Asterix3

Assesment of SOFC CHP Systems Built in the Technology of HTceramix

AIP / APPLICATION AREA	AIP 2009 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2009.3.5 Proof-of- concept fuel cell systems
START & END DATE	01 Jan. 2011 - 31 Dec. 2014
TOTAL BUDGET	€ 3,096,890.80
FCH JU CONTRIBUTION	€ 1,361,894
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Dantherm Power A/S

Partners: HTceramix, EIFER, CNR ITAE

PROJECT WEBSITE/URL

http://asterix3.eu/

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The Asterix3 project aims to develop a proof of concept micro CHP system based on SOFC technology with progress beyond state of the art and towards the market requirements.

The requirements are used to create a design specification for all subsystems and finally for the Proof of concept system. Each seperate subsystem has its own set of objectives that is simulated and optimized for the proof of concept system in order to reach longest possible lifetime, high system efficiency and the ability to compete on investment cost with traditional technologies.

PROGRESS/RESULTS TO-DATE

- Subsystem "HoTbox™" has been modified in crucial points.
- All systems have been built, tested and evaluated upon
- Gross system efficiency measured at EIFER @713 W: 44.7%
- A complete CHP system have been built and tested with auxiliary burner and heat storage at Dantherm Power
- A new control system has been developed

FUTURE STEPS

- Bilateral conversations between HTceramix and Dantherm Power will determine whether or not to continue working on the system in the years to come

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- New solutions to improve the SOFC system have been developed within this project. However there is still a lot that has to be done before the system can become introduced to the market on commercial terms

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013 AIP 2009	Electrical peak efficiency net AC	Not quantified	< 35%	Gross system efficiency measured at EIFER @713 W: 44.7%
	Electrical efficiency (Nominal average)	Not quantified	< 30%	This have been achieved – however the value was calculated as the PI wasn't available at the time
	Total efficiency of the system	Not quantified	< 90%	EIFER has measured a total efficiency of the system to 78,9 %.

BeingEnergy

Integrated Low Temperature Methanol Steam Reforming and High Temperature Polymer Electrolyte Membrane Fuel Cell.

AIP / APPLICATION AREA	AIP 2011 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2011.4.4 Research, development and demonstration of new portable Fuel Cell systems
START & END DATE	01 Sep. 2012 - 29 Feb. 2016
TOTAL BUDGET	€ 4,220,423.40
FCH JU CONTRIBUTION	€ 2,245,244.00
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Universidade do Porto (UPorto)

Partners: Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Teknologian Tutkimuskeskus VTT (VTT), SerEnergy A/S (Serenergy), Consiglio Nazionale Delle Ricerche (ITM-CNR), Universidad Politecnica de Valencia (UPVLC-ITQ), Inovamais - Serviços de Consultadoria em Inovação Tecnológica S.A.(INOVA+), RHODIA Operations (Rhodia)

PROJECT WEBSITE/URL

http://www.beingenergy.eu/

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

- Synthesizing, characterizing, and optimizing of catalysts for low temperature methanol steam reforming (LT-MSR, 180 °C) and the developing of strategies for industrial preparation of the selected catalysts;
- Development, characterization and optimization of a cell-reactor for the LT-MSR;
- Integration, characterization and optimization of the low temperature methanol steam reforming reactors with a high temperature polymer electrolyte membrane fuel cell (HT-PEMFC);
- Development, characterization and optimization of the LT-MSR/HT-PEMFC 500 We prototype.

PROGRESS/RESULTS TO-DATE

- The best Cu-based catalyst developed is more active than G66 MR from Süd Chemie, about 2 times more active (W/F^0 = 30 kg·mol^{-1}·s, 180 °C and 1:1.5 S/C), and produces less than 1000 ppm of CO at the working conditions;
- A very active Pd/ZnO catalyst has been obtained which is 4 times more active than the Cu/Zn/Al_2O_3 catalyst G66 MR from Süd Chemie;
- The reformer simulator is completed and reformer loaded with first catalyst was studied; a new design for the packed bed reformar was developed;
- Simulator predicting experimental results of combined unit was developed and the characterization of the lab scate intregrated system was performed;
- A newly developed bipolar plate material was tested and the fuel cell stack lifetime has increased; a liquid cooled system with liquid heated reformer

FUTURE STEPS

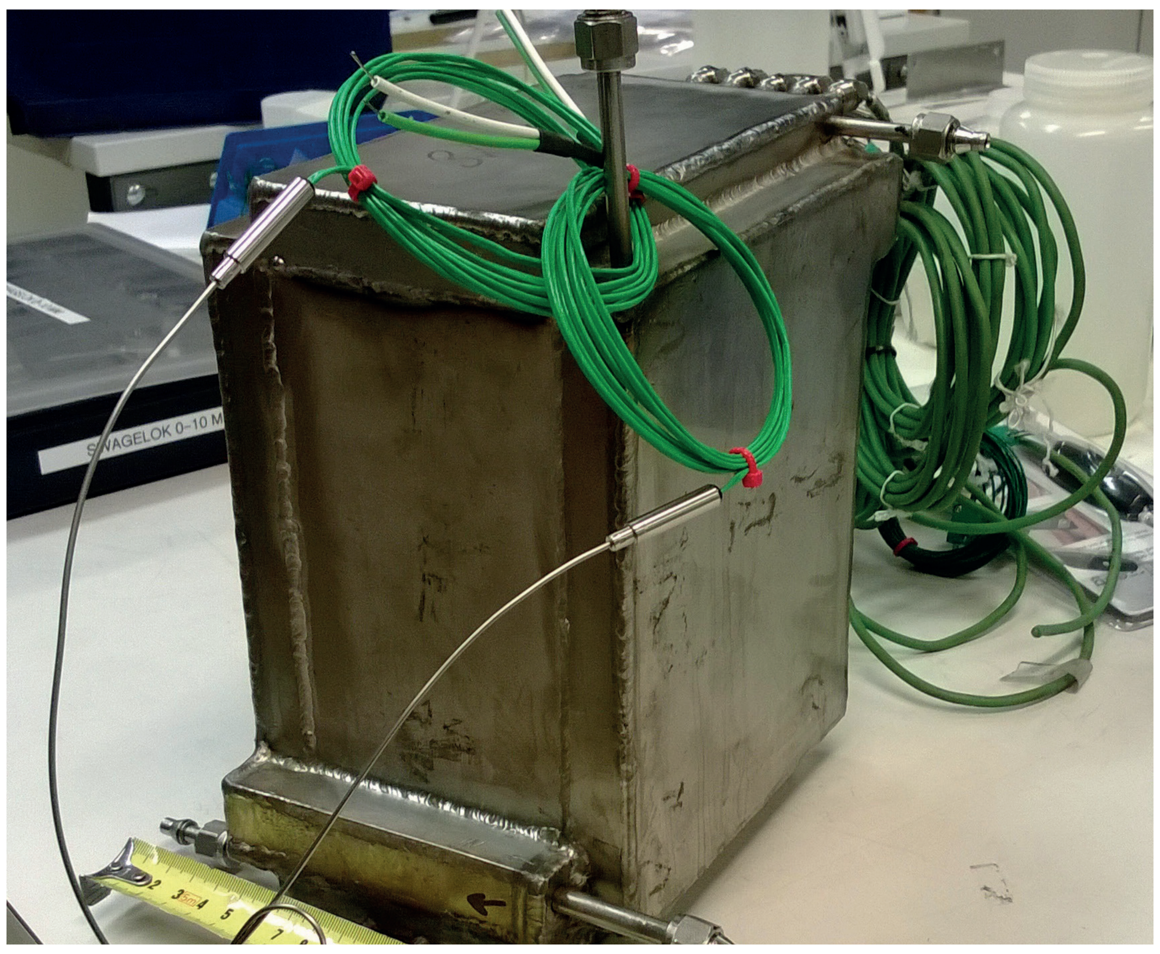
- Optimization and full characterization of the best performing in-house catalyst based on CuZnGa;
- The reformer with new design will be manufatured and integrated in the lab scale combined sytem;
- Optimization of a new energy integrated power supply using a liquid thermal fluid;
- Optimization of startup procedure to reach 15-20 minutes.

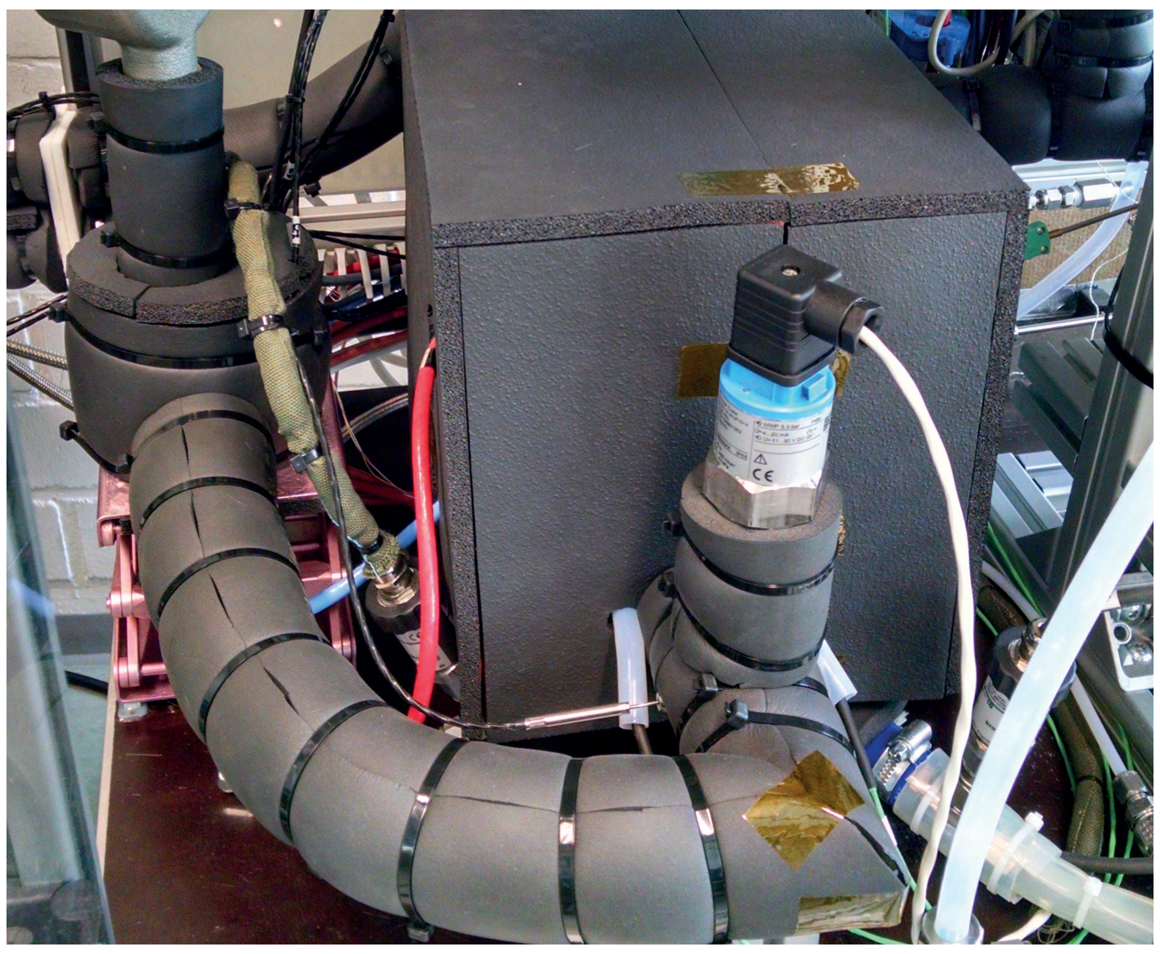
CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Development and characterization of a new and more active catalyst for the methanol steam reforming reaction – 2x more active and producing < 1000 ppm of CO at 180 °C;
- Development of an efficient heat exchange system between the reformer and the fuel cell stack based on a liquid thermal fluid;
- Development of a PPS based bipolar plates for high temperature fuel cells and development of PPS bipolar plates for integrated cellular reformer and fuel cell, benefiting the heat transfer between both reactors and the compactness;
- Fast start-up based on fuel burner and an efficient heat exchange system.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Lower emissions and use of multiple fuels	Not applicable	Methanol as fuel	Not applicable
AIP 2011	Electrical efficiency	30%	>35%	>35%
AIP 2011	Lifetime including 100 start-stop cycles	1000 h	>1500 h	Lifetime of fuel reached 8000 hours
AIP 2011	Specific size and weight of less	35 kg/kW and 50 L/kW	< 35 kg/kW and < 50 L/kW	40 kg·kW^{-1} and 77 L·kW^{-1}.





