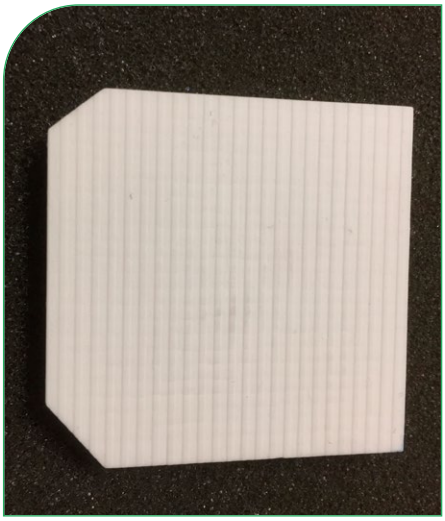
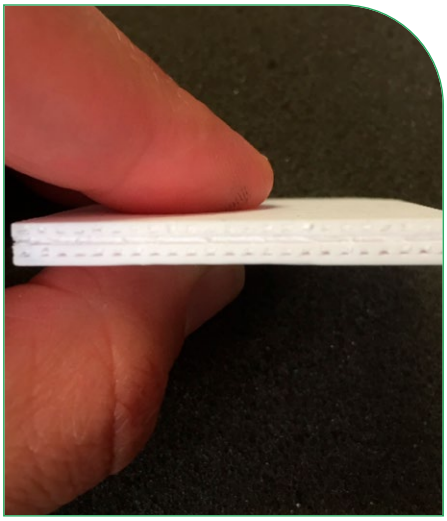
CELL3DITOR

COST-EFFECTIVE AND FLEXIBLE 3D PRINTED SOFC STACKS FOR COMMERCIAL APPLICATIONS

Project ID:	**700266**
Call topic:	**FCH-02.6-2015**: Development of cost-effective manufacturing technologies for key components of fuel cell systems
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€2 191 133.75**
FCH JU max. contribution:	**€2 180 662.50**
Project start - end:	01/07/2016 - 30/04/2020
Coordinator:	**FUNDACIO INSTITUT DE RECERCA DE L'ENERGIA DE CATALUNYA, ES**
Website:	**www.cell3ditor.eu/**

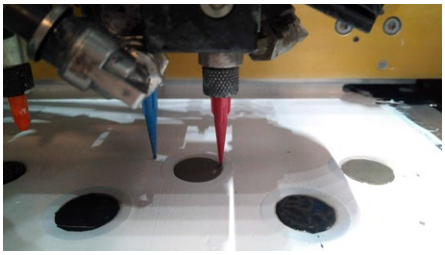




BENEFICIARIES: 3DCERAM, SAAN ENERGI AB, PROMETHEAN PARTICLES LTD, HYGEAR FUEL CELL SYSTEMS BV, FRANCISCO ALBERO SA, UNIVERSIDAD DE LA LAGUNA, DANMARKS TEKNISKE UNIVERSITET

PROJECT AND OBJECTIVES

Current solid oxide fuel cell (SOFC) production involves time-consuming processes. The Cell3Ditor's target is to develop 3D-printing techniques for the fabrication of SOFCs. The work covers research and innovation along all stages of the value chain. The project's outcomes include a unique hybrid multi-material ceramic 3D printer capable of printing a single-repeating unit (electrolyte, anode, cathode and interconnector), including voids for gas fluidics. In parallel, inks and slurries of the relevant materials have been formulated, and all co-sintering processes developed.



NON-QUANTITATIVE OBJECTIVES

- Mass production of printable slurries of 8YSZ for SLA 3D printing
- The materials have been developed and are commercially available
- 3D printer for the fabrication of multi-material complex geometries of functional ceramics
- The dual multi-material 3D printer has been developed and is commercially available
- Single-step shaping of SOFC parts
- Complex shapes have been performed and sintered
- Single-step sintering of SOFC parts
- Processes have been developed for single-step sintering of parts
- Inks and slurries for inkjet printing and robocasting (LSM, Ni-YSZ, LCTM).

PROGRESS AND MAIN ACHIEVEMENTS

- Develop a unique ceramic multi-material hybrid 3D printer
- Develop inks and slurries of relevant materials: 8YSZ (electrolyte), Ni-YSZ (anode), LSM (cathode), LCTM (interconnector) and sacrificial
- Develop co-sintering processes for HT processing of the multi-material parts.

