ALKAMMONIA

Ammonia-fuelled alkaline fuel cells for remote power applications.

PANEL 3
Technology validation in stationary applications

ACRONYM	ALKAMMONIA
CALL TOPIC	SP1-JTI-FCH.2012.3.5: System level proof of concept for stationary power and CHP fuel cell systems at a representative scale
START DATE	1/05/2013
END DATE	30/04/2017
PROJECT TOTAL COST	€2,8 million
FCH JU MAXIMUM CONTRIBUTION	€1,9 million
WEBSITE	http://alkammonia.eu/

PARTNERSHIP/CONSORTIUM LIST

AFC ENERGY PLC, ACTA SPA, UNIVERSITAET DUISBURG-ESSEN, ZENTRUM FÜR BRENNSTOFFZELLEN-TECHNIK GMBH, UPS SYSTEMS PLC, PAUL SCHERRER INSTITUT, FAST – FEDERAZIONE DELLE ASSOCIAZIONI SCIENTIFICHE E TECNICHE

MAIN OBJECTIVES OF THE PROJECT

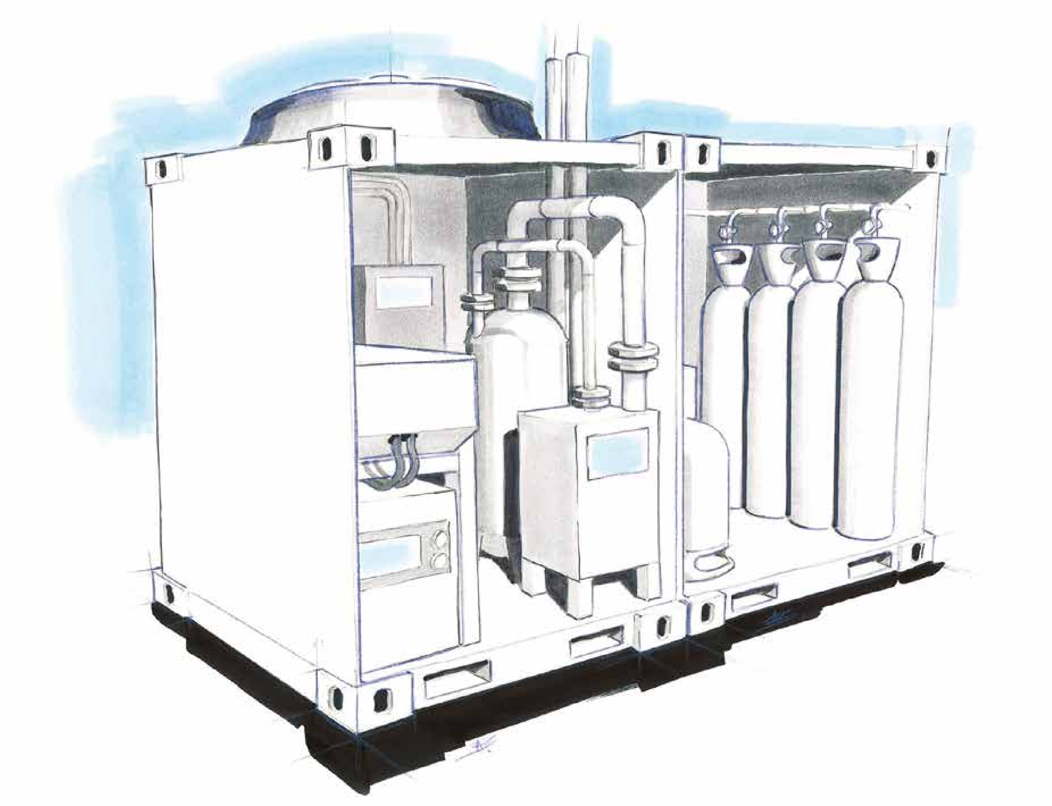
In project ALKAMMONIA a proof-of-concept system designed to provide power for telecommunication mast applications is being developed and tested. The project integrates innovative and proven technologies: an efficient alkaline fuel cell system, a novel ammonia fuel system which consists of a fuel delivery system and a cracker system for generation of high purity hydrogen. These components are being developed to produce a prototype and integrated system showing the benefits of the concept. Once integrated, the system will be tested and results shared with end-users.

