GRASSHOPPER

GRID ASSISTING MODULAR HYDROGEN PEM POWER PLANT

Project ID:	**779430**
PRD 2023:	**Panel 4 – H2 end uses – stationary applications**
Call topic:	**FCH-02-7-2017: Development of flexible large fuel cell power plants for grid support**
Project total costs:	**EUR 4 387 063.75**
Clean H_2 JU max. contribution:	**EUR 4 387 063.75**
Project period:	**2.1.2018–31.3.2022**
Coordinator:	**Informatizacija Energetika Avtomatizacija DOO, Slovenia**
Beneficiaries:	Abengoa Innovación Sociedad Anónima, Johnson Matthey Hydrogen Technologies Limited, Nedstack Fuel Cell Technology BV, Politecnico di Milano, Zentrum für BrennstoffzellenTechnik GmbH

http://www.grasshopperproject.eu/

PROJECT AND OBJECTIVES

The GRASSHOPPER project aims to create a next-generation MW-sized fuel cell power plant (FCPP) that is more cost-effective and flexible in power output than current FCPPs. The FCPP will be demonstrated in the field as a 100 kW submodule pilot plant, implementing newly developed balance-of-plant system components and stacks. A new stack design has been developed with increased power density, and short-stack testing has been concluded. The pilot plant is undergoing factory acceptance testing on hydrogen. A dynamic simulation model of the pilot plant has been developed to support optimisation in the field and the scaling up of the design.

NON-QUANTITATIVE OBJECTIVES

The project aims to ensure operation flexibility and grid stabilisation capability through fast responses. The operation strategy was defined considering the requirements in terms of response time for grid stabilisation.

PROGRESS AND MAIN ACHIEVEMENTS

- The project has developed, built and tested the next generation of proton-exchange membrane (PEM) fuel cells for industrial applications. The tests carried out to date have demonstrated automatic mode operation and power demand adaptation capabilities. 50 % electrical efficiency, even in dynamic operation, has been achieved. The pilot plant can achieve full power (100 kWe gross power, 80 kWe net power) over time and modulate from 50 % to 100 % in less than 20 seconds and from zero to full load in less than 60 seconds from a warm standby mode.
- Building on the experiences of the pilot plant, the GRASSHOPPER team designed a modular 2 MW-scale low-cost FCPP with grid-supporting capability. The CAPEX of a unitary 2 MW flexible and dynamic FCPP for grid balancing has been estimated to be €1 500/kW (assuming stack costs of < €450/kW). The mass production of several of these plants at a production scale of 25 MW/year could reduce the total costs further.
- The project has also achieved outstanding results at the membrane electrode assembly (MEA) and stack levels. MEA platinum content has been reduced by > 80 %. A cell with an active area of 300 cm^2 designed for mass manufacturing was finalised and tested in a short stack, showing a performance of 0.689 V at 1 A/cm^2, increasing the power density by 60 % relative to previous technology. This has allowed the design of single stacks of 27 kW nominal power, representing four times the power of the stacks used for the first generation of this type of power plant (developed and demonstrated in the Clean Hydrogen Joint Undertaking project DEMCOPEM-2MW).
- The pilot plant has been successfully transported and commissioned in Arnhem, the Netherlands, where testing will continue until the final site preparations are completed. The tests have already contributed significantly to the continuation of the development of stack and operation modes.

FUTURE STEPS AND PLANS

- The project activities will continue in the years to come. In the very short term, tests of the GRASSHOPPER fuel cell system prototype will continue in an operational environment. This should allow the GRASSHOPPER solution to reach TRL 7. Although the project has ended, the consortium has committed to report operational data to the Clean Hydrogen Joint Undertaking through the Technology Reporting Using Structured Templates (TRUST) platform.
- In parallel, and with the support of Dutch funding, it is expected that the GRASSHOPPER technology will be developed with a view to reaching TRL 8–9 by the end of 2025.
- In addition, support has been awarded (under the umbrella of the IPCEI Hy2Tech) to build a GW-scale factory, which should allow, among other activities, the mass manufacturing of the GRASSHOPPER solution.

QUANTITATIVE TARGETS AND STATUS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	MEA cost reduction	%	65	65	✓
	Stack efficiency	%	55	55	
	Stack CAPEX	€/kWe	450	450	
	Operation flexibility	–	Load following capacity over a 20–100 % power range	Load following capacity of 20–100 % for stack and 0–100 % for FCPP	
			50 % power in < 20 seconds	50 % power in < 20 seconds	
			100 % power in < 60 seconds	100 % power in < 60 seconds	
	Availability	%	95	N/A	⚙
	System electrical efficiency	%	50	43	⚙
MAWP addendum (2018–2020)	System CAPEX	€/kWe	1 500	1 500	✓
AWP 2017	Stack lifetime	hours	20 000	N/A	⚙

Clean Hydrogen Partnership
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