduction vs stationary SoA
GH1 (20µm)	Standard	Standard	81% Pt reduction vs stationary SoA
GH2(20µm)	High	Standard	
GH3(20µm)	High	Enhanced	

New MEA designs with high volume automotive CCM type construction, significantly lower Pt content than stationary power MEAs

WP3 - Deliver higher power density, maintain durability of MEA

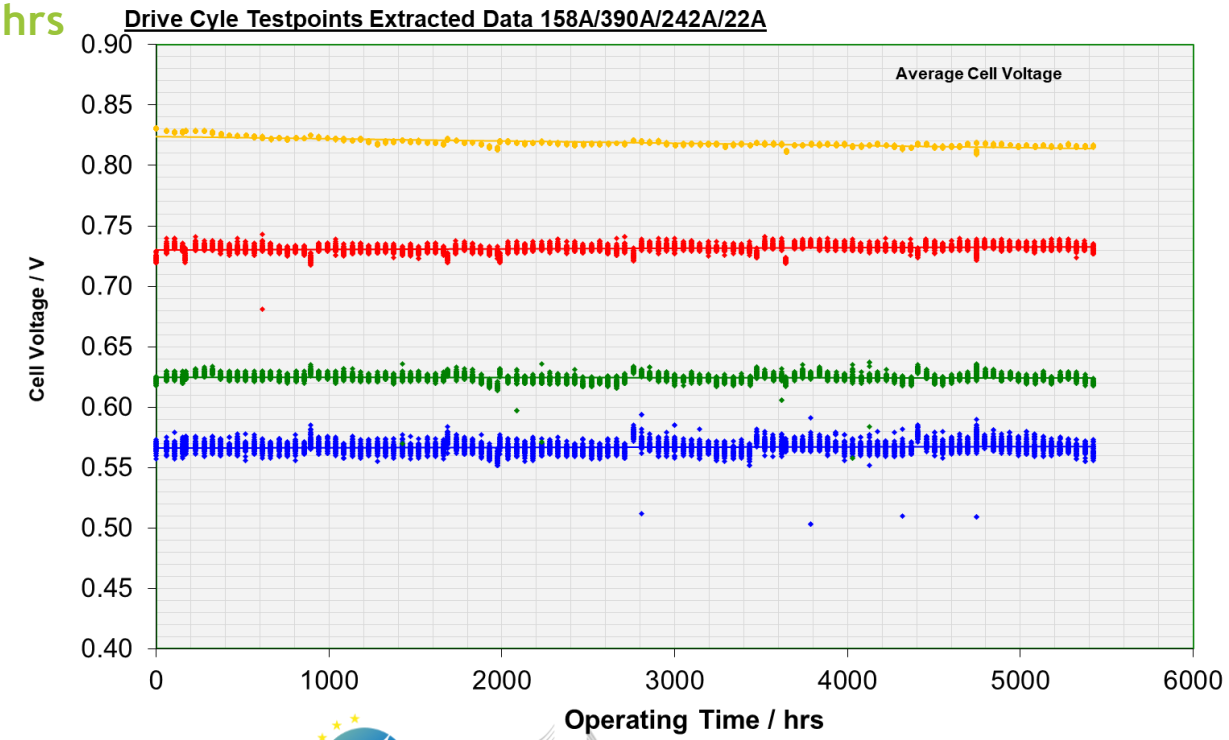
Achievement to-date

Operate at 0.68 V at 1 A/cm², maintain durability of SoA MEA 20,000hrs

25% 50% 75%

Target
0.68 V at 1 A/cm², 20,000 hrs
Achieved
0.68 V at 1 A/cm², 5500 hrs in drive cycles in AST

GRASSHOPPER GH3 CCM MEA performance on target or better in optimised cell hardware. Excellent durability as shown in NEDC-type drive cycle test over 5500hrs