PROGRESS/RESULTS TO-DATE

- A two-dimensional, non-isothermal and stationary simulation model of a complete alkaline single cell has been developed.
- A pre-prototype fuel cell system has been built.
- Development of an effective catalyst for ammonia cracking is on schedule.
- A high-level integrated system design has been completed.
- Project presented at various conferences; scientific paper published.

FUTURE STEPS

- Develop and complete fuel cell prototype.
- Develop and complete ammonia cracker prototype.
- Refine power conditioning.
- Develop next generation cartridge.
- Further work on life-cycle and economic analyses to include new data acquired from cell and cracker development.



CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Alkaline fuel cell modelling highly dependent on actual data from fuel cell and cracker.
- Fuel cell and cracker must be developed hand-in-hand.
- Life Cycle Analysis revealing valuable insight into all environmental factors to be considered.
- Fuel cell efficiency can / will be further improved with more systematic development.
- System integration into relatively small container requires smart design and arrangement of components.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES /TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAIP 2008-2013
Integration of the cracker and the alkaline fuel cell technologies into a proof-of-concept system	Multi-MW installed electrical capacity in the EU for precommercial demonstration	System designed, built and currently being tested; updated system and stack are in preparation	90 %	Project is setting state-of-the-art	
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AIP 2012
Ammonia cracker that uses a combustion process to provide the heat for the dissociation process	Novel system architectures, including new fuel processing and storage materials	Burning of "off-gas" will improve the efficiency of cracking	98 %	Project is setting state-of-the-art	
Detailed analysis of the environmental and socio-economic impacts of the proof of concept system	Assessment of the fuel cell system's ability to successfully compete with existing technologies	Additional data gathered for multi-criteria decision analysis and further cost analysis	99 %	Project is setting state-of-the-art	

AutoRE

AUTomotive deRivative Energy system

PANEL 3

Technology validation in stationary applications

ACRONYM	AutoRE
CALL TOPIC	FCH-02.5-2014: Innovative fuel cell systems at intermediate power range for distributed combined heat and power generation
START DATE	1/08/2015
END DATE	31/07/2018
PROJECT TOTAL COST	€4,4 million
FCH JU MAXIMUM CONTRIBUTION	€3,4 million
WEBSITE	http://www.autore-fch.com/

PARTNERSHIP/CONSORTIUM LIST

ALSTOM POWER LTD, GENERAL ELECTRIC (SWITZERLAND) GMBH, DAIMLER AG, ELVIO ANONYMI ETAIREIA SYSTIMATON PARAGOGIS YDROGONOU KAI ENERGEIAS, SVEUCILISTE U SPLITU, FAKULTET ELEKTROTEHNIKE, STROJARSTVA I BRODOGRADNJE, UNIVERSITA DEGLI STUDI DELLA TUSCIA, STIFTELSEN SINTEF

