

REACTT

RELIABLE ADVANCED DIAGNOSTICS
AND CONTROL TOOLS FOR INCREASED
LIFETIME OF SOLID OXIDE CELL TECHNOLOGY



Project ID	101007175
PRR 2025	Pillar 1 - H ₂ Production
Call Topic	FCH-02-3-2020
Project Total Costs	2 712 322.50
Clean H ₂ JU Max. Contribution	2 712 322.50
Project Period	01-01-2021 - 31-05-2025
Coordinator Beneficiary	INSTITUT JOZEF STEFAN, SI

Beneficiaries

TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, BITRON SPA, SOLYDERA SA, HAUTE ECOLE SPECIALISEE DE SUISE OCCIDENTALE, UNIVERSITA DEGLI STUDI DI SALERNO, AVL LIST GMBH, ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE, COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES

<http://www.reactt-project.eu>

PROJECT AND GENERAL OBJECTIVES

REACTT will realise a monitoring, diagnostic, prognostic, and control (MDPC) tool for reversible solid oxide cell (rSOC) stacks and systems to increase stack lifetime by 5 %; reach a production loss rate of 1.2 %/1 000 h; increase availability by 3 %, targeting overall availability of 98 %, and reduce operation and maintenance costs by 10 %. The additional cost of the MDPC tool will not exceed 3 % of the overall system manufacturing costs.

NON-QUANTITATIVE OBJECTIVES

- Education/training. Inclusion of the topic of solid oxide cell technologies in MSc and PhD study programmes.
- Public awareness. The web page and the dissemination material are the first step towards raising public awareness.
- Safety. Fault detection, isolation and mitigation in solid oxide electrolyser cells (SOECs) / solid oxide fuel cells (SOFCs) preclude process disruption and potential hazards.
- Regulations and standards. The formulation of a new work item proposal is to be submitted to Technical Committee 105 of the International Electrotechnical Commission.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

- Second release of the updated MDPC board with enhanced communication functionalities concerning the local system controller and the excitation unit. The platform is low-cost, yet with high computational performance, thanks to the carefully selected components and optimised hardware and software design.

- The upgraded excitation module for stack perturbation with conventional sinusoidal and non-conventional discrete random binary signal has been integrated with the MDPC board.
- An extensive experimental campaign has been conducted on two SOEC 70-cell stack boxes. Valuable and comprehensive datasets under carefully selected degradation scenarios have been acquired.
- A framework of the model-based approaches has been settled for feature extraction. It entails two types of approaches: (i) the passive approach utilising conventional signals and the simplified lumped models of the stack and system and (ii) the active approach that requires additional perturbation of the stack to get the complete fingerprint of the stack dynamics in terms of the electrochemical impedance spectra (EIS). EIS spectra are further deconvoluted and interpreted by using equivalent circuit models.
- A real-time optimisation (RTO) strategy for operating solid-oxide electrolyser (SOE) systems at optimal efficiency has been proposed. The RTO problem is formulated as a constrained nonlinear optimisation problem and, at this stage, constraint adaptation with input filtering has been selected as RTO solution approach. First simulation results were obtained on a simulated SOEC system. The proposed RTO scheme effectively pushes the system to higher levels of efficiency and maintains the system there despite perturbations by tracking active constraints.

FUTURE STEPS AND PLANS

The main activities will be focused on the final integration of the MDPC tool and its validation on the three 70-cell SOEC stacks and a 25/cell r-SOC stack.

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	Q&M cost	€/ (kg/d)/y	120	The experimental campaign has not been completed so no statement can be made about where SolydEra would stand when benefiting from the technology developed.		Based on a recent inventory, no statement can be made about where competitors stand at the moment in their quality and maintenance costs.	2023
	Electrical Consumption at Rated Capacity	kWh/kg	39	34.8, achieved for the stack does not include consumption of the BoP.		40-45	2022