

24_7 ZEN

REVERSIBLE SOEC/SOECFC SYSTEM FOR A ZERO EMISSIONS NETWORK ENERGY SYSTEM



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Coordinator Beneficiary	FUNDACIO INSTITUT DE RECERCA DE L'ENERGIA DE CATALUNYA, ES
Beneficiaries	DIAXIRISTIS ETHNIKOU SISTIMATOS FISIKOU AERIOU ANONIMI ETERIA, HELLENIC GAS TRANSMISSION SYSTEM OPERATOR, KIWA CREIVEN S.R.L., OST - OSTSCHWEIZER FACHHOCHSCHULE, EUNICE LABORATORIES MONOPROSOPHI ANONYMI ETAIREIA, KIWA CERMET ITALIA SPA, CLUSTER VIOOIKONOMIAS KAI PERIVALLONTOS DYTIKIS MAKEDONIAS, INERCO INGENIERIA, TECNOLOGIA Y CONSULTORIA, SA, SOLYDERA SPA, BOSAL EMISSION CONTROL SYSTEMS NV, SOLYDERA SA, FACHHOCHSCHULE ZENTRALSCHWEIZ - HOCHSCHULE LUZERN, ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS, POLITECNICO DI TORINO, IDRYMA TECHNOLOGIAS KAI EREVNAS

<https://24-7zenproject.eu/>

PROJECT AND GENERAL OBJECTIVES

24_7 ZEN aims to design and construct a highly efficient 33/100kW reversible solid oxide cell (rSOC) power-balancing plant, showcasing its compatibility with both electricity and gas grids. The project consortium, comprising diverse expertise, leads innovation in energy management and rSOC system development. The consortium pioneers' advancements across the value chain, from cell-level material to fully operational rSOC systems and plug-and-play grid interconnection ecosystems on the demo site. Key players include an organisation involved in renewable energy generation (EUNICE), a transmission system operator (DESFA), and international quality assurance (KIWA). The 24_7 ZEN ecosystem will showcase efficient power-to-gas-to-power routes, utilising H₂ or natural gas as fuel, enabling H₂ grid injection, transitioning in less than 30 minutes and achieving a round-trip efficiency of 45 %, all while adhering to standards and safety regulations.

The consortium aims to develop and validate a scalable ecosystem applicable to multi-MW installations. Further research will focus on improving rSOC performance (targeting degradation rates of 0.4 %/kh for 1 000 hours and a current density of 1.5 A/cm² in both modes) and enhancing cost-competitiveness (reducing CAPEX from EUR 6 000 / kW to EUR 3 500 / kW).

NON-QUANTITATIVE OBJECTIVES

- Identify requirements for a 24_7 ZEN ecosystem compatible and interconnected to grid.
- Enhance 24_7 ZEN system performance by optimising rSOC cell and stack manufacturing.
- Design, manufacture and test to validate a scalable full rSOC system.
- Full-scale demonstration of the 24_7 ZEN grid balancing ecosystem sustained for over 4 months.
- Set out a roadmap exploiting project results for the scaling up and deployment of grid balance rSOC systems.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

- Top-level requirements for rSOC system integration with electricity and gas grids have been defined, identifying

three integration configurations. Establishment of the control strategy and energy management system based on operational profiles.

- Significant advancements have been made in enhancing rSOC components, particularly in electrode testing and interconnect development. The use of Co-free oxygen electrodes and new composition of Fe-AU doped fuel electrodes has achieved high current densities in both modes of operation.
- rSOC stack and hot BoP design and development has led to the creation of detailed designs and simulations of the innovative stack together with the thermal management components on a single body solution.
- Ongoing activities in system integration and design, including conceptual engineering and detailed design, have been conducted to ensure seamless integration of components.
- System requirements and use cases have been clearly defined, addressing critical aspects such as electricity supply, water flow, and natural gas supply.

These results signify a significant step forward in the development of the rSOC system, bringing the project closer to its goal of creating a high-performing solution for sustainable grid management.

FUTURE STEPS AND PLANS

- Advancing the scalability of the achieved outcomes.
- Scale-up of enhanced button cells to larger cell areas and stack levels to support increased power output and integration potential.
- Integration of key developed components, including the rSOC stack and heat exchangers, into the full system module, incorporating the pre-designed Balance of Plant (BoP).
- Final system integration activities to assemble a fully functional rSOC system module suitable for grid-scale application.
- Validation through demonstration testing of the fully integrated rSOC system within the Greek energy grid over a four-month period, focusing on its grid-balancing capability.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?	SoA result achieved to date (by others)	Year for reported SoA result
Project's own objectives	Efficiency on SOFC mode	%	57		50	2019
	Transient Time (SOFC/SOEC)	min	30		N/A	N/A
	Degradation rate cycling SOFC/SOEC	%/khr	0.4		1 (SOFC) 2 (SOEC)	N/A
	Current Density under Co-SOEC	A/cm ²	1		N/A	N/A
	Total System Power in rSOC	kW	33/100		25/75	N/A
	Efficiency on SOEC mode	%	80		81	2021