FUTURE STEPS AND PLANS

- The project has finished
- The outstanding challenge is the fabrication of whole stacks
- A faster fabrication rate has yet to be achieved.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives	Manufacturing energy required per stack produced	MJ/stack	3 900	400	✓	5 600	2015
	Manufacturing CO_2 emissions: global warming potential (GWP)	kg CO_2-eq	<1 230	93	✓	1 230	
	Weight	kg/stack	2.5	5.03	✗	15.77	

GRASSHOPPER
GRID ASSISTING MODULAR HYDROGEN PEM POWER PLANT

Project ID:	**700350**
Call topic:	**FCH-02-7-2017**: Development of flexible large fuel cell power plants for grid support
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€4 387 063.75**
FCH JU max. contribution:	**€4 387 063.75**
Project start - end:	01/01/2018 - 31/12/2020
Coordinator:	**INEA INFORMATIZACIJA ENERGETIKA AVTOMATIZACIJA DOO, SI**
Website:	**www.grasshopperproject.eu/**

BENEFICIARIES: POLITECNICO DI MILANO, NEDSTACK FUEL CELL TECHNOLOGY BV, ABENGOA INNOVACION SOCIEDAD ANONIMA, ZENTRUM FUER BRENNSTOFFZELLEN-TECHNIK GMBH, JOHNSON MATTHEY FUEL CELLS LIMITED

PROJECT AND OBJECTIVES

The GRASSHOPPER project aims to create a next generation MW-size fuel cell power plant (FCPP) which is more cost-effective and flexible in power output. The FCPP will be demonstrated in the field as a 100 kW sub-module pilot plant, implementing newly developed stacks with improved MEAs and balance-of-plant system components. A new stack design with increased power density has been developed. The pilot plant's construction is close to completion. A dynamic simulation model of the plant has been developed, to allow for the study of further optimisation strategies.

NON-QUANTITATIVE OBJECTIVES

- Operational flexibility and grid stabilisation capability via fast response
- Operation strategy defined, taking grid stabilisation response time requirements into consideration.

PROGRESS AND MAIN ACHIEVEMENTS

- The pilot power plant is close to completion. Planning of testing and commissioning activities is ongoing
- Single-cell testing with the new GH MEAs and cell plates show performance close to the target of 0.68 V @ 1 A/cm^2
- Dynamic simulation model of the pilot plant is ready, incorporating the defined operating strategies.

FUTURE STEPS AND PLANS

- Manufacturing of the new Grasshopper design stacks for the 100 kW pilot plant
- Testing, commissioning, operation and validation of the pilot plant
- Stack design verification and optimisation
- Cost analysis of the stacks and system.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives	MEA cost reduction	%	65		MEA cost price of electricity 0.04 €/kWh	2018
	Stack efficiency	%	55		55	
MAWP addendum (2018-2020)	System electrical efficiency	%	50		50	
	CAPEX	€/kWe	1 500		3 000	
AWP 2017	Stack lifetime	Hours	20 000		16 000	

INNO-SOFC
DEVELOPMENT OF INNOVATIVE 50 KW SOFC SYSTEM AND RELATED VALUE CHAIN

Project ID:	**671403**
Call topic:	**FCH-02.5-2014** -Innovative fuel cell systems at intermediate power range for distributed combined heat and power generation
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€3 998 081.25**
FCH JU max. contribution:	**€3 998 081.25**
Project start - end:	01/09/2015 - 31/10/2019
Coordinator:	**TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, FI**
Website:	**www.innosofc.eu/**

BENEFICIARIES: ENERGY MATTERS BV, CONVION OY, ELCOGEN OY, ELRINGKLINGER AG, FORSCHUNGSZENTRUM JULICH GMBH, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

PROJECT AND OBJECTIVES

The INNO-SOFC project is developing an innovative 50 kW SOFC system and related value chain, from interconnects and stacks to end-users and application analysis. The project is based on the products of industrial partners and motivated by their interest in improving their products and consolidating an efficient value chain through collaboration. The INNO-SOFC system has been transported to the Lempäälä smart grid.