DEMCOPEM-2MW

Demonstration of a Combined Heat Power 2 MWe PEM Fuel Cell Generator and Integration into an Existing Chlorine Production Plant

AIP / APPLICATION AREA	AIP 2013 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2013.3.5 Field demonstration of large scale stationary power and CHP fuel cell systems
START & END DATE	01 Jan. 2015 - 31 Dec. 2018
TOTAL BUDGET	€ 10,524,200.40
FCH JU CONTRIBUTION	€ 5,466,525.00
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Akzo Nobel Industrial Chemicals B.V.

Partners: Nedstack Fuel Cell Technology B.V., MTSA Technopower B.V., Johnson Matthey Fuel Cells Limited, Politecnico di Milano

PROJECT WEBSITE/URL

www.demcopem-2mw.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The project main objective is to design, construct and demonstrate an economical combined heat and power PEM fuel cell power plant (2 MW electrical power and 1.5 MW heat) and integration into a chlor-alkali (CA) production plant. The project will demonstrate the PEM Power Plant technology for converting the hydrogen into electricity, heat and water for use in the chlor-alkali production process, lowering its electricity consumption by 20%.

The demonstration will take place in China as this is the ideal starting point for the market introduction.

PROGRESS/RESULTS TO-DATE

- Project website
- Basic design of PEM-unit ready
- Hazard and Operability Analysis
- Decision DC-DC or DC-AC conversion
- Model of integrated PEM-unit

FUTURE STEPS

- Validation of MEA design
- Stacks preparation
- Factory Acceptance Test of Unit
- Units shipment to China
- Installation by chlorine factory

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Industrial fuel cell system, rated at 2 MWe, and 1.5 MW heat fully integrated into the chlorine plant.
- Conversion to heat and power of the by-product/waste hydrogen and restitution of the energy content of the by-product/waste hydrogen to the production process
- Demonstration of the lifetime of PEM fuel cells well beyond 16,000 hours is one of the main objectives.
- Automatic operation with remote monitoring, backed-up by an advanced data-acquisition system that will enable improvement of parameters during the period of demonstration.
- Contribution to the general goals of the JTI FCH, as stated in the revised Multi Annual Implementation Plan, to have > 5 MW @ € 3,000/kW installed fuel cell capacity in 2015 and > 50 MW @ € 1,500/kW installed fuel cell capacity in 2020.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-13	Stationary Power Generation & CHP Industrial/Commercial, H_2 based	1 MW / 4,500 €/kW (baseline) >5 MW / 3,000 €/kW (2015 mid-term) 50 MW / 1,500 €/kW (2020 long-term)	2 MW / < 2,500 €/kW and potential for 20 more similar sized PEM power plants Commercial Introduction in 2017 and stepwise cost reductions to reach < 1,500 €/kW	N/A (tests not completed, project started in Jan 2015)

DIAMOND

Diagnosis-Aided Control for SOFC Power Systems

AIP / APPLICATION AREA	AIP 2013 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2013.3.3 Stationary Power and CHP Fuel Cell System Improvement Using Improved Balance of Plant Components/Sub-Systems and/or Advanced Control and Diagnostics Systems
START & END DATE	01 Apr. 2014 - 31 Mar. 2017
TOTAL BUDGET	€ 3,613,488.40
FCH JU CONTRIBUTION	€ 2,101,808.00
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: HyGear

Partners: COMMISSRIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, TEKNOLOGIAN TUTKIMUSKESKUS VTT, UNIVERSITA DEGLI STUDI DI SALERNO, HTceramix SA, INEA INFORMATIZACIJA ENERGETIKA AVTOMATIZACIJA DOO, INSTITUT JOZEF STEFAN

PROJECT WEBSITE/URL

http://www.diamond-sofc-project.eu/about/

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The DIAMOND project aims at improving the performance of solid oxide fuel cells (SOFCs) for CHP applications by implementing innovative strategies for on-board diagnosis and control. Advanced monitoring models will be developed to integrate diagnosis and control functions with the objective of having meaningful information on the actual state-of-the-health of the entire system. The new concepts will be validated using two different SOFC systems.

PROGRESS/RESULTS TO-DATE

- List of faults and failures of SOFC CHP systems
- Definition of the operating windows of the test systems
- Review of existing control and diagnostic methods
- Definition of testing protocols
- Preparation of fault signature matrices, low level control schemes and soft sensors

FUTURE STEPS

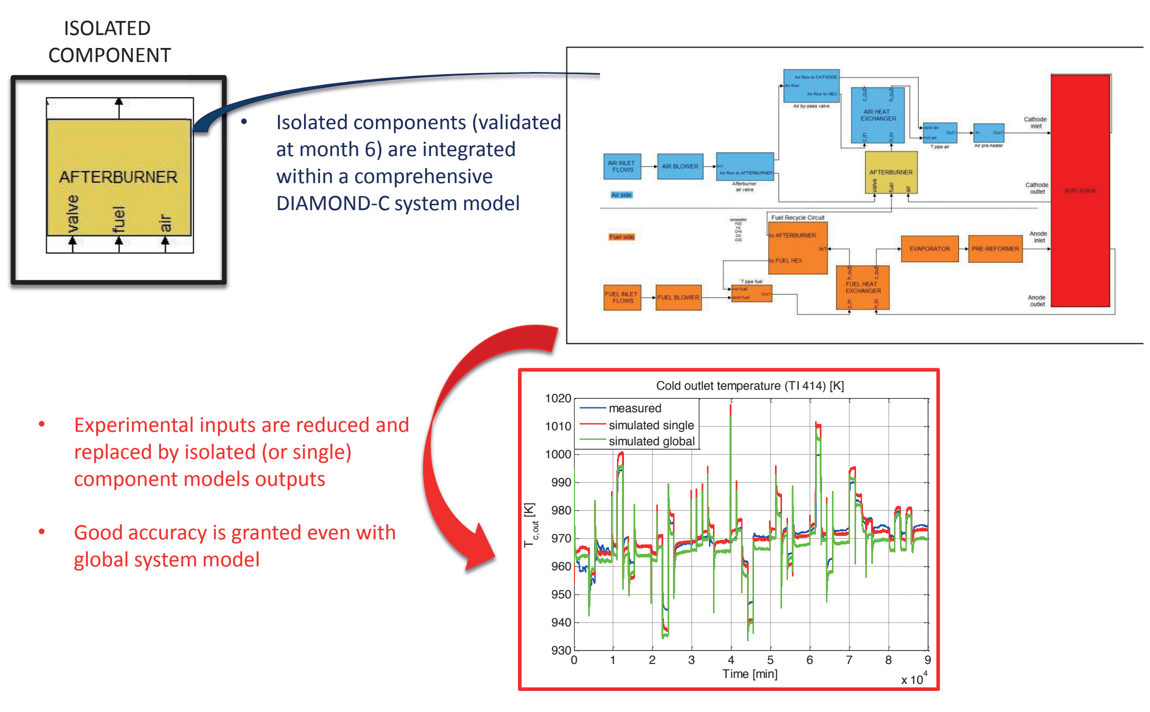
- Diamond A and C system testing for model data acquisition
- Development and implementation of advanced supervisory control
- Implementation of selected FDI schemes
- Evaluation of implemented control and FDI algorithms on the Diamond A and C systems
- Fault Signature Matrices for both Diamond C and A systems

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Several system characteristics have been made and validated with real-world system data (O/C, stack temp., reformer operation)
- It is recognized that a high-level control and FDI management system is necessary for system operation optimization
- Low-level control was designed and verified on the SOFC stack model. It provides much better stack temperature control and system efficiency than the open-loop operation. The low-level control will be upgraded with the supervisory controller which will be able to monitor and control the overall SOFC system performance.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Electric efficiency	35%-45%	50%	No system test done yet Diamond C system net efficiency of >50% was first documented in 2013.
MAIP 2008-2013	Durability	30,000 hrs.	10 years, >85,000 hrs.	No system test done yet
AIP 2013	Advanced controls and diagnostics	Capable of optimizing efficiencies	Strategies to guarantee optimal operation	Diagnostic tools are being developed • Soft sensors for determining maximum stack temperature and O/C ratio developed • Applicability of THDA explored from SRU to stack level System model validated Low-level feedforward-feedback control loop designed A dynamic model of Diamond C system has been developed and validated: The model is being exploited to design the control and diagnostic strategies; Control-oriented models are being developed for real-time monitoring. FSM development procedure through FTA and model simulations has been defined.
AIP 2013	System life > 10 years for smaller-scale applications	> 10 years for smaller-scale application	10 years	No system test done yet



ene.field

European Wide Field Trials for Residential Fuel Cell Micro-CHP

AIP / APPLICATION AREA	AIP 2011 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2011.3.7 Field demonstration of small stationary fuel cell systems for residential and commercial applications
START & END DATE	1 Sep. 2012 - 31 Aug. 2017
TOTAL BUDGET	€ 52,351,061.70
FCH JU CONTRIBUTION	€ 25,907,168,77
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: COGEN Europe

Partners: Bosch Thermotechnik, Dantherm Power, Elcore, RBZ, SOLIDpower, Vaillant, Hexis, SenerTec, Viessmann, GDF, Dolomiti Energia, British Gas, Element Energy, Hyer, Imperial College, DCHT, Envirpark, Politecnico, DBI, EST, GWI, DTU, Eifer, DONG,

PROJECT WEBSITE/URL

www.enefield.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The main aim is to remove barriers to the roll-out of technically mature fuel cell micro-CHP systems through a large scale deployment. This will trigger important first steps in the establishment of genuine product support networks, well-developed supply chains and the growth of new skills to support commercial micro-CHP rollout.

The deployment of large numbers of micro-CHP devices will also help to drive costs down, increase consumer awareness and establish new routes to markets, in preparation for commercial rollout.

PROGRESS/RESULTS TO-DATE

- The field trials started on September 2013 and at August 2015 over 250 units installed across 8 field trials Information packs for householders in 12 different languages, ene.field website and regular communications (press releases, newsletters)
- Different Regional Workshops took place (Spain, Italy and Germany)
- Establishment of: Utility Working Group and Regulations Codes and Standards working group; and production of position papers (RCS, Grid connection, smart grid)
- Data collected for 8 different systems and 1st reports produced (field trial support, supply chain analysis).