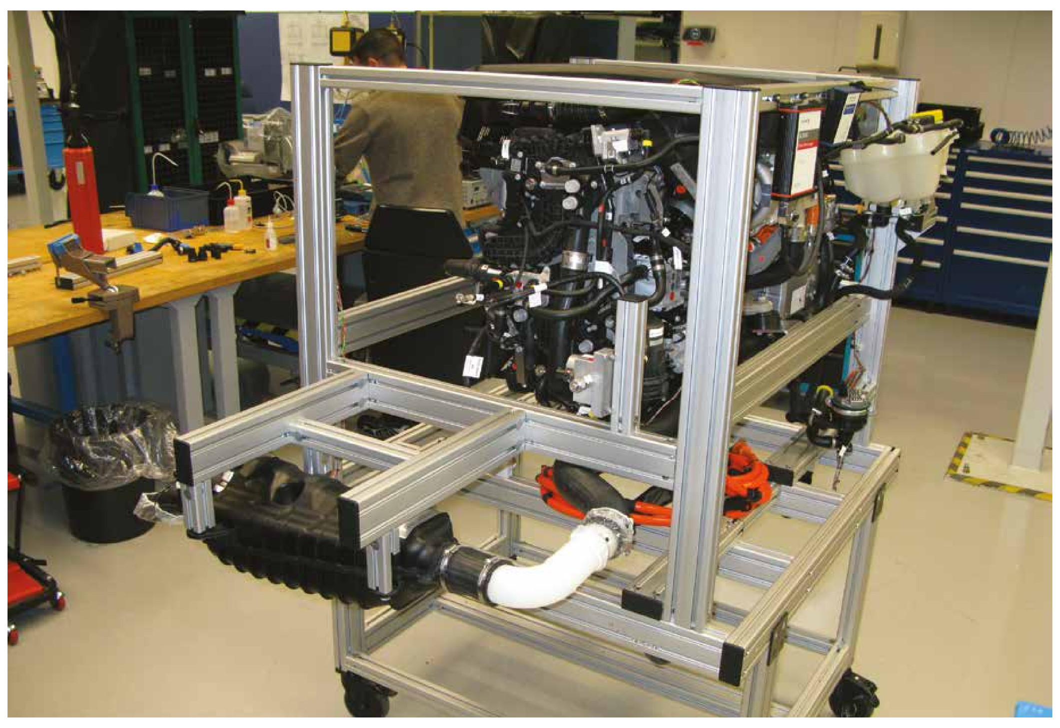
MAIN OBJECTIVES OF THE PROJECT

The main project objective is to create the foundations for commercialising an automotive derivative fuel cell system in the 50 to 100 kW_e range, for combined heat and power in commercial and industrial buildings.

1. To develop system components allowing reduced costs, increased durability and efficiency and, ultimately, allowing the levelised cost of electricity (LCOE) to reach grid parity
2. To build and validate a first 50 kW_e PEM prototype CHP system. To create the required value chain from automotive manufacturers to stationary energy end-users.

PROGRESS/RESULTS TO-DATE

- Full consortium meeting for project kick-off, first deliverable: management manual submitted and distributed to partners.
- First general assembly meeting held, website and logo created.
- System requirements determined and testing plan completed.
- Numerical performance modelling of the system completed; The PEM fuel cell stack (electrochemical), the fuel processor (thermo-chemical) & the BoP.
- Short stacks ordered and to be delivered this month.



FUTURE STEPS

- The system design will be finalised and the procurement plan made.
- Short' stacks will be adapted to operate on reformate gas and a report will document the results of these tests.
- Design and construction of the hydrogen production system including reactors, heat exchangers and steam generators.
- Validation and updating of performance model with single component and whole system test results.
- Delivery of fuel cell for integration into energy system.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Project at early stage of development, no major findings or conclusions yet.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:				MAWP 2014-2020
System CAPEX <€3,000/kW	2017: CAPEX of €5-8.5k/kW	Testing stage not reached yet.	90 %	€6-10k/kW (2012)
Stack life-time >30,000 h, 15y operation	2017: 6-20 years of plant operation	Testing stage not reached yet.	90 %	2-20y (2012)
Scheduled and preventive maintenance for reaching >98 % availability	2017: 97 % plant availability	Testing stage not reached yet.	90 %	97 % (2012)
Electrical efficiency: End of project: 40 % Long term: 47 %	2017: 41-50 % electrical efficiency (LHV)	Projected up to 40 % (from modelling).	90 %	"39 %-43 % http://panasonic.co.jp/ap/FC/en_about_01.html http://www.nrel.gov/hydrogen/highlight-stationary-fc.html
Thermal Efficiency: >43 %	2017: 24-41 % thermal efficiency (LHV)	Testing stage not reached yet.	90 %	56 % http://panasonic.co.jp/ap/FC/en_about_01.html
Grid parity at mass production	2017: LCOE of 2.5*grid parity € ct/kWh	Testing stage not reached yet.	90 %	3*grid parity
NOx<40mg/kWh	2017: NOx emissions <40 mg/kWh	Testing stage not reached yet.	90 %	NOx<40

CLEARGEN DEMO

The Integration and demonstration of Large Stationary Fuel Cell Systems for Distributed Generation

PANEL 3

Technology validation in stationary applications

ACRONYM	CLEARGEN DEMO
CALL TOPIC	SP1-JTI-FCH.2011.3.6: Field demonstration of large stationary fuel cell systems for distributed generation and other relevant commercial or industrial applications
START DATE	1/05/2012
END DATE	31/12/2019
PROJECT TOTAL COST	€8,5 million
FCH JU MAXIMUM CONTRIBUTION	€4,5 million
WEBSITE	