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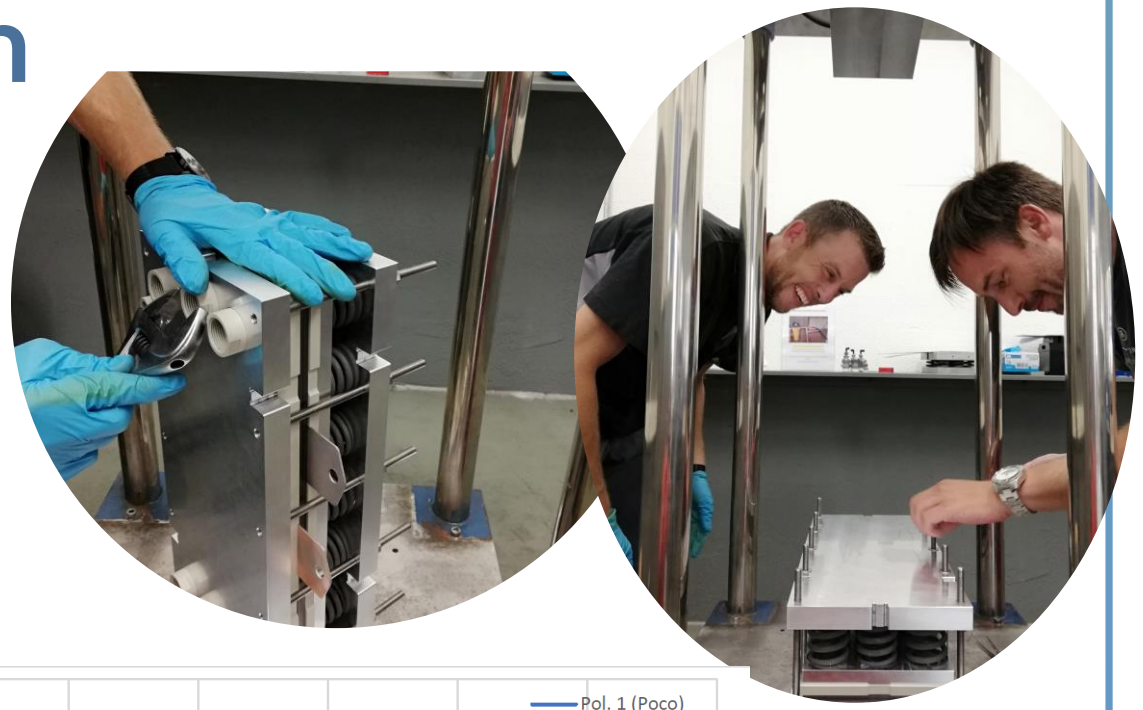
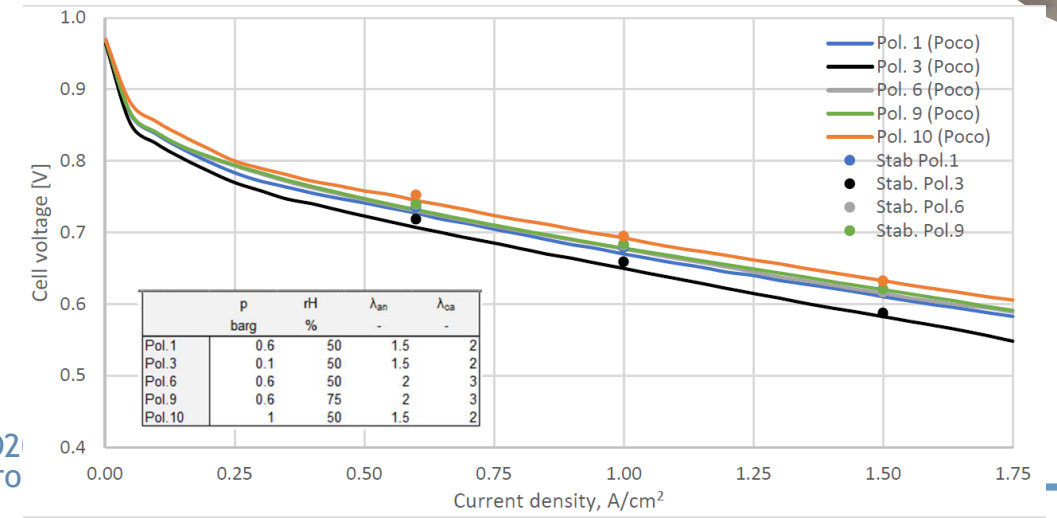
WP4 - Improved stack design and pilot production

Main milestones achieved in stack development

- New Grasshopper stack design completed
- Performance testing conducted on a short stack with milled cell plates demonstrating a performance of 0.68 V @ 1 A/cm^2
- Long term testing of the Grasshopper MEAs ongoing in the current 70 kW plant of Nedstack in Delfzijl
- Mould prepared and design verification ongoing





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WP4 - Grasshopper Pilot Plant

Main milestones achieved in site preparation for the 100 kW pilot plant

- Site exact plot decided in Chemiepark Delfzijl, the Netherlands
- Permit application in progress with Provincie Groningen
- Quantitative Risk Assessment for the plant and location performed