FUTURE STEPS

- 2015-2016-2017 – Deployment of approx. 500 units in field trials in Austria, Belgium, Germany, Luxembourg, Italy, Netherlands, Denmark, Switzerland, Slovenia and the UK
- 2015-2016-2017 – Data reporting and analysis: monthly aggregation of the data from the trials first report
- 2015 – Analysis of the field support and barriers: study in progress
- 2015 – Development of an environmental life cycle and costs assessment: studies under peer review (September 2015)
- 2016 - Establish a commercialization framework

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Key learnings around the practical implications of installing, operating and supporting a fleet of fuel cells with real world customers
- An implementable consistent monitoring scheme has been put in place.
- Awareness of the project has been built up (and will continue) with outreach to a range of target groups and potential supporters.
- Production volume is a serious limiting factor for the successful development of the supply chain
- New relationships have been developed to strengthen the supply chain and reduce costs of mCHP systems in Europe

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Number of units	1000	1000	250 (installations ongoing)
AIP 2011	Efficiency (electrical) (%)	>35	>35	Achieved – to be confirmed by data analysis
AIP 2011	overall efficiency (LHV)	>85	>85	Achieved – to be confirmed by data analysis

FCpoweredRBS

Demonstration Project for Power Supply to Telecom Stations Through FC Technology

AIP / APPLICATION AREA	AIP 2010 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2010.4.2: Demonstration of industrial application readiness of fuel cell generators for power supply to off-grid stations, including the hydrogen supply solution
START-DATE	01 Jan. 2012 - 31 Dec. 2015
TOTAL BUDGET	€ 10,591,649
FCH JU CONTRIBUTION	€ 4,221,270
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Ericsson Telecommunication Italy

Partners: Ericsson Telecommunication Italy, Dantherm Power AS, GreenHydrogen DK APS, Joint Research Centre, Università degli Studi di Roma Tor Vergata

PROJECT WEBSITE/URL

www.fcpoweredrbs.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

Field trials in 14 live Radio Base Station sites and Lab test in 2 research centers. Demonstrate to the TLC operators the possible advantage, in term of TCO, associated to power off-grid RBS with a new system combining renewable sources in substituting the Diesel generator.

PROGRESS/RESULTS TO-DATE

- Benchmarking test executed and provisional TCO calculated in Lab;
- Authorization process defined for installation rollout
- Solution and smart metering O&M completed;
- H2 supply solution and safety procedures implemented
- 11 live site up and running in main TLC Italian operator network;

FUTURE STEPS

- Integration with O&M TLC processes
- Field Tests and TCO consolidation
- Dissemination in TLC industry
- FC Certification procedures TLC compliant

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The project results will give an immediate answer with respect to the market readiness of the proposed solution.
- The Consortium would expect that if the TCO will demonstrate to be in line with expectation a proper market proposition may be already available
- O&M processes and procedures are essential for the successful penetration of the FC technology into TLC market
- Off-grid sites usual setup limits this FC based solution penetration.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Number of kw installed	100MW	About 80kw	About 53 kW installed in filed and labs.
AIP 2010	H2 based solution to replace diesel/ Life cycle assessment	TCO comparison	TCO calculation based on a Real Business Case model	TCO tool completed and preliminary business case ready
AIP 2010	Live TLC Sites powered with FC	-	15 sites	11 live sites in operation within two large TLC operators radio network
AIP 2010	FC deployed according to TLC operational requirements	-	Installations compliant with official regulation and TLC constraints	All the live sites have been assessed according to standard certification rules and Operators requirements

FERRET

A Flexible Natural Gas Membrane Reformer for M-CHP Applications

AIP / APPLICATION AREA	AIP 2013 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2013.3.3 Stationary Power and CHP fuel cell system improvement using improved balance of plant components/ sub-systems and/or advanced control and diagnostics systems.
START & END DATE	01 Apr. 2014 - 31 Mar. 2017
TOTAL BUDGET	€ 3,202,767
FCH JU CONTRIBUTION	€ 1,730,663
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Eindhoven University of Technology

Partners: Fundación Tecnalia Research & Innovation, Politecnico di Milano, ICI caldaie S.P.A., HyGear BV, Johnson, Matthey PLC

PROJECT WEBSITE/URL

http://www.ferret-h2.eu/

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

Within the FERRET project, the consortium will improve the technology based on membrane reactors and test a fully functional reactor for use in a current m-CHP unit from HyGear.

FERRET project will:

- Design a flexible reformer in terms of catalyst, membranes and control for different natural gas compositions
- Use hydrogen membranes to produce pure hydrogen and help with shifting all the possible H_2 production reactions towards the desired products, thus reducing side reactions.
- Scale up the new H_2 selective membranes and catalyst production
- Introduce ways to improve the recyclability of the membrane

PROGRESS/RESULTS TO-DATE

- First membranes developed
- First generation catalyst developed

FUTURE STEPS

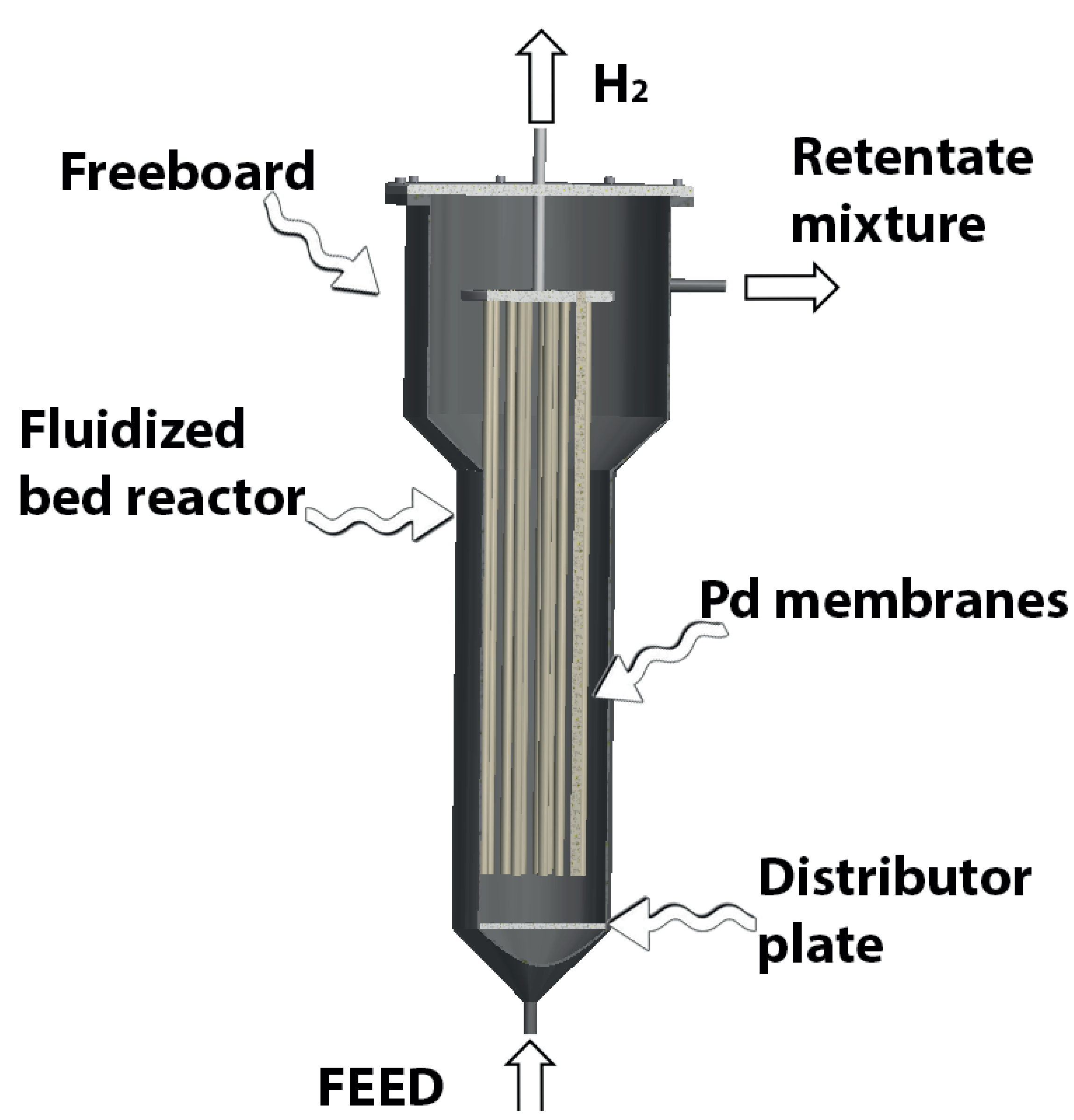
- Further development of the catalysts and high performance Pd-based membranes.
- Prototype reactor testing and validation.
- Proof of concept of the novel micro-CHP system. The new m-CHP will integrate the new reactor prototype and FC stacks with an optimised BoP.
- Modelling and simulation of both reactor and complete system

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- FERRET gives an answer to the segmented energy market in Europe
- FERRET will develop a flexible reformer that can cope with the differences in natural gas quality around Europe
- Proof of Concept of an advanced high performance, flexible and cost effective NG based micro-CHP system.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Overall efficiency CHP units	> 80%	> 90%	40%
MAIP 2008-2013	Emissions and fuels	Lower emissions and use of multiple fuels	Flexibility to use different natural gas qualities. Reduced CO_2 emissions compared to conventional reformers.	40%
MAIP 2008-2013	Cost per system (1kWe + household heat).	2015 target: Cost 10,000 € per system (1kWe + household heat). 2020 target: 5,000 € per system (1kWe + household heat).	5,000 € (1kWe + house heat)	50%
AIP 2013	Proof-of-Concept of CHP applications at laboratory scale.	Proof-of-Concept of CHP applications within laboratory.	TRL 4 – technology validated in lab	15%
AIP 2013	Durability	several hundreds of continuous operating hours	1000h of operation at nominal power output	N/A



FluidCELL

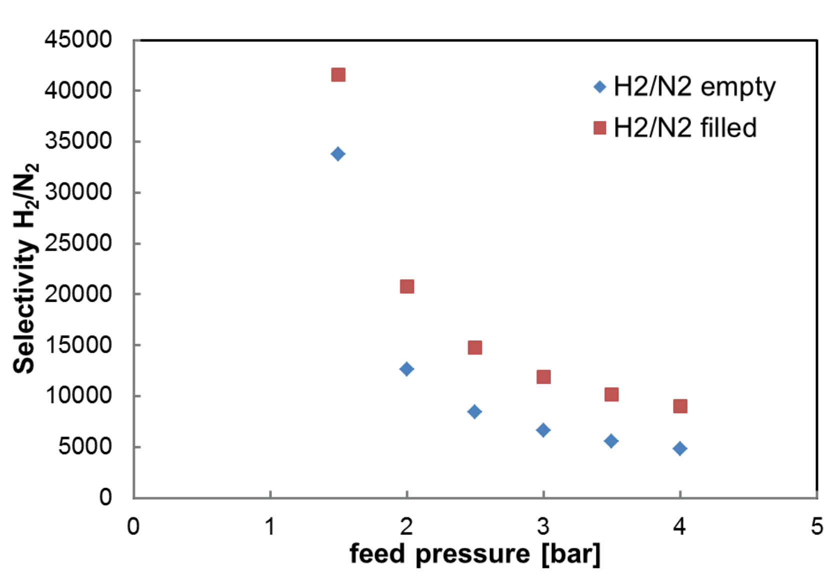
Advanced m-CHP Fuel CELL System Based on a Novel Bio-Ethanol Fluidized Bed Membrane Reformer

AIP / APPLICATION AREA	AIP 2013 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2013.3.4 Proof of concept and validation of whole fuel cell systems for stationary power and CHP applications at a representative scale. SP1-JTI-FCH.2013.3.3 Stationary Power and CHP fuel cell system improvement using improved balance of plant components/ sub-systems and/or advanced control and diagnostics systems.
START-DATE	01 Apr. 2014 - 31 Mar. 2017
TOTAL BUDGET	€ 4,193,548.92
FCH JU CONTRIBUTION	€ 2,492,341
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Fundación Tecnalia Research & Innovation