PARTNERSHIP/CONSORTIUM LIST

DANTHERM POWER A.S, HYDROGENE DE FRANCE, AQUIPAC SAS, JEMA ENERGY SA, CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE, LOGAN ENERGY LIMITED, LINDE GAS MAGYARORSZAG ZARTKORUEN MUKODO RESZVENYTARSASAG, BUDAPESTI MUSZAKI ES GAZDASAGTUDOMANYI EGYETEM

MAIN OBJECTIVES OF THE PROJECT

The objectives of the CLEARGen Demo project are: 1) The development and construction of a large scale fuel cell system, purpose-built for the European market; 2) The validation of the technical and economic readiness of the fuel cell system at the megawatt scale, and 3) The field demonstration and development of megawatt scale system at a European chemical production plant.

PROGRESS/RESULTS TO-DATE

- The project details are defined.
- The agreement between beneficiaries is negotiated and signed.
- The contract with Ballard Power System on supply of equipment is signed.
- Agreement with AkzoNobel on providing hydrogen and area for locating the equipment is made.
- The dialog for getting political support for a feed-in tariff for the produced electricity is initiated.

FUTURE STEPS

- Procurement of components and manufacture of a European compliant ClearGen fuel cell system.
- Prepare the host site and get the building and operation permissions.

- Design the fuel purification system.
- Installation and commissioning of the ClearGen unit with all associated components and support services.
- System operation and maintenance; system monitoring assessment.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Getting a feed in tariff for the produced electricity is taking a long time, so alternative options are being investigated.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAIP 2008-2013
Cost target	€3,000/kW	€3,000/kW	90 %	To be done	Market price is very sensitive to the volume produced. Hence, the market development will be important to the price reduction
Stack lifetime	20,000 h	To be done	98 %	To be done	Expected to be exceeded after the project end
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AIP 2011
Electrical efficiency (LHV)	>50 %	43 %	70 %	48 % in lab test	Reduction of parasitic losses is an important exercise in achieving the high system efficiency
System lifetime	20,000 h	To be done	98 %	To be done	Expected to be exceeded after the project end
(c) Other project objectives:					
Availability	95 %	80 %	95 %	To be done	Not part of MAIP and AIP

D2Service

Design of 2 technologies and applications to service

PANEL 3

Technology validation in stationary applications

ACRONYM	D2Service
CALL TOPIC	FCH-02.9-2014: Significant improvement of installation and service for fuel cell systems by Design-to-Service
START DATE	1/09/2015
END DATE	31/08/2018
PROJECT TOTAL COST	€3,6 million
FCH JU MAXIMUM CONTRIBUTION	€2,9 million
WEBSITE	www.project-D2Service.eu

PARTNERSHIP/CONSORTIUM LIST

EWE-Forschungszentrum für Energietechnologie e. V., SOLIDPOWER SPA, DANTHERM POWER A/S, ZENTRUM FUR BRENNSTOFFZELLEN-TECHNIK GMBH, BOSAL EMISSION CONTROL SYSTEMS NV, BRITISH GAS TRADING LIMITED, ENERGY PARTNERS SRL

MAIN OBJECTIVES OF THE PROJECT

The main objective of the project D2Service is to noticeably reduce costs and labour for repair work (maintenance), thereby increasing the distribution of energy-efficient fuel-cell-based technology