WP5 - System modelling and performance optimization

A stationary model of the Fuel Cell Power Plant has been developed in Aspen Plus®, including:

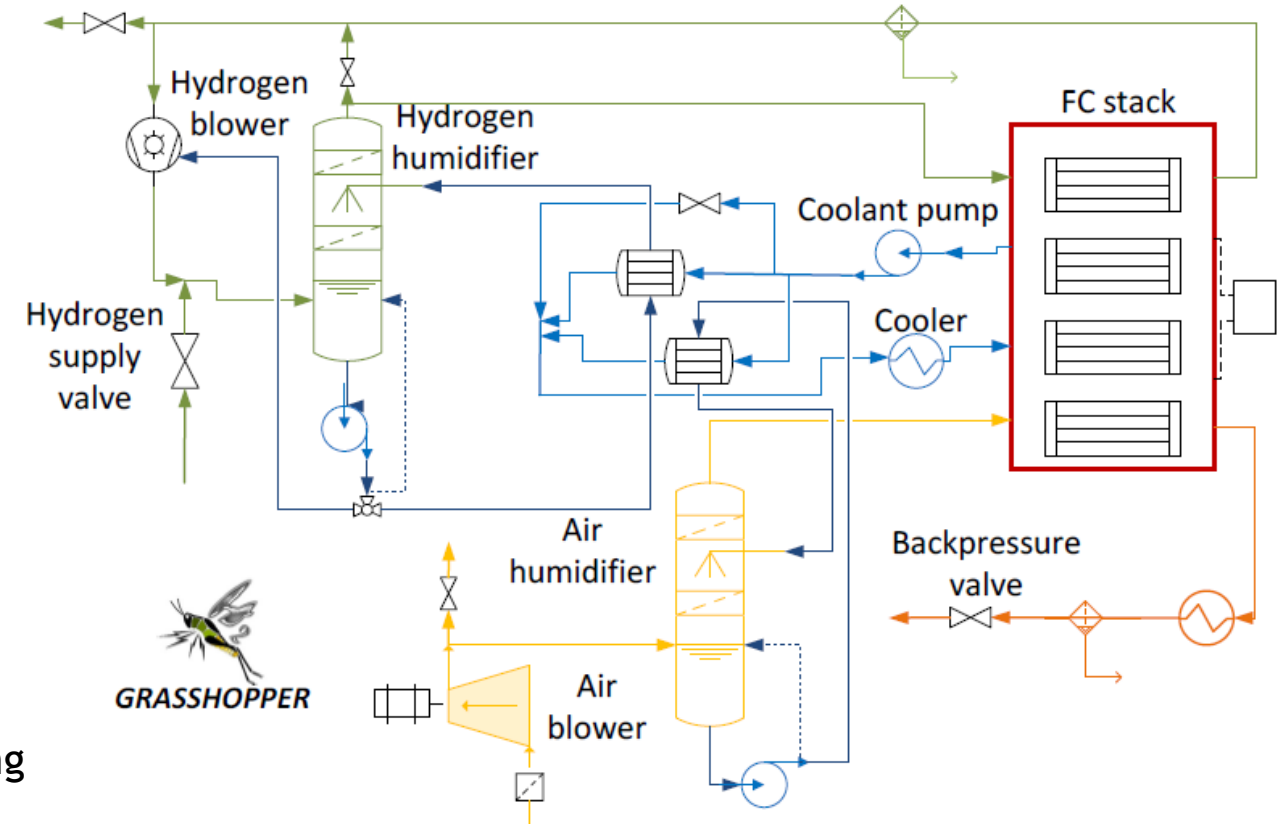
- a customized model for the PEM FC stack;
- models of the main balance of plant components.

The model has allowed to simulate the plant operation and asses its performances, considering:

- different plant configurations;
- different loads and operating conditions.

Results of the simulation activity has allowed to:

- identify the optimal configuration and operating points of the 100kW$_{el}$ pilot plant;
- identify required changes in configuration and operating points to optimize the plant scale-up.