NON-QUANTITATIVE OBJECTIVES

- A public modelling tool was created to analyse different business cases
- Published in https://blueterra.nl/en/project/inno-sofc/

PROGRESS AND MAIN ACHIEVEMENTS

- INNO-SOFC system FAT approved and transported to the Lempäälä smart grid
- Stack long-term testing lasted 12 000 hours with <0.4 % degradation rate
- A public modelling tool was created to analyse different business cases: https://blueterra.nl/en/project/inno-sofc/

FUTURE STEPS AND PLANS

- The project has finished.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives	System CAPEX	€/kW	4 000	N/A	✗	9 000	2018
	System lifetime	Hours	30 000	N/A	✗	N/A	N/A
	Stack degradation rate	%/kh	<0.5	<0.4	✓	0	2019

INSIGHT

IMPLEMENTATION IN REAL SOFC SYSTEMS OF MONITORING AND DIAGNOSTIC TOOLS USING SIGNAL ANALYSIS TO INCREASE THEIR LIFETIME

Project ID:	**735918**
Call topic:	**FCH-02-5-2016** - Advanced monitoring, diagnostics and lifetime estimation for stationary SOFC stacks and modules
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€3 146 056.25**
FCH JU max. contribution:	**€2 498 948.75**
Project start - end:	01/01/2017- 31/12/2019
Coordinator:	**COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, FR**
Website:	**insight-project.eu/**

BENEFICIARIES: ABSISKEY, TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, SOLIDPOWER SPA, BITRON SPA, SOLIDPOWER SA, ABSISKEY CP, UNIVERSITA DEGLI STUDI DI SALERNO, AVL LIST GMBH, INSTITUT JOZEF STEFAN, ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE, DANMARKS TEKNISKE UNIVERSITET

PROJECT AND OBJECTIVES

The INSIGHT project aims to develop a monitoring, diagnostic and lifetime tool for SOFC stacks. Monitoring is based on two advanced techniques (EIS and THD), in addition to conventional stack signal. Durability tests with faults added on purpose generate the data required to develop and validate the algorithms. Fault-mitigation logics will be developed to avoid stack failures and slow down their degradation. Low-cost hardware, consisting of a single board able to embed the tool, will be developed and integrated in a commercial microCHP, which will be tested in the field.

NON-QUANTITATIVE OBJECTIVES

- Methodology for fault detection/isolation and mitigation
- Fault detection and isolation algorithm and complete fault signature matrix (which correlates the variation of the features and the fault accounted for). The tool then proposes mitigation action to the system controller
- Modification of the DC/DC converter for excitation
- The DC/DC converter of the EnGen 2 500 micro-CHP system has been modified, and the Bitron Box, developed to embed the monitoring, diagnostic and lifetime tools, has been developed, manufactured and interfaced with the EnGen 2 500.

PROGRESS AND MAIN ACHIEVEMENTS

- Non-linear perturbation techniques (THD and PRBS) have been found as quick analysis tools, with an answer consistent with conventional EIS measurements
- MDLT (hardware and software) tool developed and interfaced with modified DC/DC converter of the Engen 2 500 system from SolidPower
- 6 200 hours of in-field system tests, and validation of the MDLT tool under these conditions for fuel starvation fault.

FUTURE STEPS AND PLANS

- The project has finished.

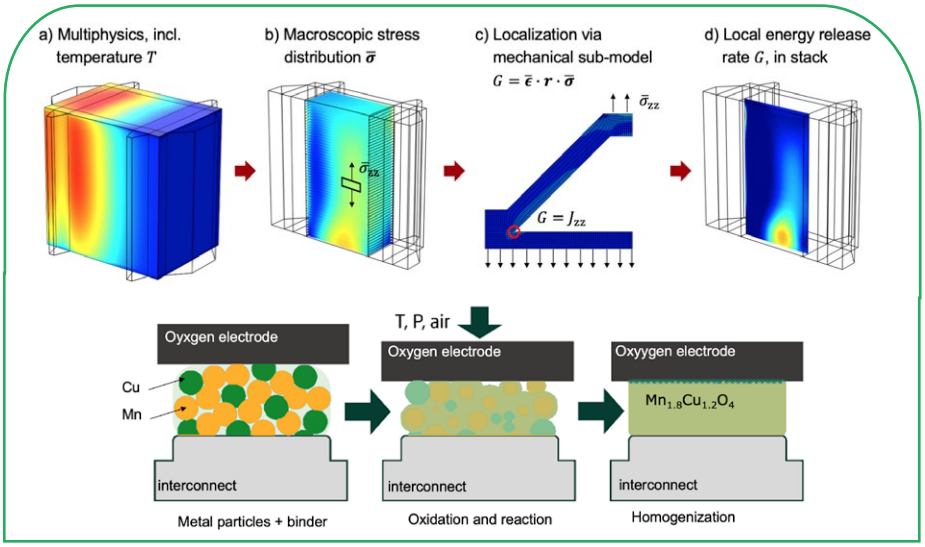
QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)
Project's own objectives	Perform test with faults added on purpose	Test 3 faults	All tested	✓	Evaluation of C deposition
	Develop monitoring, diagnostic and lifetime tool (MDLT)	Tool developed	7 tools delivered to partners for testing		No other similar tool for SOFC, as far as open literature is concerned
	Implement the MDLT on board	Implementation done	6 200 hours of in-field tests		N/A
AWP 2016	Lifetime	Prolong lifetime by 5 %	Achieved. Earlier detection of fuel starvation with the tool: the tool is able to detect issues only 10 % above nominal conditions, while with classical signals it is detected 'only' 22 % above nominal conditions.		No other similar tool for SOFC, as far as open literature is concerned
	Cost	System cost increase due to additional hardware for MDLT less than 3 %	The share of the MDLT tool is 2 % if board prototype cost is considered, and 1.3 % for series production, thus reaching the targets set		No other similar tool for SOFC, as far as open literature is concerned