Partners: Eindhoven University of Technology, Commissariat à l'Energie Atomique et aux Energies Alternatives, Politecnico di Milano, University of Salerno, Porto University, ICI caldaie S.P.A., HyGear BV, Quantis Sàrl



PROJECT WEBSITE/URL

www.fluidcell.eu

PROJECT CONTACT INFORMATION

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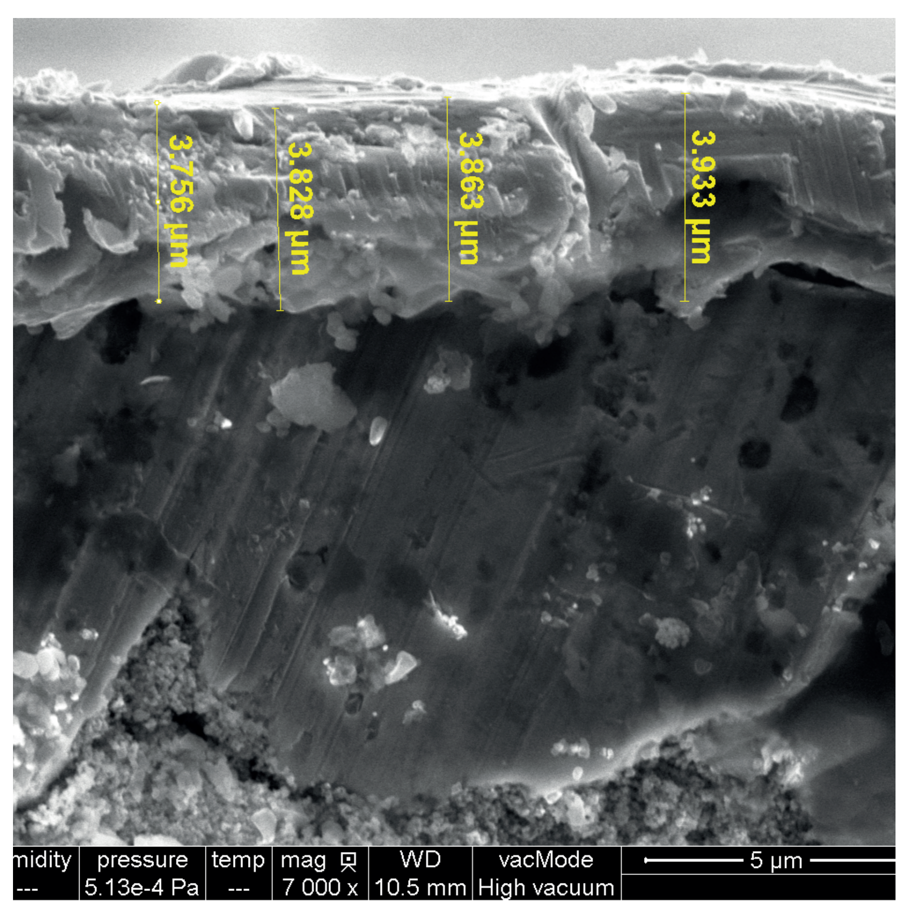
MAIN OBJECTIVES OF THE PROJECT

FluidCELL aims the Proof of Concept of an advanced high performance, cost effective bio-ethanol micro-CHP cogeneration FC system for decentralized off-grid applications.

The system will be based on:

- Design, construction and testing of an advanced bio-ethanol reformer for pure hydrogen production (3.5 Nm3/h) based on Catalytic Membrane Reactor in order to intensify the process of hydrogen production through the integration of reforming and purification in one single unit and
- Design and optimization of all the subcomponents for the BoP with particular attention to the optimized thermal integration and connection of the membrane reformer to the FC stack.



PROGRESS/RESULTS TO-DATE

- First generation catalyst and membranes developed.
- Reference fixed bed membrane reactor performance completed with membranes from TECNALIA and commercial catalyst.
- State-of-the-art of PEM FCs for stationary applications completed.
- CHP performance simulation with membrane fuel processor completed.
- Screening Life Cycle Assessment.

FUTURE STEPS

- Development of novel catalysts and high performance Pd-based membranes.
- Prototype reactor assembling, testing and validation.
- Proof of concept of the novel micro-CHP system. The new m-CHP will integrate the new reactor prototype and FC stacks with an optimised BoP.
- Technical economic assessment and optimization of both reactors and complete system
- Life Cycle Analysis and safety analysis

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- FluidCELL gives an answer to the large number of off-grid decentralized energy consumers that actually depend on expensive and high polluting sources such as LPGs, bottle gas, heating oil or solid fuels.
- Proof of Concept of an advanced high performance, cost effective bio-ethanol micro-CHP system.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Overall efficiency CHP units	> 80%	> 90%	40%
MAIP 2008-2013	emissions and fuels	Lower emissions and use of multiple fuels	Bio-ethanol as fuel (instead of natural gas). Reduced anthropogenic CO_2 emissions compared to conventional fossil fuels.	30%
MAIP 2008-2013	Cost per system (1kWe + household heat).	2020 target: 5,000 € per system (1kWe + household heat).	5,000 € (1kWe + house heat)	40% • Cost could be achieved for mass production. • The industrial requirements of the m-CHP system have been completed. • First generation catalyst developed. • First generation of membranes developed. • Reference commercial fixed bed membrane reactor performance completed with membranes from TECNALIA and commercial catalyst. • State-of-the-art of PEM FCs for stationary applications completed. • Benchmark case definition with conventional fuel processor completed. • CHP performance simulation with membrane fuel processor completed. • Screening Life Cycle Assessment.
AIP 2013	Proof-of-Concept of CHP applications within laboratory.	Proof-of-Concept of CHP applications within laboratory.	TRL 4 – technology validated in lab	15%
AIP 2013	Durability	several hundreds of continuous operating hours	1000h of operation	N/A

FLUMABACK

Fluid Management Component Improvement for Back Up Fuel Cell Systems

AIP / APPLICATION AREA	AIP 2011 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2011.3.3: Component Improvement for stationary power applications
START & END DATE	01 Jul. 2012 - 30 Jun. 2015
TOTAL BUDGET	€ 3,999,005
FCH JU CONTRIBUTION	€ 2,482,969
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Electro Power Systems S.p.A.

Partners: Domel, Tubiflex, Environment Park, Jožef Stefan Institute, Foundation for the Development of New Hydrogen Technologies in Aragon, NedStack Fuel Cell Technology BV, Onda, University of Ljubljana – Faculty of Mechanical Engineering, Joint Research Centre – Institute for Energy and Transport

Air Blower

PROJECT WEBSITE/URL

www.flumaback.eu

PROJECT CONTACT INFORMATION

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Mitja Mori
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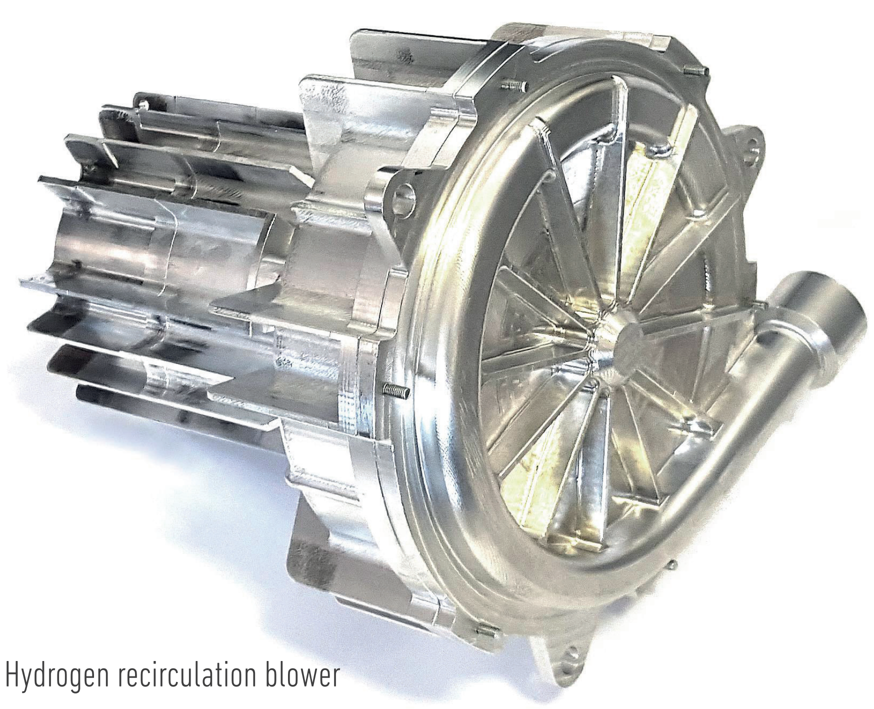
MAIN OBJECTIVES OF THE PROJECT

The project focuses on new design and improvement of balance of plant (BoP) components, specifically:

- Air and fluid flow equipment, including subcomponents and more specifically air and hydrogen blower;
- Humidifier;
- Heat exchanger.

The goals of the project:

- Improving BoP components performance, in terms of reliability;
- Improving the lifetime of BoP components at both component and system levels;
- Reducing cost in a mass-production perspective;
- Simplifying the manufacturing/assembly process of the entire system.



Hydrogen recirculation blower

PROGRESS/RESULTS TO-DATE

- Three iterations of air blower, hydrogen pump and humidifier developed and tested singularly and on 3kW and 6kW fuel cell systems
- Air blower almost fully achieved project targets in terms of cost, efficiency and lifetime; hydrogen recirculation blower, novel product developed within the FluMaBack project achieves specified pressure-flow requirements; but some further development needed to achieve higher level of reliability; humidifier, a novel product developed within the FluMaBack project as well, achieve the expected technical performance and cost target but some further development needed in terms of manufacturing process.
- Increase of efficiency at system level achieved.
- RCS, LCA and End-of-life assessment performed
- Market analysis performed.

FUTURE STEPS

Project concluded on 30th June 2015

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Air blower developed shows significant improvements respect to SoA in terms of cost, efficiency and lifetime. It is is ready to be used in comercial fuel cell system products.
- Hydrogen blower developed in the project enables good foundations for further development to improve lifetime. Since there is only limited publically available information on the subject, further research must be made on identifying advantages or disadvantages of different working principles used for hydrogen recirculation pumps/blowers.
- Humidifier developed in FluMaBack Project is very promising in terms of identified material (alternative to Nafion), design and manufacturing costs. Further development acitivites are required in the manufacturing process to improve lifetime.
- Fuel cell system with improved BoP components has higher efficiency and it is more cost effective.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Cost system €/kW – midterm 2015	€ 1,500/kW	214 €/kW total cost of BoP components to be developed	Achieved for the 6 kW fuel cell system if the production samples consist of 100 pieces (159 €/kW) . If the production samples are 800 pieces each, the total target cost/kW has been achieved for both 3 kW (220 €/kW) and 6 kW (124 €/kW) fuel cell system.
MAIP 2008-2013	Durability/reliability	10,000 h	10,000 h	Verified 10,000h lifetime of air blower and confirmed the same perfomances in comparison with the BoL. Degradation of humidifier observed in long term tests. No ageing test on the hydrogen blower because of reliability issues.
AIP 2011	Component life time and maintenance cycle	Component life and maintenance cycle consist with system life up to 10 years for small-scale application	Life time BoP components: 10,000 hours, durability, reliability and robustness of single developed BOP components in order to provide maintenance cycles consistent with system life up to 10 year.	Same results of point above.
AIP 2011	BoP electrical efficiency	BOP Electrical efficiency > 90% for system < 10 kWe	BOP Power consumption relative to 6 kW fuel cell system output power of 8,3%	BOP Power consumption relative to 6 kW fuel cell system output power of 11%.
AIP 2011	Novel design and optimisation of non-stack components		Novel design and optimisation of air blower, hydrogen pump and humidifier.	Optimisation of air blower, novel design of both hydrogen pump and humidifier achieved.

