REFLEX

REVERSIBLE SOLID OXIDE ELECTROLYZER AND FUEL CELL FOR OPTIMISED LOCAL ENERGY MIX

Project ID	779577
PRR 2024	Pillar 1 – Renewable hydrogen production
Call topic	FCH-02-3-2017: Reversible solid oxide electrolyser (rSOC) for resilient energy systems
Project total costs	EUR 2 999 575.48
Clean H_2 JU max. contribution	EUR 2 999 575.25
Project period	1.1.2018–30.6.2023
Coordinator	Commissariat à l'énergie atomique et aux énergies alternatives, France
Beneficiaries	Aktsiaselts Elcogen, Danmarks Tekniske Universitet, ENGIE, ENGIE Servizi SpA, Green Power Technologies SL, Parco Scientifico Tecnologico per l'Ambiente SpA, Sylfen, Teknologian tutkimuskeskus VTT Oy, Universidad de Sevilla

http://www.reflex-energy.eu/

PROJECT AND GENERAL OBJECTIVES

The Reflex project aimed to develop an innovative renewable energy storage solution, based on reversible solid oxide cell (rSOC) technology, that can operate in either electrolysis mode, to store excess electricity to produce H_2, or fuel cell mode, when energy exceeds local production levels, to produce electricity and heat from H_2 or other fuel. It has improved rSOC components (cells, stacks, power electronics, heat exchangers) and defined the system, its set points and advanced operation strategies.

PROGRESS AND MAIN ACHIEVEMENTS

- Enlarged cells were produced.
- The project has improved the stack for rSOC operation.
- The rSOC module design was completed and its assembly has started.
- The cold site acceptance test and hot site acceptance test have been performed.
- Prior to the start of the two Reflex modules, 5 632 hours of operation were performed on the alpha prototype and 135 full cycles were successfully applied from one mode to the other over the 3 372 hours of operation above 650 °C.
- Progress in terms of the six project objectives is reported below.

Objective 1. Enhance system components for efficient reversibility in functional environments.

- Optimisation and manufacturing of cells, stacks and heat exchangers completed.

Objective 2. Reduce losses in electrical, gas and heat management at the system level.

- Work on power electronics completed, with the best efficiency achieved in the DC/DC converter laboratory, at 96 %.
- Balance-of-plant components integrated into alpha prototype for validation before implementation in Reflex modules.

Objective 3. Define dynamic and smart switching strategies in full operational environment.

- Alpha prototype tests conducted to determine operating limits of stacks and logic of transitions between modes.
- Algorithms ported to Reflex system validated in 2023 and to be tested in 2024.

Objective 4. Demonstrate the whole system up to technology readiness level 6.

- System installed in Cheylas, France, with reduced number of modules.
- Electrolysis power of 55 kW for 10 Nm^3/h of H_2 (10 kW in fuel cell mode) and thermal production of 6 kW achieved.

Objective 5. Provide hydrogen, electricity and heat with relevant costs for application.

- Maximum acceptable capital expenditure and operational expenditure defined for rSOC technology to be competitive on total cost of ownership.

Objective 6. Design a business model for the whole value chain.

- Most promising use cases for rSOC systems identified for power-to-power in the building sector.

FUTURE STEPS AND PLANS

The project has finished.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?	SOA result achieved to date (by others)	Year for reported SOA result
Project's own objectives	Cell active area	cm^2	200	200	✓	128	2021
	Power electronic efficiency	%	95	96		88	2019
	Durability in SOEC step during rSOC operation at 0.58 A/cm^2 and SC = 68 %	%/1 000 h	2	1.2		2.3 for current densities of 0.6–0.7 A/cm^2 and SC = 50 %	2015
	Power modulation SC = 80 %	%	50–100 in SOFC, 70–100 in SOEC	58–100 in SOEC, 13–100 in SOFC (natural gas) and 23–100 in SOFC (H_2)		57–100 in SOEC	2019
	Current density in SOEC mode	A/cm^2	1.2	N/A		1.15 A/cm^2 at 750 °C; 1 A/cm^2 at 800 °C	2015–2016

Clean Hydrogen Partnership
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