LOWCOST-IC

LOW COST INTERCONNECTS WITH HIGHLY IMPROVED CONTACT STRENGTH FOR SOC APPLICATIONS

Project ID:	**826323**
Call topic:	**FCH-02-6-2018**: Cost-effective novel architectures of interconnects
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€2 335 997.50**
FCH JU max. contribution:	**€2 335 997.50**
Project start - end:	01/01/2019 - 31/12/2021
Coordinator:	**DANMARKS TEKNISKE UNIVERSITET**
Website:	**https://www.lowcost-ic.eu**



BENEFICIARIES: TECNO ITALIA SRL, SUNFIRE GMBH, SOLIDPOWER SPA, BORIT NV, APERAM STAINLESS FRANCE SA, AKTIEBOLAGET SANDVIK MATERIALSTECHONOLOGY, AVL LIST GMBH CHALMERS TEKNISKA HOEGSKOLA AB, FORSCHUNGSZENTRUM JULICH GMBH

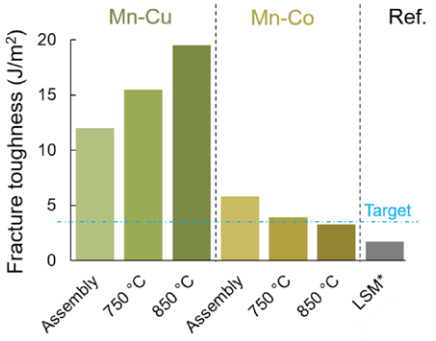
PROJECT AND OBJECTIVES

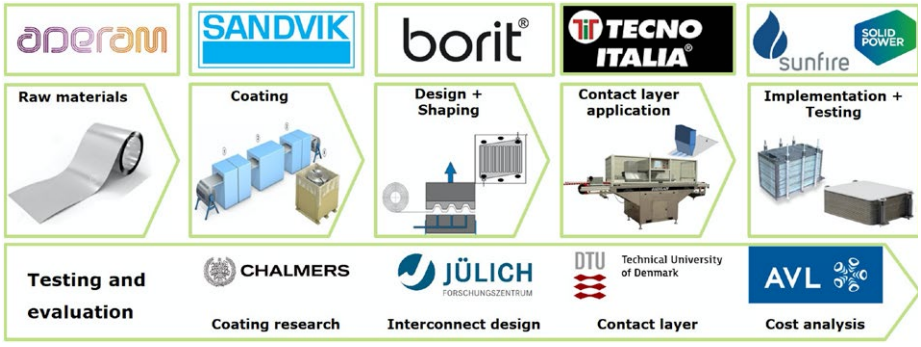
The overall objective of LOWCOST-IC is to contribute to the successful upscaling of widespread commercialisation of solid oxide cell (SOC) technologies by:

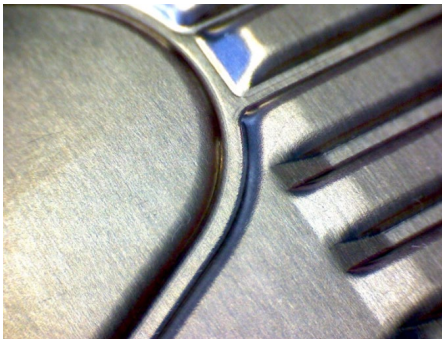
- increasing the robustness of SOC stack lifetime by developing novel, highly robust air electrode contact layers and testing new interconnect coatings in SOC stacks;
- minimising the interconnect development and production cost by introducing cheaper, high-volume steel, and applying state-of-the-art large-scale roll-to-roll methods for SOC manufacturing and developing a novel interconnect shape design route.