NELLHI

New all-European high-performance stack: design for mass production

NELLHI

New All-European High-Performance Stack: Design for Mass Production

AIP / APPLICATION AREA	AIP 2013 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	Topic SP1-JTI-FCH.2013.3.2 Improved cell and stack design and manufacturability for application specific requirements for stationary fuel cell power and CHP systems
START & END DATE	01 May 2014 - 30 Apr. 2017
TOTAL BUDGET	€ 2,858,447.20
FCH JU CONTRIBUTION	€ 1,633,895.00
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: ENEA (ITA)

Partners: Elcogen AS (EST), Elcogen Oy (FIN), VTT (FIN), Flexitallic (GBR), Borit (BEL), Sandvik Materials Technology (SWE), CUTEC (GER)

PROJECT WEBSITE/URL

www.nellhi.eu

PROJECT CONTACT INFORMATION

Stephen McPhail
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MAIN OBJECTIVES OF THE PROJECT

NELLHI combines European know-how in single cells, coatings, sealing, stack designs and manufacturing technology to produce an innovative and modular 1 kW SOFC stack, together with the proof of concept of a 10 kWe SOFC stack module. Improvements over the state of the art in cost, performance, efficiency, and reliability will be proven, as a combined result of high-performance cells and manufacturability designed for mass production at high yield.

The project target is an off-the-shelf, modular stack assembly that can be integrated in stationary CHP applications of various sizes fed by natural gas – from single kilowatt to multi-megawatt scale.

PROGRESS/RESULTS TO-DATE

- First-generation stack has been assembled and sent out for testing
- Second-generation components are being frozen
- In-depth characterization of cell processes carried out
- Website running and first scientific results presented

FUTURE STEPS

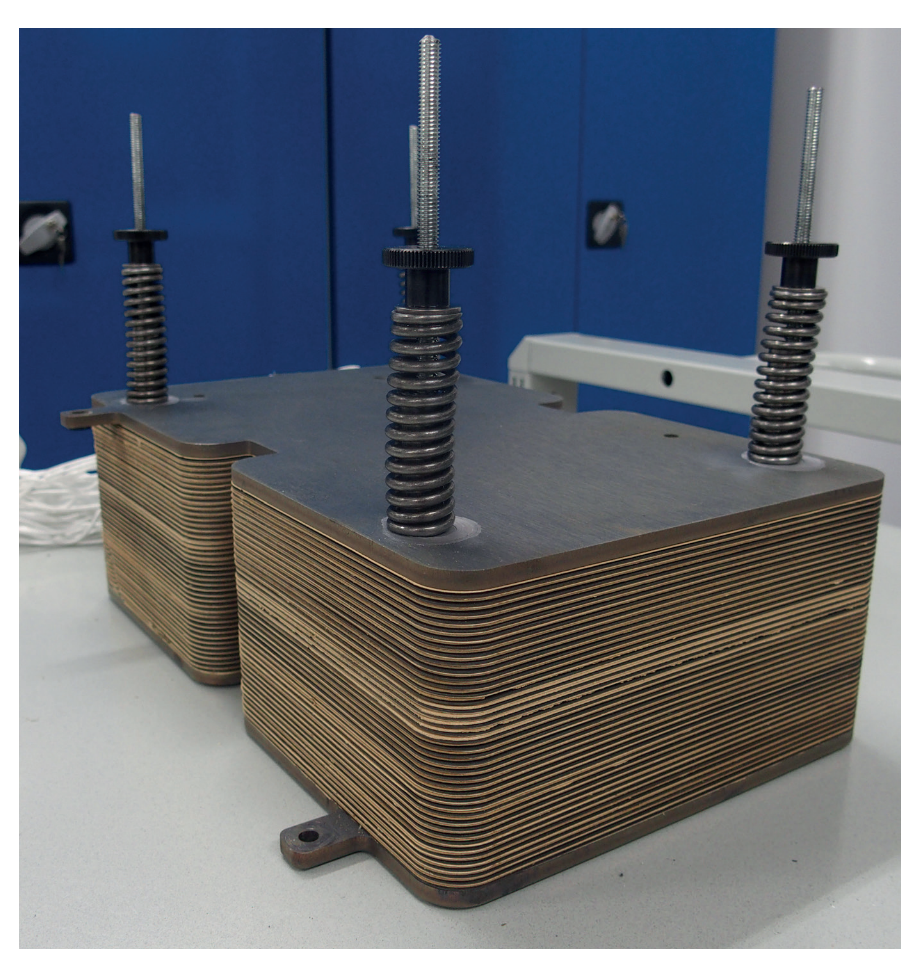
- Repeatability of cell validation and further cell process mapping
- Flow field modelling and experimental validation
- Component assembly to 2nd generation stack
- Testing of stack and feedback to design process

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Sealing properties massively improved
- Outstanding quality, robustness and volume-driven cost effectiveness of the interconnect production process envisaged
- In-depth and full-range assessment of cell characteristics expected to cross-correlate to modelling outcome
- Robustness, leakage rate and degradation characteristics significantly improved in SOFC stack

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Efficiency for mCHP system stacks	35-45 % (elec) 75-85 % (tot)	Cell voltage ca. 850 mV @ 0.5 Acm-2 at 650°C	Cell voltage ca. 870 mV @ 0.5 Acm-2 at 650°C
AIP 2013	increase robustness and lifetime	Beyond SoA	Less than 0.2% voltage loss in 1000 hours and 0.5% after 10 thermal cycles (enables >25000 hours life-time)	Less than 5mOhm.cm2 in 1000 hours (9000 hours experiment) demonstrated with unit cells (better than project targets). Less than 0.5 % degradation after 10 thermal cycles. demonstrated.
AIP 2013	increase performance, power density, and efficiency	Beyond SoA	Stack's performance at 900mV with 0.3 Acm-2 current density at 650 °C with increased cell footprint. The stack's fuel utilization capabilityshould be at least 65%.	Stack voltage ~910 mV @ 0.3 Acm-2 at 650°C Demonstrated stack fuel utilization capacity of 85%.
AIP 2013	reduce materials and manufacturing cost	Beyond SoA	Cost target for cells less than 300 €/ kWe. Target for ready interconnect ~ 200 €/kW The price target for the final sealing materials is 30€/kWe	Manufacturing process intrinsically upscalable to mass production, so in line with targets, based on production volume



PEMBeyond

PEMFC System and Low-Grade Bioethanol Processor Unit Development for Back-Up and Off-Grid Power Applications

AIP / APPLICATION AREA	AIP 2013 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2013.4.4 Development of 1-30 kW fuel cell systems and hydrogen supply for early market applications
START & END DATE	01 May 2014 - 30 Apr. 2017
TOTAL BUDGET (EUR)	€ 4,586,324.90
FCH JU CONTRIBUTION (EUR)	€ 2,315,539.00
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: VTT Technical Research Centre of Finland

Partners: PowerCell Sweden Ab, Genport srl, Fraunhofer ICT-IMM, University of Porto

PROJECT WEBSITE/URL

http://pembeyond.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

In PEMBeyond project a cost-competitive, energy-efficient and durable integrated PEMFC based power system operating on low-grade (crude) bioethanol will be developed for back-up and off-grid power generation.

The system will be:

- Using crude (80-90%) bioethanol as primary fuel
- Cost-competitive (complete system < 2 500 €/kW @ 500 units)
- Energy-efficient (> 30% overall system efficiency, > 45% PEMFC system efficiency)
- Durable (> 20 000 hours system lifetime)

Extensive techno-economic and environmental analyses will be carried out throughout the project to ensure attractiveness of the concept. A roadmap to volume production will be one of the main deliverables of the project.

PROGRESS/RESULTS TO-DATE

- Definition of system specifications completed
- Market Analysis for Telecom back-up systems completed
- "Product version" PEMFC stack design ready and first stacks delivered
- System/subsystem development work (PEMFC system, bioethanol reformer, complete system) is in progress
- Experimental hydrogen impurity studies ongoing to determine final hydrogen quality specifications used.

FUTURE STEPS

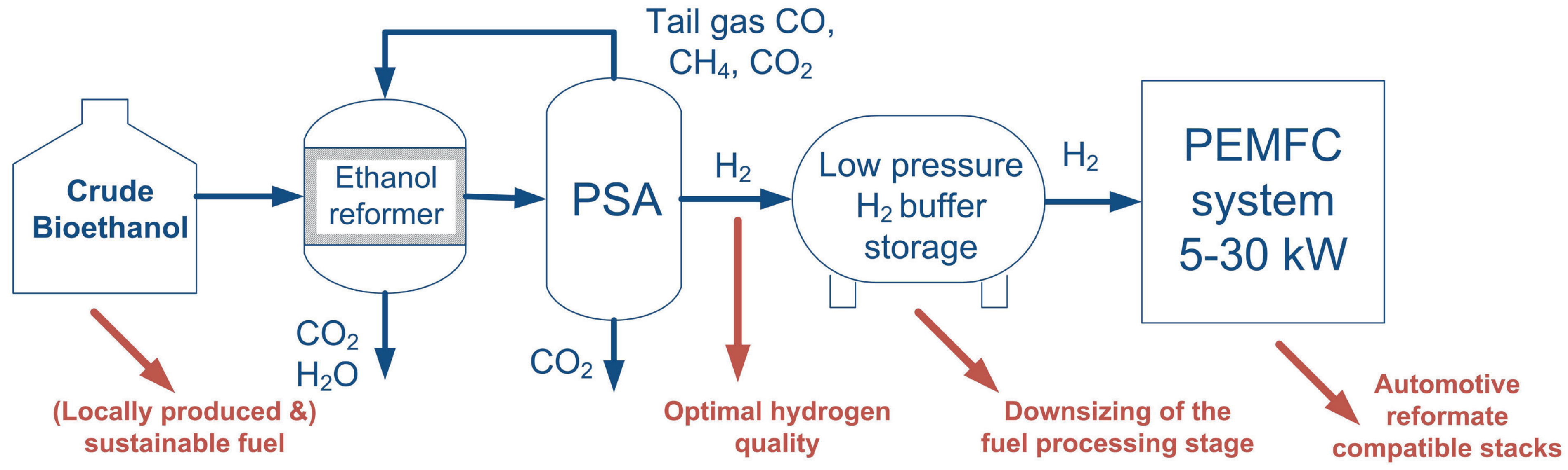
- Hydrogen quality specifications frozen
- Completion of component/subsystem (PEMFC stack & system, bioethanol reformer, PSA) development
- Functional testing of components/subsystems separately
- Complete system integration, testing and field-trial
- Completing the techno-economic & Environmental analyses

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Very high interest from potential end-user companies (telecom) to the project and system to be developed
- Both local and EU level regulation affect significantly the telecom back-up market and the system requirements
- According to the Market Analysis conducted within the project, a significant portion of the telecom backup market (60%) can be served by the PEMBeyond system (Served Available Market).
- No major technical obstacles are foreseen at this point in developing a back-up power system to reach the set targets and system specifications

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Number of new UPS/back-up power units in the EU market	1000 units	1 new back-up power unit installed during the project	System and subsystems design work in progress
MAIP 2008-2013	Cost of industrial/commercial units	1,500 - 2,500 €/kW	< 3,300 €/kW (@>500 units & 5 kW) < 2,500 €/kW (@>500 units & 25 kW)	9,000 €/kW, estimated with current existing subsystem and component designs in the beginning of the project
AIP 2013	Fuel cell and hydrogen system cost (including H2 generator)	€2,500/kW (@ >500 units)	< 3,300 €/kW (@>500 units & 5 kW) < 2,500 €/kW (@>500 units & 25 kW)	9,000 €/kW, estimated with current existing subsystem and component designs in the beginning of the project
AIP 2013	Fuel cell system (FCS) efficiency	45%	> 45%	> 45% according to first FCS simulations. Experimental data not available yet.
AIP 2013	System life-time	20,000 hours (fuel cell stack 20,000 hours)	> 20,000 hours	N/A, not sufficiently data available yet from stack development
AIP 2013	System efficiency when working with an integrated hydrogen generator	> 30%	> 30%	~30% according to first system simulations. Experimental data not available yet.