WP5 - System modelling and performance optimization

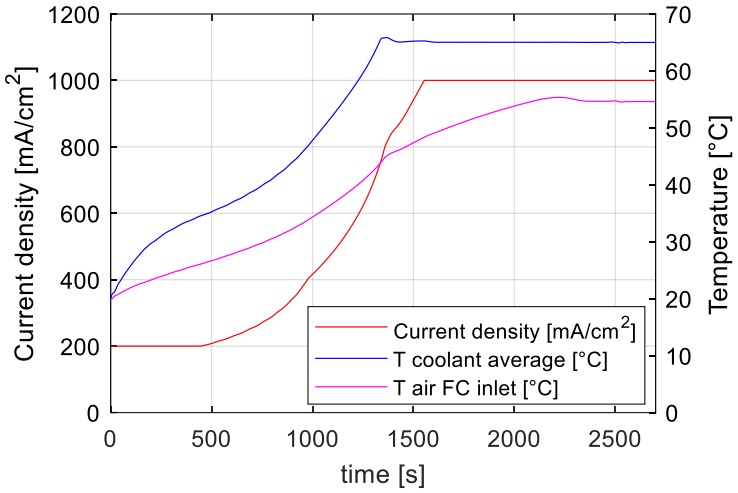
A dynamic model of the Fuel Cell Power Plant has been developed in MATLAB Simulink.

The model allow to investigate plant behavior during variable load operation, simulating:

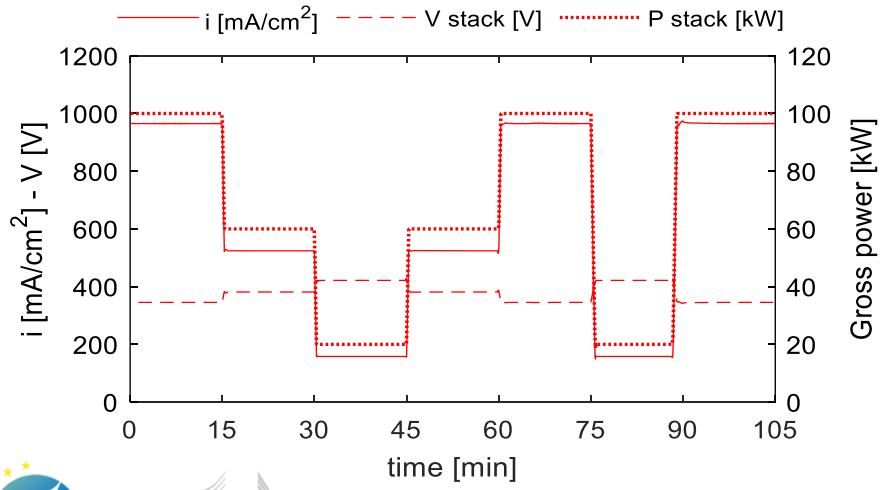
- Cold startup;
- Load-following operation.

Simulations results allowed to:

- assess the system flexibility, required for the provision of ancillary services;
- Identify a preliminary plant operation strategy;
- identify the critical aspects to be overcome in plant scale-up to the MW size.



Cold startup (Warm-up procedure)



Load-following operation

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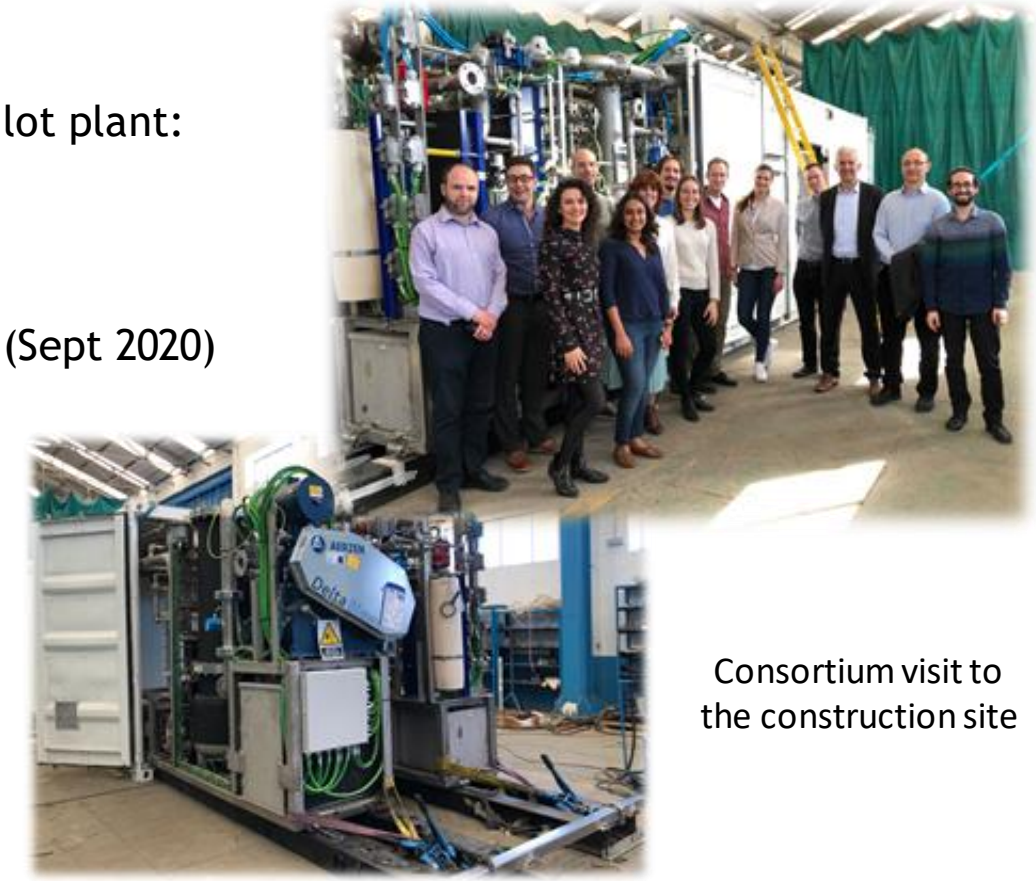
WP6 - Grasshopper Pilot Plant