PROGRESS AND MAIN ACHIEVEMENTS

- Two novel contact layers developed, using reactive bonding, being ~3 and ~10 times tougher than the state-of-the-art
- Roll-to-roll manufacturing process verified by ensuring self-healing properties of Sandvik coatings after shaping with hydroforming by Borit
- New 3D multiphysics solid oxide cell stack model developed for design studies, computing over 100 times faster than conventional models.







QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives	Fracture energy	J/m²	5.1	8	✓	1.7	2013
	Area specific resistance at 750 °C	mOhm.cm²	15	60	✗	15	2019
	Area specific resistance at 850 °C	mOhm.cm²	25	21	✓	N/A	N/A

MAMA-MEA
MASS MANUFACTURE OF MEAS USING HIGH SPEED DEPOSITION PROCESSES

Mass Manufacture of MEAs
Using High Speed Deposition Processes

Project ID:	**779591**
Call topic:	**FCH-02-8-2017**: Step-change in manufacturing of fuel cell stack components
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€3 189 816**
FCH JU max. contribution:	**€3 189 816**
Project start - end:	01/01/2018 - 31/12/2020
Coordinator:	**TECHNISCHE UNIVERSITAET CHEMNITZ, DE**
Website:	**mama-mea.eu**

BENEFICIARIES: SYSTEM SPA, JOHNSON MATTHEY FUEL CELLS LIMITED, INEA INFORMATIZACIJA ENERGETIKA AVTOMATIZACIJA DOO, NEDSTACK FUEL CELL TECHNOLOGY BV, UNIVERSITA DEGLI STUDI DI MODENA E REGGIO EMILIA, FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG EV

PROJECT AND OBJECTIVES

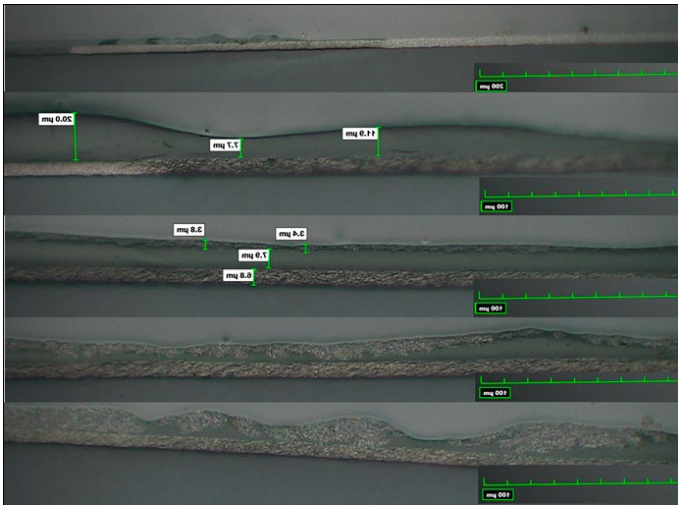
The task of the MAMA-MEA project is to develop an innovative additive layer deposition process integrating all main CCM components (membrane, catalyst layers, sealing) using single, continuous roll-to-roll manufacturing for the PEM fuel cell industry. This will increase the volume manufacturing rate by over 10 times compared with state-of-the-art processes, while also increasing key material utilisation and reducing materials and costs. Currently, a multi-layer deposition process is being developed and multi-layer structures have been prepared.