POWER-UP

Demonstration of a 500 kWe Alkaline Fuel Cell System with Heat Capture

AIP / APPLICATION AREA	AIP 2012 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2012.3.7: Field demonstration of large-scale stationary power and CHP fuel cell systems
START & END DATE	1 Apr. 2013 - 30 Jun. 2017
TOTAL BUDGET	€ 11,552,448
FCH JU CONTRIBUTION	€ 6,137,565
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: AFC Energy PLC (UK)

Partners: Air Products PLC (UK) GB Innomech Ltd (UK), Zentrum für Brennstoffzellen-Technik GmbH (DE), Paul Scherrer Institut (CH), FAST - Federazione Delle Associazioni Scientifiche E Tecniche (IT)

PROJECT WEBSITE/URL

http://project-power-up.eu/

PROJECT CONTACT INFORMATION

Mr Christopher TAWNEY
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MAIN OBJECTIVES OF THE PROJECT

A 500 kWe alkaline fuel cell system will be demonstrated at Air Product's industrial gas plant in Stade, Germany. Performance, cost, social, economic and environmental impacts will be independently assessed, and certification for the post-funding period will be prepared. In addition, a prototype high-volume manufacturing line will be achieved through the introduction of automation.

PROGRESS/RESULTS TO-DATE

- Demonstration site permitted; utilities and buildings complete.
- Scaled-up alkaline fuel cell system complete. System constructed, tested and shipped to demo site *(being commissioned at the time of writing)*
- Fuel cell production line upgraded; extrusion now replaces blade mixing
- Automated stack assembly complete
- Recycling/re-use targets for catalyst and system components achieved

FUTURE STEPS

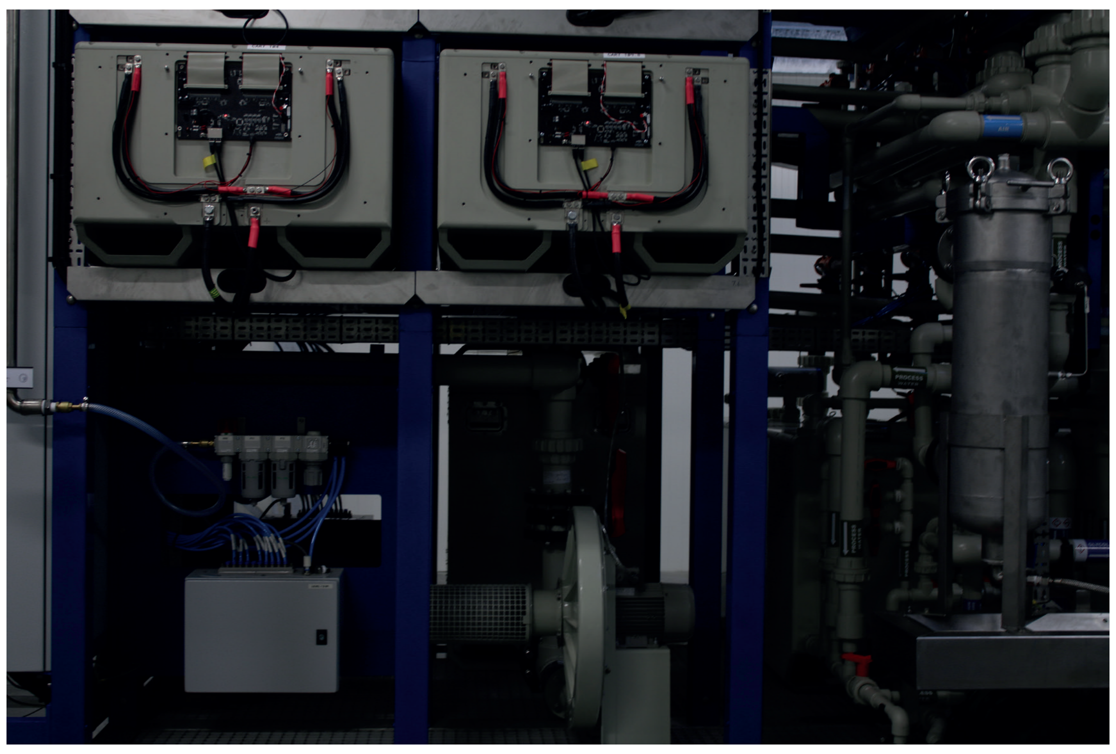
- Power production by Q3 2015
- Connection to the grid by Q3 2015
- Operational data to confirm cost of ownership, system performance, and economic/environmental/social impacts
- Automation of stack disassembly
- Certification

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Automation of fuel cell production has increased volumes without reducing quality
- Project targets are achievable
- Scaled-up system design will be basis of future commercial product
- Huge commercial interest in system from beyond Europe
- Connection to grid will be achieved by Q3 2015

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Power generated in the field	*>5 MW by 2015*	240 kW by end 2015	N/A (test not finalized)
MAIP 2008-2013	Cost	*3,000 €/kW Assuming supported deployment from 2013+*	3,000 €/kW is the target cost (CapEx and OpEx), using demonstration systems. Target cost for the post-funding period will be significantly lower	The first system had a number of one-off high-cost items which will not be repeated. We now believe that this target is realistic for initial systems
AIP 2012	Conversion efficiency	58% (elec)	58 – 59%	On track to achieve by end of project
AIP 2012	Lifetime / duration of	15,000 hrs	15.000	On track to achieve by end of project



ReforCELL

Advanced Multi-Fuel Reformer for CHP-Fuel Cell Systems

AIP / APPLICATION AREA	AIP 2010 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2010.3.3 Component improvement for stationary power applications
START & END DATE	01 Feb. 2012 - 31 Dec. 2015
TOTAL BUDGET	€ 5,546,194.57
FCH JU CONTRIBUTION	€ 2,857,211
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Fundación Tecnalia Research & Innovation

Partners: Eindhoven University of Technology, Commissariat à l'Energie Atomique et aux Energies Alternatives, Politecnico di Milano, SINTEF, ICI caldaie S.P.A., HyGear BV, SOPRANO INDUSTRY, Hybrid Catalysis BV, Quantis Sàrl, JRC –JOINT RESEARCH CENTRE- EUROPEAN COMMISSION

PROJECT WEBSITE/URL

www.reforcell.eu

PROJECT CONTACT INFORMATION

José Luis Viviente
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MAIN OBJECTIVES OF THE PROJECT

ReforCELL aims at developing a high efficiency PEM fuel cell micro Combined Heat and Power system (net energy efficiency > 42% and overall efficiency > 90%) based on a novel, more efficient and cheaper pure hydrogen production unit (5 Nm3/h), together with optimized design of the subcomponent for the BoP. The target will be pursued with the integration of the reforming and purification in one single unit using Catalytic Membrane Reactors (CMR).

PROGRESS/RESULTS TO-DATE

- Metallic supported membranes working under 500°C have been developed with high selectivities (>150,000). Long term testing (~1200 h) has been demonstrated at 400°C.
- Reactor prototype has been assembled.
- PEM FC has been fully characterised and stack size, components manufacturing and integration have started.
- Test facility for the m-CHP system completed
- m-CHP designed.
- A preliminary LCA analysis for environmental impact assessment has been delivered

FUTURE STEPS

- Pilot scale CMR reformer validation
- Stack for the m-CHP
- Integration of the BoP and stack in the m-CHP.
- Testing the new m-CHP system.
- Complete Life Cycle Analysis and safety analysis

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

The incorporation of catalytic membranes reactors in the PEM fuel cell micro-CHP systems could improve the efficiency while reducing the cost due to the integration of the reforming and purification in one single unit (working at lower temperature) and the optimized design of the subcomponent for the BoP.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Overall efficiency CHP units	*> 80%*	> 90%	90 % can be achieved if the appropriate heat exchanger sizing and insulation is adopted (see D7.3)
MAIP 2008-2013	Micro-CHP (residential), natural gas based Cost per system (1kWe + household heat).	2015 target: Cost 10,000 € per system (1kWe + household heat). 2020 target: 5,000 € per system (1kWe + household heat).	5,000 € (1kWe + house heat)	• Cost could be achieved for mass production. However this is not the actual situation for some components. An estimated cost will be calculated when knowing the final components and theirs costs at the end of the project. • m-CHP system will be assembled end September / beginning October. • Stack is being built. To be delivered in September. • Reformer prototype has been assembled. It will be delivered in September after validation.
AIP 2010	Viable mass production	Viable mass production	Mass production technologies are considered in the development	-
AIP 2010	Electrical efficiency (%) >42%	> 42%	> 42%	According to the simulation techno-economic optimization of the lay-out for the ReforCELL system (D7.3) the target could be achieved. However, measuring it a real m-CHP is delayed.
AIP 2010	Recyclability	LCA and safety study	LCA and safety study	A preliminary LCA analysis for environmental impact assessment has been delivered (D8.1).

Sapphire

System Automation of PEMFCs with Prognostics and Health Management for Improved Reliability and Economy

AIP / APPLICATION AREA	AIP 2012 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2012.3.3: Robust, reliable and cost effective diagnostic and control systems design for stationary power and CHP fuel cell systems
START & END DATE	01 May 2013 – 30 Apr. 2016
TOTAL BUDGET	€ 3,269,417.10
FCH JU CONTRIBUTION	€ 1,745,140
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: SINTEF Foundation (Norway)

Partners: European Institute for Energy Research (Germany), FCLAB Research Federation (France), University of Split (FESB, Croatia), Center for Solar and Hydrogen Energy Research (German), Dantherm Power A/S (Denmark)

PROJECT WEBSITE/URL

www.sapphire-project.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

To develop an integrated prognostics and health management (PHM) system, including a health-adaptive controller to extend the lifetime and increase the reliability of low-temperature PEM fuel cell stacks in μCHP systems.

This is achieved by developing degradation and health assessment methods that can be applied on-line with existing or inexpensive additional sensors, prognostic algorithms to estimate the Residual Useful Life (RUL) of the stack given its current state and predicted usage, and a control system to maximise the RUL by manipulating the operating conditions of the system.