Main milestones achieved regarding the Grasshopper 100 kW pilot plant:

- Construction of Pilot plant completed
- Transported to Abengoa's Testing Facilities in Seville (Spain) (Sept 2020)

Transport to testing facilities



Consortium visit to the construction site

WP6 - Grasshopper Pilot Plant

Currently FAT (Factory Acceptance Test) is underway:

- BOP Circuit testing (N2, Demi Water, Air, Hydrogen…)
- Control loop adjustments
- KPI achievability exploration
- Automation and software programing (SCADA…)

STACK INTEGRATION AND POWER TESTING APROACHING SOON!

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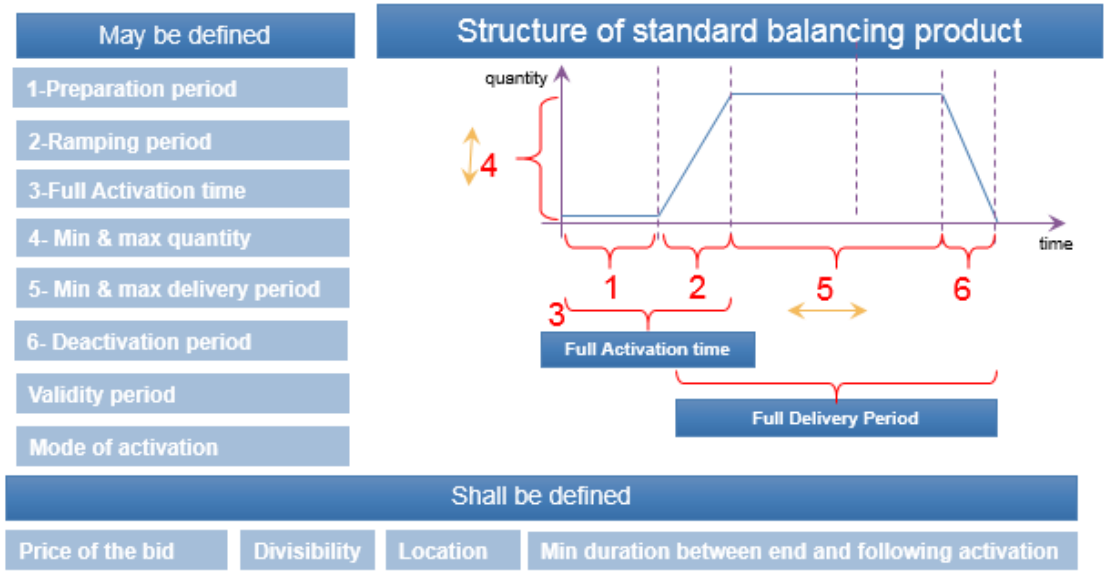
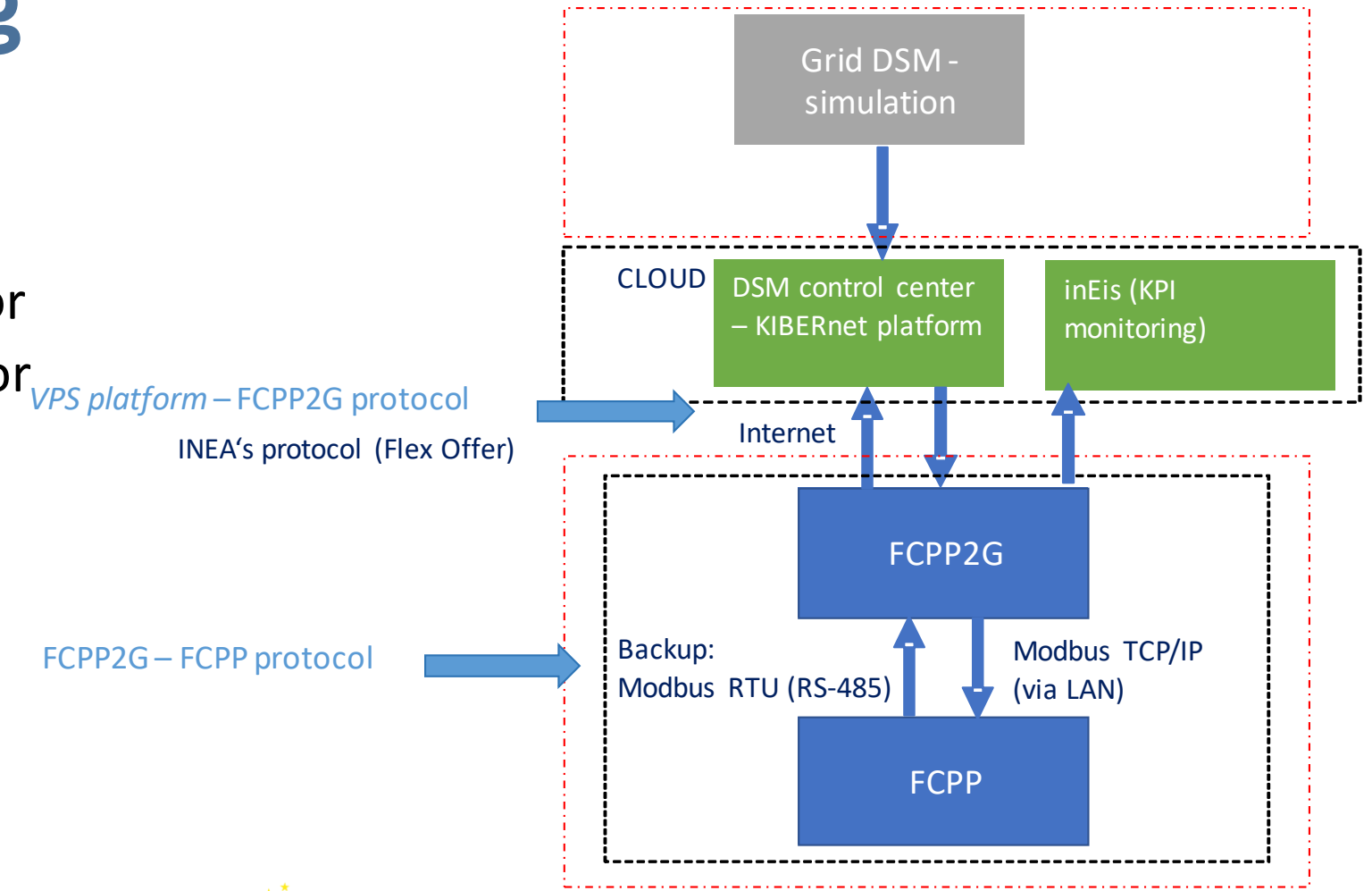
WP7 - Introduction of system service - xFRR products

- Market potentials - revenue stream
  - Selling electricity (CHP)
  - Balancing services
  - Congestion management
- Proposed use cases
  - Energy trading
  - Balance market services : aFRR, mFRR, congestion management