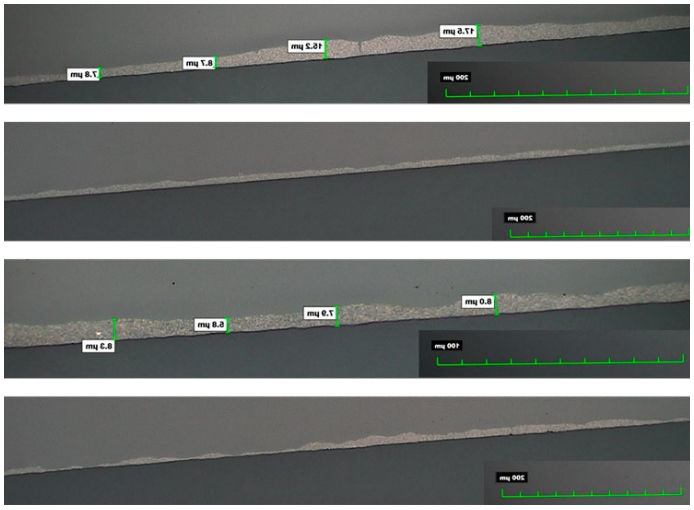
PROGRESS AND MAIN ACHIEVEMENTS

- Inkjet printing of seal layer on CCM is possible. Optimisation process is ongoing
- ALM pilot line capable of producing MEA for fuel cell testing. Production of MEAs for first two stacks is ongoing
- Samples produced by ALM in short stack tests achieved performance targets.

FUTURE STEPS AND PLANS

- Characterisation and selection of additive manufactured MEAs
- Process design of the pilot ALM line (INEA, JMFC)
- Production of MEAs for two full-size stacks using the pilot ALM production line at JMFC
- Full stack assembly and ALM performance and lifetime parity validation in stacks at NFCT
- Further improvement of the selected processes and corresponding inks (SG, JMFC, ENAS, UNIMORE, TUC).





QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
AWP 2017	CAPEX	€/kW	12 000		N/A	N/A
	Lifetime	Hours	20 000		23 000	2017
	Degradation	%/1 000 hour	0.25		3 µVh	2017

OXIGEN

NEXT-GENERATION SOLID OXIDE FUEL CELL STACK AND HOT BOX SOLUTION FOR SMALL STATIONARY APPLICATIONS

Project ID:	**779537**
Call topic:	**FCH-02-9-2017**: Development of next-generation SOFC stack for small stationary applications
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€2 996 873.75**
FCH JU max. contribution:	**€2 996 873.75**
Project start - end:	01/01/2018 - 31/12/2020
Coordinator:	**SOCIETE EUROPEENNE DES PRODUITS REFRACTAIRES, FR**
Website:	**oxigen-fch-project.eu/**

BENEFICIARIES: SINTEF AS, SAINT-GOBAIN CENTRE DE RECHERCHES ET D'ETUDES EUROPEEN, EIFER EUROPAISCHES INSTITUT FUER ENERGIEFORSCHUNG EDF KIT EWIV, ICI CALDAIE SPA, SAINT GOBAIN RECHERCHE SA, ENGIE, STIFTELSEN SINTEF, FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG EV, COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES

PROJECT AND OBJECTIVES

OxiGEN aims to develop an innovative SOFC platform, including an all-ceramic stack design and a modular hotbox, thanks to its higher durability and simpler design for micro-CHP.
The objectives are:

- Define the most suitable hotbox functional specifications for residential and commercial segments (completed)
- Develop a higher power stack and modular hotbox to build a 1 kWe prototype and assess the performances and durability targets (in progress)
- Propose material-based solutions for future long-term improvements (in progress)
- Study the cost-of-ownership of the solution.

NON-QUANTITATIVE OBJECTIVES

- Define market specifications for residential and small commercial applications and hotbox boundary limits: completed
- Stack design: completed
- Hotbox design: completed
- GEN 3 short stack: in progress.

PROGRESS AND MAIN ACHIEVEMENTS

- Define market specifications for residential and small commercial applications and hotbox boundary limits (ENGIE/SG/CEA)
- GEN 1 stack and hotbox manufacturing (SG/IKTS) and pre-test at ICI Caldaie and GEN 1 short stacks test at CEA
- Novel electrolyte development for better cell performances (SINTEF).

FUTURE STEPS AND PLANS

- Manufacture a hotbox with the stack reaching DC efficiency of at least 55 % and a lifetime of about 2 500 hours
- Assess the durability and performance of the stack and hotbox combination
- GEN 3 short stack with new materials in electrolyte and anode functional layers to improve the stack's performance
- Assessment of the cost of the hotbox up to boundary limits to achieve 1 000 €/kWe.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objective: short stack	**DC electrical efficiency**	**%**	**59**	**50**	✗	**47**	**2016**
Project's own objective: electrolyte	**conductivity**		**>30**	**300**	✓	**N/A**	
Project's own objective: hotbox	**DC efficiency**		**55**	**0**	✗		**N/A**