PROGRESS/RESULTS TO-DATE

- Performed extensive cell and stack testing
- Long-term system testing with current technology
- Developed prognostic and diagnostic algorithms
- Identified modes of operation with no degradation
- Synthesised advanced controllers

FUTURE STEPS

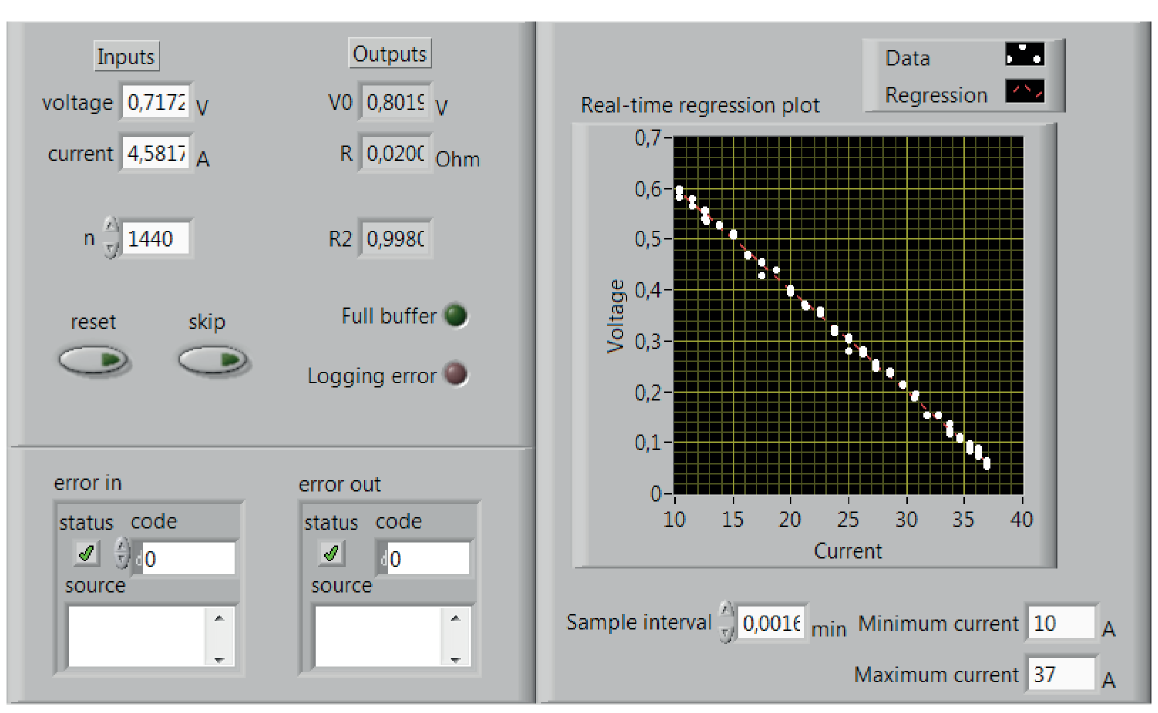
- Long-term testing with new technology
- Validation of prognostic algorithms
- Validation of control performance
- Evaluation of stack design influence on degradation

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Degradation can be strongly reduced with appropriate action
- Cost constraints will be achieved
- Prognostics without on-line EIS is possible

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	FC lifetime	30000 h	> 20000 h With current tech	> 9000 h tested ~ 50000 projected
AIP 2012	FC lifetime	20000 h With current tech	> 20000 h With current tech	> 9000 h tested ~ 50000 projected
AIP 2012	Extra cost for control system	100 €/kW	100 €/kW	136 €/kW



FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

sofcom
FCH-JU project

SOFCOM

SOFC CCHP with Poly-Fuel: Operation and Management

AIP / APPLICATION AREA	AIP 2010 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2010.3.4 - Proof-of-concept and validation of integrated fuel cell systems
START & END DATE	01 Nov. 2011 - 30 Apr. 2015
TOTAL BUDGET	€ 6,250,227.23
FCH JU CONTRIBUTION	€ 2,937,753.00
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Politecnico di Torino (Italy)

Partners: Teknologian Tutkimuskeskus VTT (Finland), Topsoe Fuel Cells A/S (Denmark), Società Metropolitana Acque Torino spa (Italy), Matgas 2000 A.I.E. (Spain), Consiglio Nazionale delle Ricerche (Italy), Instytut Energetyki (Poland), Ecole Polytechnique Fédérale de Lausanne (Switzerland), Technische Universitaet Muenchen (Germany), Università di Torino (Italy)

PROJECT WEBSITE/URL

www.sofcom.eu (http://areeweb.polito.it/ricerca/sofcom/en/)

PROJECT CONTACT INFORMATION

Massimo Santarelli
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MAIN OBJECTIVES OF THE PROJECT

SOFCOM is an applied research project devoted to demonstrate the technical feasibility, the efficiency and environmental advantages of CHP systems based on SOFC fed by biogenous primary fuels (biogas and bio-syngas) integrated by a process for the CO2 separation and Carbon reutilization.

The Demonstration is implemented in the context of other 2 axes:

Lab-scale: fuel production section; fuel cleaning section; fuel processing section; SOFC CHP section; carbon capturing module (oxy-combustion, CO2 separation, C fixing in algae)

System Analysis: energy, economic, environmental analysis of the option of SOFC-based CHP plants as distributed systems using local biogenous energy sources; development of guidelines for the scale-up; development of pre-normative results; LCA analysis

PROGRESS/RESULTS TO-DATE

- Analysis of biogas contaminant effects on SOFC anodes: halogens, siloxanes, sulphur, also with combined and synergetic effects
- DEMO of complete biogas-cleaning-SOFC-CO2 recovery from anode exhaust
- DEMO of SOFC stack fed with lean fuel (syngas from biomass gasification)
- Biogas-SOFC-CO2 recovery plants: scale-up and exploitation analysis

FUTURE STEPS

Done

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- SOFCOM demonstrates (through in-field DEMO) the high interest of electrochemical systems based on high temperature fuel cells to operate as the core of future energy systems with renewable fuels and multi-product configuration, with particular care on CO2 management through C re-utilization in different processes (electrochemical, chemical, or biological as in SOFCOM).
- scale-up of the biogas-SOFC plant. New project **DEMOSOFC** (FCH2 JU Call 2014), providing a industrial size (175 kWe) DEMO of a SOFC system installed in a waste water treatment plant, fully fed by biogas from WWTP.
- deep analysis of biogas contaminant effects on SOFC anodes: combined and synergetic effects
- activities on SOFC fed by lean syngas and strong interest in going on with the activities on the contaminants effect on cells and elements of the stack
- CO2 recovery from SOFC anode exhausts

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	High electrical efficiencies	45%+ for power systems and of 80%+ for CHP systems, with lower emissions and use of non-fossil fuels.	From the first analysis, the figures are as follows: a) 49.50% of the primary fuel is converted in high value electric power; b) 47.16% of the primary fuel is converted in low grade heat flow, but fully useful in the WWTU plant to supply the heat requirements of the thermo-phillic sewage digesters; c) 1.22% of the primary fuel is converted back in useful biomass, which can be re-inserted in the digester for biogas production, or used for other applications (e.g. bio-fuel productions). Also, it has to be considered that: a) the biogas is a completely sustainable fuel, b) the system provides a complete closed loop of the Carbon atoms	The DEMO has been tested in the industrial context. The electric efficiency has reached 53%.
MAIP 2008-13	Demonstration activities target proof-of-concept, technology validation or field demonstrations	NA	SOFCOM develops two final demonstration of complete biofuel-fed SOFC systems: DEMO 1 Torino (IT): field demonstration of WWTU biogas-fed SOFC with CO2 recovery and reuse; real operating environment. DEMO 2 Helsinki (FI): technology validation within in-house test facility of bio-syngas-fed SOFC; in-house validation.	DEMO 2 Helsinki (FI): done. DEMO 1 Torino (IT): done.
MAIP 2008-13	Field demonstration activities are split into small (residential and commercial applications) and large (distributed generation or other industrial or commercial applications) scale.	NA	The DEMO 1 in Torino is a small scale demonstration activity but performed in a real industrial application scale. The DEMO 2 in Helsinki is a small scale demonstration activity but with emphasis on future scale-up (biomass gasification fuel).	DEMO 2 Helsinki (FI): done. DEMO 1 Torino (IT): done.
AIP 2010	Development of proof of concept prototypes that combine fuel cell units into complete systems, performing integration and testing with fuel delivery and processing subsystems; interface with devices featuring delivery of customer requirements (e.g. power, heat, cooling and CO2 capture), also integrating renewable sources and other services wherever appropriate	NA	SOFCOM develops of two proof-of-concept demonstration plants, which integrates SOFCs into complete systems. The demonstration site in Torino (Italy) consists in SOFC generator fully integrated in a large waste-water treatment plant producing biogas; the generator works in a cogenerative mode, producing electrical power, plus heat; it is also integrated with a CO2 separation and reutilization module (photo-bio-reactor for algae water and Carbon fixing). The demonstration site in Helsinki (Finland) is based on the integration of the SOFC with another fuel typology: a bio-syngas (from gasification) is used to feed the SOFC unit, which works in CCHP configuration.	DEMO 2 Helsinki (FI): done. DEMO 1 Torino (IT): done.
AIP 2010	Identification of technical and economic requirements in order to be competitive in the marketplace	NA	Analysis, following the real experience performed in the Demonstration Activity, with a scale-up analysis of the integrated SOFC systems studied.	Analysis done, to be used especially for next scale-up project in the area of biogas-fed FCs (DEMOSOFC, financed in the FCH2 JU Call 2014)
AIP 2010	Validation activities, performed in a real system environment or with real equipment in a simulated system environment	NA	The proof-of-concept validation of the tested systems on the demonstration sites is one of the main results of the project; this is followed by a close examination of the lessons learned, which will eventually enable us to identify the reliability of the SOFC integrated systems, weaknesses, and eventually to establish the market maturity.	Validation activities done in a real industrial site

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

SOFT-PACT

Solid Oxide Fuel Cell Micro-CHP Field Trials

AIP / APPLICATION AREA	AIP 2010 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2010.3.5: Field demonstration of stationary fuel cell systems
START & END DATE	08 Jul. 2011 - 07 Oct. 2015
TOTAL BUDGET	€ 10,312,703
FCH JU CONTRIBUTION	€ 3,950,893
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: E.ON NEW BUILD & TECHNOLOGY LIMITED

Partners: CERAMIC FUEL CELLS GMBH, IDEAL BOILERS LIMITED, HOMA SOFTWARE BV

PROJECT WEBSITE/URL

www.soft-pact.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

SOFT-PACT has been established to undertake a large scale field demonstration of SOFC generators that can be utilised in residential applications. The objectives being to:

- Design, develop and deploy integrated fuel cell mCHP systems
- Long term reliability and life data from the systems
- Remote control and diagnostics of all the systems from a central point in real time
- Training and re-skilling of installation and maintenance engineers
- Identification and quantification of benefits to the homeowner

Key outputs (EU market study, data from two field trials, building of installation capability and completion of the development of an optimised integrated FC system)

PROGRESS/RESULTS TO-DATE

- EU FC Market Opportunities Study Report
- Deployment of Pathfinder BlueGen Systems in DE & UK
- Specification for Integrated Fuel Cell Appliance
- Cost Reduction and Component Optimisation of BlueGen
- Design, test, build and deployment of Integrated Fuel Cell Appliances in Field Trial

FUTURE STEPS

- Monitoring Data Analysis
- Decommissioning & removal of field trial units (Mid 2015)
- Final Reports

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Large opportunities for fuel cell deployment with EU @ right price
- Policy and incentive support must be maintained to aid volume production cost reductions
- Range of systems required to meet all EU markets (gas types and local regulations)
- Deployment of systems by local companies requires hybrid installation engineer training to reduce costs.
- Fuel Cell Start ups are extremely dependant on Investors – (CFC currently in administration – June 2015)

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	FC system *life time* (h)	>5,000	>10,000	Ongoing (test not finalized)
AIP 2010	Deployment of fuel cel*ls* with Trial	10	Up to 100	39 BlueGen Systems 26 Integrated Fuel Cell Appliances (SIFC) 65 Fuel Cell Systems Total (ongoing)
AIP 2010	FC system Electrical efficiency (%) (HHV)	>40	>40	56 -> 42 Over lifetime
AIP 2010	Cost Reduction (€/kWe)	€5000 /kWe	25% Reduction on BlueGen	Achieved via Re-engineering & supply chain enhancements

STAGE-SOFC

Innovative SOFC system layout for stationary power and CHP applications

AIP / APPLICATION AREA	AIP 2013 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2013.3.4: Proof of concept and validation of whole fuel cell systems for stationary power and CHP applications at a representative scale
START & END DATE	01 Apr. 2014 - 31 Mar. 2017
TOTAL BUDGET	€ 3,970,267
FCH JU CONTRIBUTION	€ 2,165,725
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: VTT Technical Research Centre of Finland Ltd

Partners: sunfire GmbH, ICI Caldaie S.p.A., Lappeenranta University of Technology, West Pomeranian University of Technology

PROJECT WEBSITE/URL

http://www.stage-sofc-project.eu/

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The project aims to develop a 5kWel Proof-of-Concept prototype of a new SOFC concept that achieves an electrical efficiency of ≥ 45% and a thermal efficiency of > 85% with a serial connection of stacks. The system combines the benefits of the simple and robust catalytic partial oxidation layout with the high efficiencies obtained by the steam reforming process. A staged cathode air supply allows an individual control of stack temperatures and saving of costly heat exchanger area. The system will be designed for small-scale CHP and off-grid applications in the power range of 5 to 50 kW.