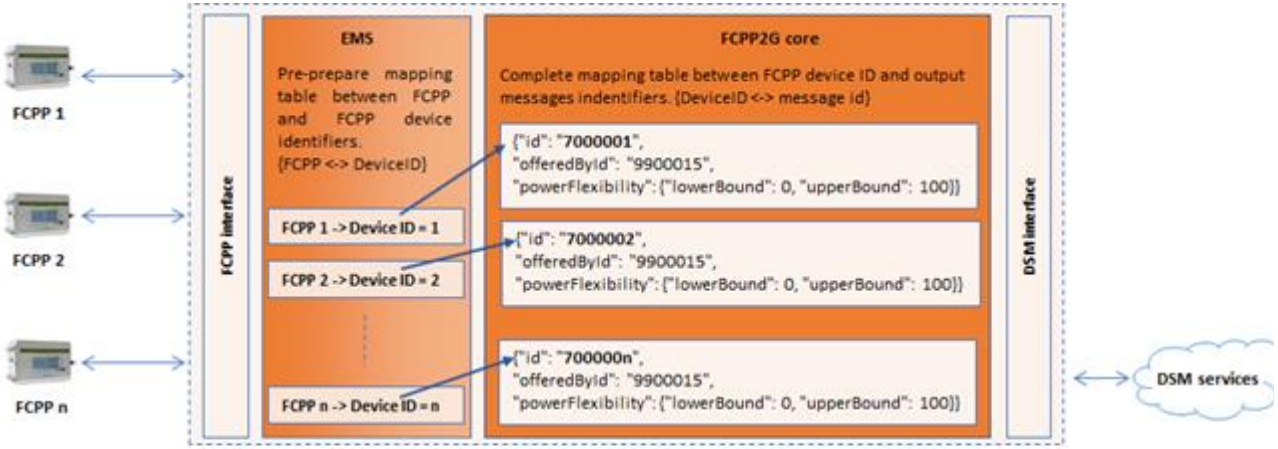
WP7 - Solution architecture for testing

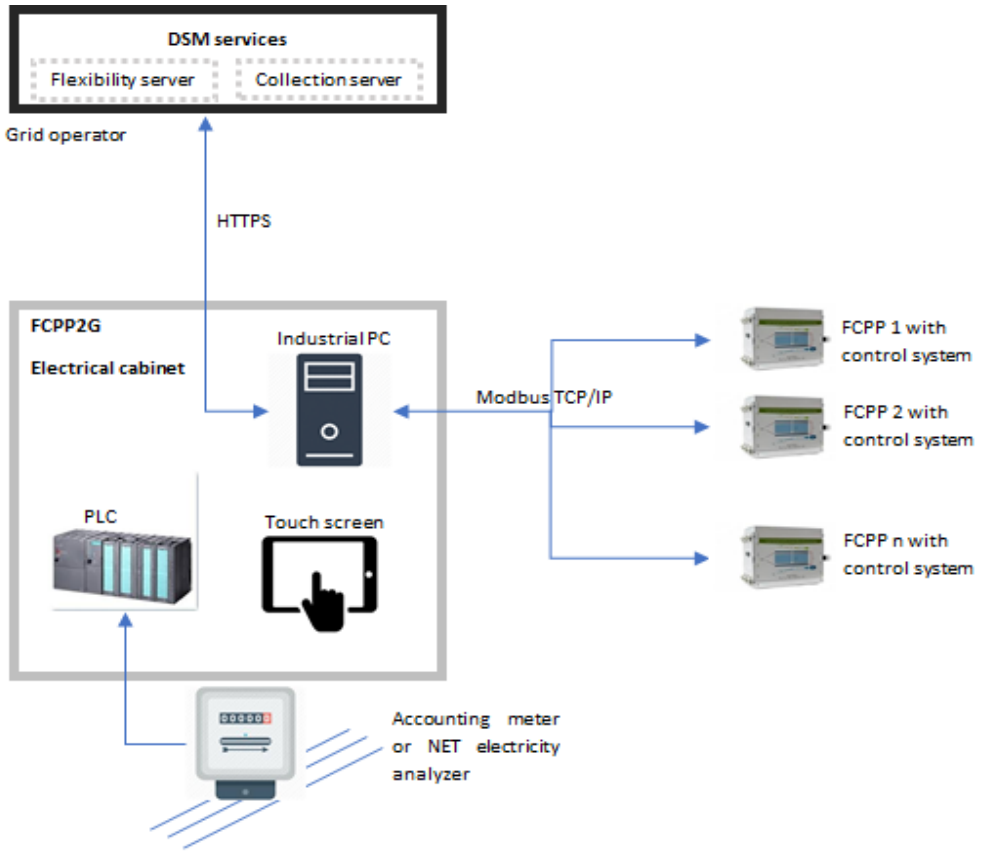
- DSM control center
  - Energy market simulator
  - System service simulator
- FCPP2G monitoring
  - Operation monitoring
  - KPI calculation



WP7 - Scalability to 1MW solution

- FCPP2G modular approach
  - Several FCPP device connection
  - Data aggregation
  - Synchronous control





WP8 - KEEP UP TO DATE

Project updates, insights and interesting facts regularly shared at the project website and other social media