QSOFC

AUTOMATED MASS-MANUFACTURING AND QUALITY ASSURANCE OF SOLID OXIDE FUEL CELL STACKS

Project ID:	**735160**
Call topic:	**FCH-02-6-2016** - Development of cost-effective manufacturing technologies for key components of fuel cell systems
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€2 110 015**
FCH JU max. contribution:	**€2 110 015**
Project start - end:	01/02/2017 - 30/04/2020
Coordinator:	**TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, FI**
Website:	**www.qsofc.eu/**

BENEFICIARIES: MUKO MASCHINENBAU GMBH, HAIKU TECH EUROPE BV, ELCOGEN OY, ELRINGKLINGER AG, AKTSIASELTS ELCOGEN, AKTIEBOLAGET SANDVIK MATERIALSTECHONOLOGY, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

PROJECT AND OBJECTIVES

The qSOFC project focuses on SOFC stack cost reduction and quality improvement by replacing manual labour in all key parts of the stack manufacturing process, including quality control, with automation. This will lead to stack cost of 1 000 €/kW and create further cost-reduction potential to 500 €/kW at mass production (2 000 MW/year). During the qSOFC project, key steps in cell and interconnect manufacturing and quality assurance will be optimised to enable mass manufacturing. The project is currently in its final phase and most of the objectives have been reached.

NON-QUANTITATIVE OBJECTIVES

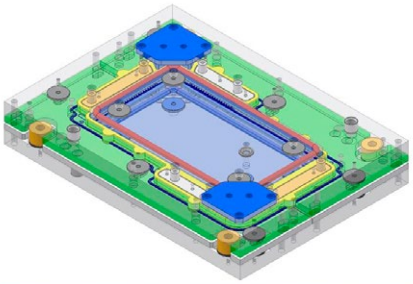
- Cell mass-manufacturing process compliance with REACH regulations
- New REACH-compliant compositions for mass manufacturing identified, tested and validated
- Development of stack quality assurance testing unit
- Unit constructed and taken into production use
- Optical inspection system developed and validated for cells
- Technology can be utilised for cells, and possibly other applications.

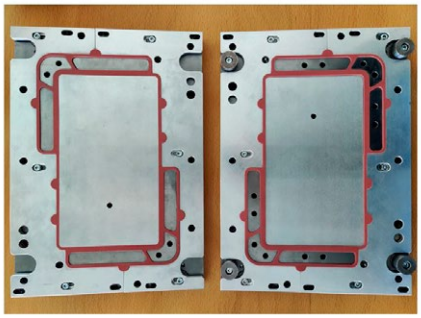
PROGRESS AND MAIN ACHIEVEMENTS

- Automated machine vision inspection system for cell manufacturing quality assurance
- Novel stack conditioning procedures have been developed, reducing stack conditioning time and cost by about 70 %
- The cell manufacturing process has been modified to ensure the high-speed manufacturing necessary for mass production.

FUTURE STEPS AND PLANS

- The project has finished.





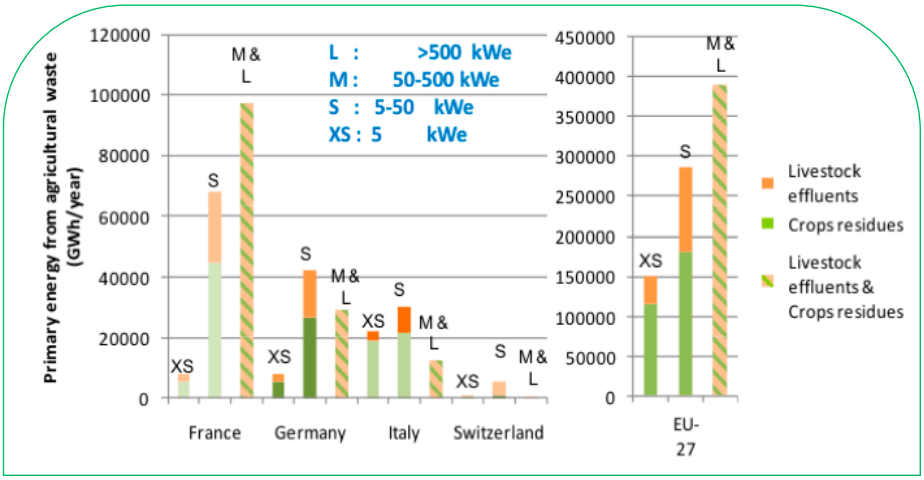
QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives	Cell layer QC time	Second/cell layer	10	11	✗	N/A	N/A
	Stack production yield	%	99.5	100	✓	99.5	2015
	Production rate	h/stack	24	17	✗	24	2014
	Energy per conditioning cycle	kWh/cycle	300	213	✓	300	2015