PROGRESS/RESULTS TO-DATE

- System simulation proof the underlying idea of the project feasibility of reaching > 45 % efficiency
- Basic design of the reformer ready and operational window specified
- 3D construction of 1st PoC ready, purchasing of components ongoing

FUTURE STEPS

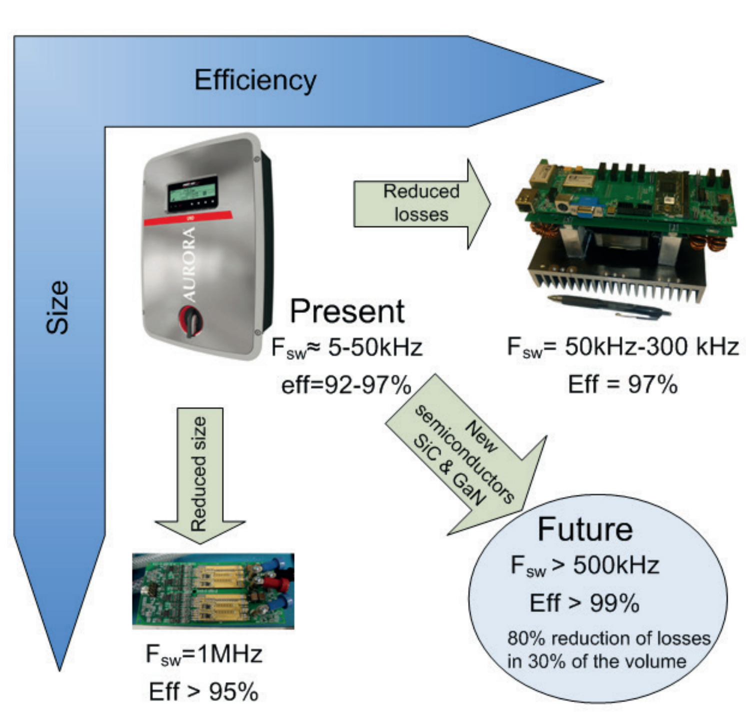
- Commissioning and test operation of 1st PoC system
- Industrial design of SOFC hotbox and coldbox
- Design and construction of final PoC prototype
- Analysis of business cases, exploitation strategy

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Based on extensive simulation work the optimal operation point has been defined
- Market analysis show great potential of technology in different applications
- Major barriers (stack costs, SOFC maturity) need to be addressed for product placement

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	FC system efficiency FC system	> 45 for power only units, > 80% for CHP units	> 45 for power only units, > 80% for CHP units	System simulation shows that >45% AC efficiency achievable, reaching >80% overall efficiency depends on heat losses and load.
MAIP 2008-2013	Lifetime for cell and stack	> 40 000 h	> 40 000 h	Results of stack components tests and field testing of SOFC unit will be used to generate lifetime forecast. A proof is not possible within the project time.
AIP 2013	Development of PoC prototype systems that combine advanced components into complete, fully integrated systems	PoC tested	5 kWel prototype built and tested	The design of 5 kW prototype has been finished. Ordering of basic components have been started. Assembling will start in September.
AIP 2013	POC projects will be expected to show successful duration of run times for whole fuel cell systems of up to several hundred hours by the end of the project.	several hundreds of hours	≥3000h	Task not started yet.



FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

TriSOFC

Durable Solid Oxide Fuel Cell Tri-Generation System for Low Carbon Buildings

AIP / APPLICATION AREA	AIP 2011 / AA 3: Stationary Power Generation & Combined Heat and Power
CALL TOPIC	SP1-JTI-FCH.2011.3.4 - Proof of concept fuel cell systems
START & END DATE	01 Aug. 2012 - 31 Jul. 2015
TOTAL BUDGET	€ 2,727,219.06
FCH JU CONTRIBUTION	€ 1,481,391.00
PANEL	Panel 3- Stationary Heat and Power Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: The University of Nottingham, UK

Partners: The Royal Institute of Technology- Sweden (KTH), The University of Birmingham-UK (UBHAM), IDMEC – Polo FEUP-Portugal (IDMEC), GETT Fuel Cells International AB-Sweden (GETT), Vestel Savunma Sanayi A.S-Turkey (VSS), Complex Ltd-Poland (COMPLEX), Swerea IVF-Sweden (IVF), INEGI -Polo FEUP, Portugal (INEGI)

PROJECT WEBSITE/URL

www.trisofc.com

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

TriSOFC aims to design, optimise and build a 1.5 kW low-cost durable LT-SOFC tri-generation prototype, based on the integration of a novel LT-SOFC stack and desiccant unit. The system will include a fuel processor to generate reformate gas when natural gas utilized and other equipment for the electrical, mechanical and control balance of plant. All components will be constituents of an entire fuel cell tri-generation prototype system to supply cooling, heat and power, which will first be tested in the lab and after further optimisation, under real-life context in the Creative Energy Homes platform built at the University of Nottingham.

PROGRESS/RESULTS TO-DATE

- Desiccant unit simulation complete
- Desiccant cooling COP 0.7-1.1
- LT-single component SOFC membranes developed with 1100mW/cm^2 achieved from single cell 6cm x 6cm and 12W power output from 2 cell stack@530°C.
- Integration of 250We microtubular SOFC tri-generation system.
- Electrical efficiency 11%, overall efficiency 48%

FUTURE STEPS

- Prove durability of LT single component membranes and stacks
- Conduct extensive field trials of LT-SOFC tri-generation system
- Commercialise individual components

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Potassium formate was found to be the most suitable desiccant for the system
- A novel combined dehumidifier/cooler/regenerator has been developed and will provide a basis for compact, light-weight and low cost tri-generation for fuel cells and other generation systems
- Single component fuel cells working at low temperatures (500-600C) will enable cost reductions in BoP and improvement in performance
- Demonstrated integration of 250We microtubular SOFC tri-generation system. Elec efficiency 11%, overall efficiency 48%.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-13	Power range	1-5kWe	200-1500We	200We
AIP 2011	efficiency	35% to 45% (elec) 75% to 85% total	Expect 40-45% elec-85-95% total	Testing of microtubular SOFC tri-generation 12% elec – 48% total.
AIP 2011	durability	30,000hrs	40,000 hours	100hours
AIP 2011	costs	2,000€/kW		Costs dependent on stack and BoP.

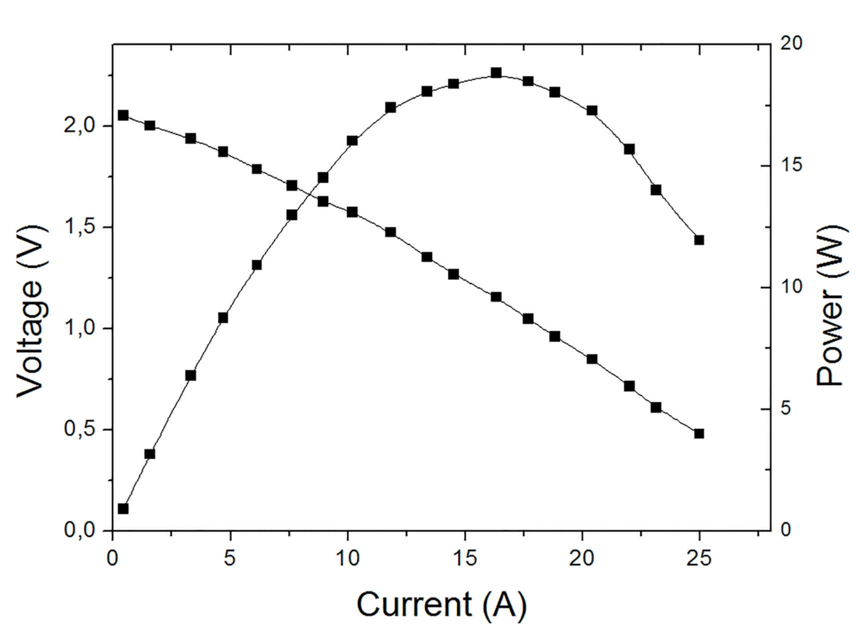

Figure 1. Variation in voltage and power output with current for 2-cell stack LT-SOFC @ 530C. Each cell is 6cm x 6cm.

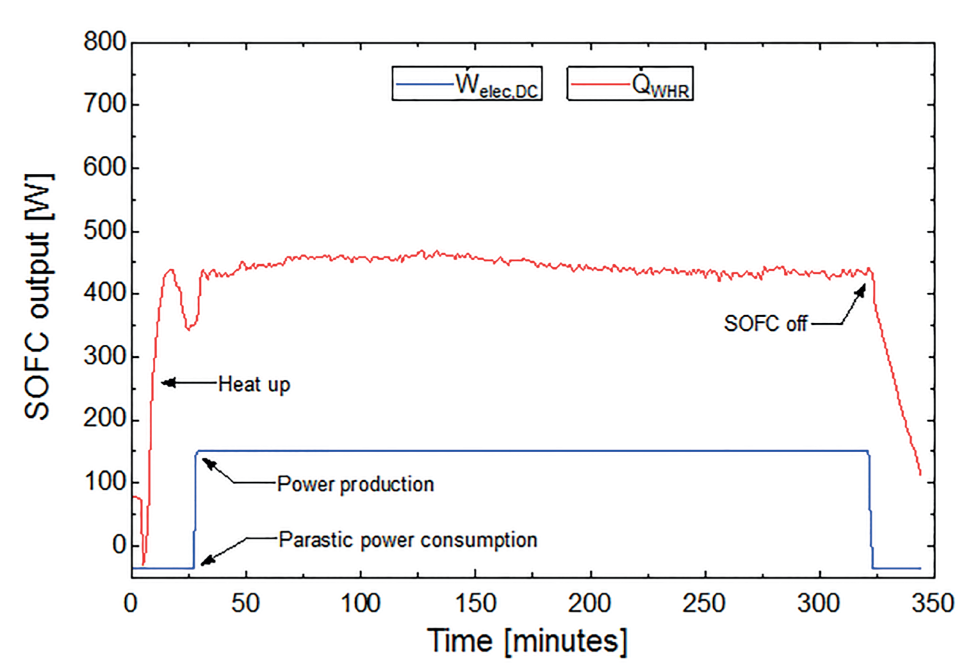

Figure 2. Electrical power and heat output from micro-SOFC tri-generation prototype.