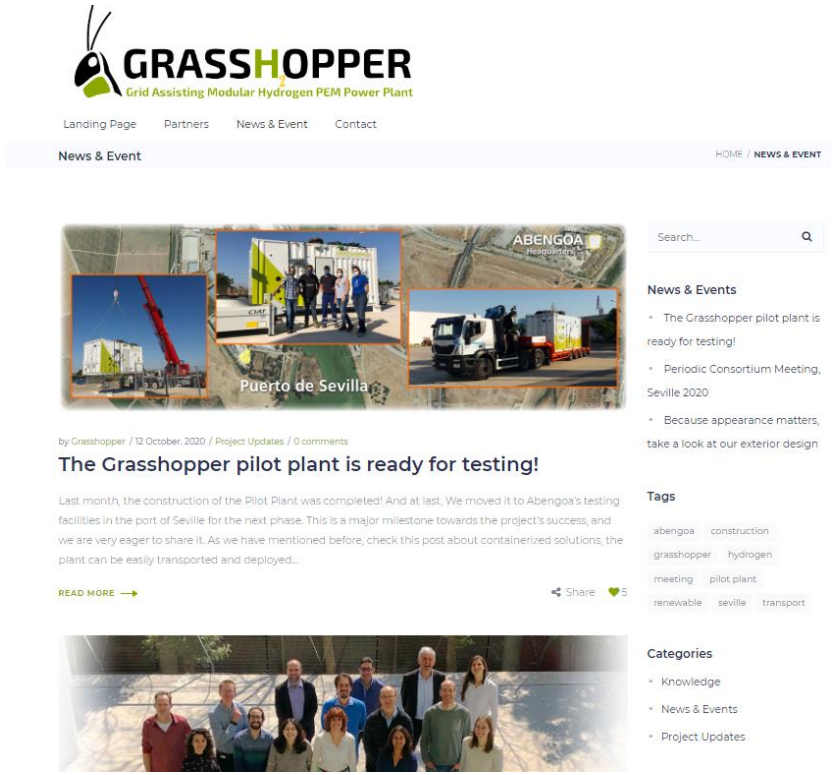
Project Overview Video

Watch in Youtube

Plant transport Video

Watch in Youtube

http://www.grasshopperproject.eu/



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GRASSHOPPER Project partners

POLITECNICO MILANO 1863

Nedstack PEM FUEL CELLS To be sure.

INEA

JM Johnson Matthey Inspiring science, enhancing life

ABENGOA

ZBT

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FCH

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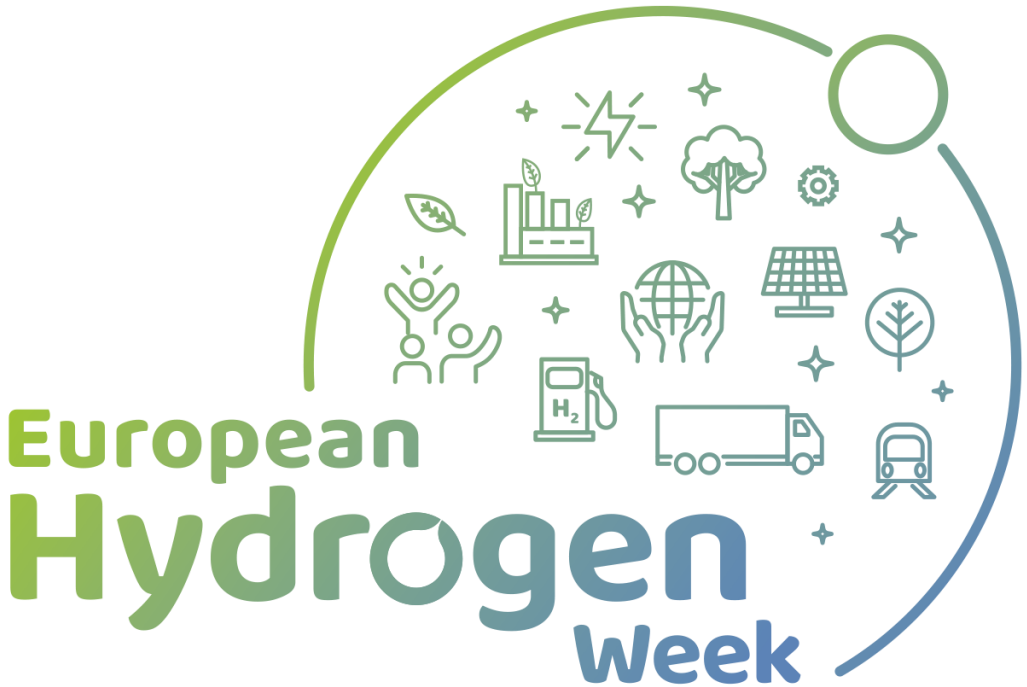

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