WASTE2WATTS

UNLOCKING UNUSED BIO-WASTE RESOURCES WITH LOW COST CLEANING AND THERMAL INTEGRATION WITH SOLID OXIDE FUEL CELLS

Project ID:	**826234**
Call topic:	**FCH-02-7-2018**: Efficient and cost-optimised biogas-based cogeneration by high temperature fuel cells
PRD 2020 Panel:	4 - Next Generation of Products - Energy
Project total costs:	**€1 681 602.50**
FCH JU max. contribution:	**€1 681 602.50**
Project start - end:	01/01/2019 - 31/12/2020
Coordinator:	**ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE, CH**
Website:	**https://waste2watts-project.net/**



BENEFICIARIES: EREP SA, ETUDES ET APPLICATIONS D'ENERGIES RENOUVELABLES ET D'EPURATION, BIOKOMP SRL, AROL ENERGY, SUNFIRE GMBH, SOLIDPOWER SPA, SOLIDPOWER SA, POLITECNICO DI TORINO, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE, COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, PAUL SCHERRER INSTITUT

PROJECT AND OBJECTIVES

WASTE2WATTS aims to develop biogas cleaning technologies to make the gas compatible with solid oxide fuel cells (SOFC). It determines what to clean the gas of and to which level. It also defines the proper scale for the best application of SOFC with biogas, and the bioresources available at those scales. It assesses reformer catalysts and cells/stacks with biogas impurities and representative gas mixtures. A system layout proposes operating strategies without the addition of external water and, if possible, a use for the bio-CO_2 outlet. A 6 kWe SOFC demo on an agro-biogas site is being prepared.

NON-QUANTITATIVE OBJECTIVES

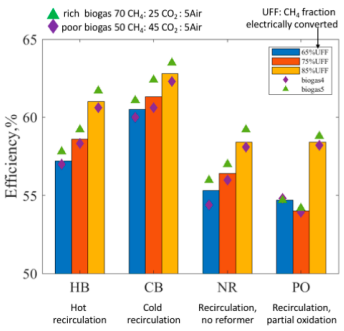
- Resource assessment of biogas in EU, CH, F, D, IT at <50 kWe scale
- Properly assess and quantify with realistic (not theoretical) estimates
- Compile a detailed database on pollutants and sorbents.

PROGRESS AND MAIN ACHIEVEMENTS

- Quantification of available, accessible biowaste resources (agro residues and manure, OFMSW) in the SOFC relevant scale of 50 kWe for EU-27, D, F, IT, CH
- Identification and quantification of sulphur compounds of real biogases to determine the cleaning sorbents and conducting test campaigns on the sorbents.
- Choice of the sorbents and their configuration in a combined cleaning unit for <50 kWe scale SOFC for agricultural biogas (pilot site identified).

FUTURE STEPS AND PLANS

- The main step is to complete the new 6 kWe SOFC system. A first version was built achieving 6.8 kWe and 64 % DC efficiency, on natural gas
- Another main step is to raise the additional funding needed for the demo of the new 6 kWe SOFC on an agro-biogas site (identified)
- A third main step is to test and develop the large-scale cleaning approach (cryo-precipitation of impurities) on a new site (identified)
- Continue the sorbents testing campaigns and build the sorbent cleaning unit for the 6 kWe SOFC demo site with agro-biogas
- Perform test campaigns on reformer catalysts and SOFC cells/stacks with relevant gas mixtures and pollutants.



QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives	Pollutant matrix	(ppm)	Identification and quantification of the organic S-compounds	Various S-compounds identified and quantified from agro-biogases	Mostly only H2S addressed	2017
	Gas cleaning		Identification and arrangement of sorbents specific to the pollutants to clean	Configuration proposed to clean from the different sulphur compounds	Expensive overkill, 1 sorbent per pollutant, over dimensioned	
	Biogas reforming without adding extra steam	(Water added)	No extra water added	System configuration and strategies identified	Steam added to biogas	
	SOFC power scale for biogas	kW	Which scale to target for SOFC	25-50 kWe	Few kWe	