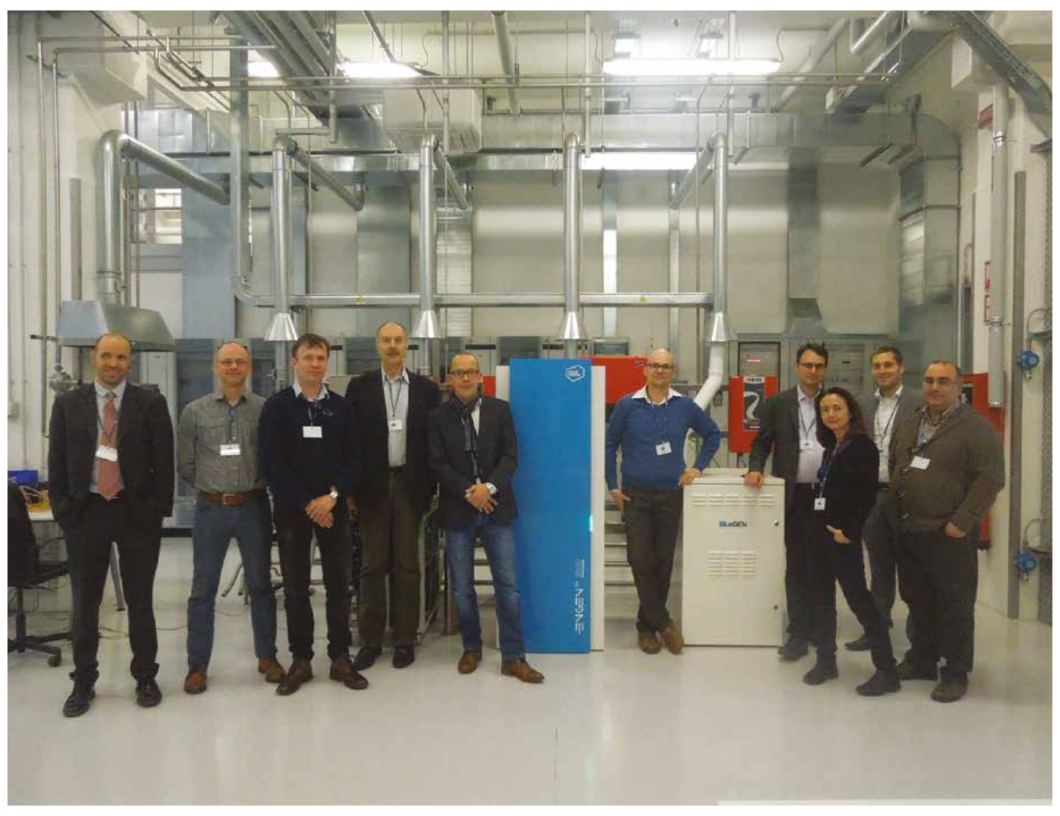
The main objective of the project D2Service is to noticeably reduce costs and labour for maintenance and repair for energy-efficient fuel-cell-based CHP units in Europe. This will be achieved be simplifying & standardising the construction of 2 CHP systems (PEM and SOFC) available on the market, so that important components are easy to exchange. In addition the project will develop graphical service manuals that explain the maintenance process to non-specialist installers.

PROGRESS/RESULTS TO-DATE

- Installation of SOFC & PEMFC units @NEXT ENERGY for analysing & evaluating failure modes, efficiencies & installation requirements.
- Prep. of lessons learned questionnaire on service issues e.g. shutdowns, downtime, failure modes & service characteristics.
- Develop a system model of the Dantherm Power µCHP to predict the amt of reactant consumed & define service intervals.
- Developing a model of the Dantherm unit, incl. mounting methods & risk assessments for service through the front.
- Set up of the D2Service website including description of the objectives, companies and related projects.

FUTURE STEPS

- Evaluation of both CHP system with regard to performance testing and annual efficiency.
- Identification of HydroDeSulphurization-material and operation parameter for life time desulphurization.



- Improving the design of hot components of the SOFC unit for critical component on-site replacement.
- Condensing the lessons learned information to a public report.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Lessons learned related to service issues e.g. downtime, shutdowns, failure modes & service characteristics.
- Solving of installation issues & experiences of both units related to grid gas composition, installation requirements on Eur. sites.
- Agreement of operation mode of the CHP systems based on specific state regulations/requirements.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAWP 2014-2020
Extend components lifetime (stack, reformer, water clean-up, desulphurization, filter)	Durability of components in fuel cell units	Still ongoing	100 %	Raw materials available on the market. Tech. design for novel 2,5 Kwel system is based on performance data. No commercial systems available.	Process ongoing: analysis of desulphurization material incl. gas composition of various sites +design adaptation to requirements (increase of surface area, lower flow velocity).
Identification of ion exchange resins + design of optimised water cartridge					AWP 2014
Ease and clear construction for fault-free exchange of components without dismantling	Reduce on-site tech. intervention time & equipment total down-time for servicing	Risk assessment finalised & submitted to FCH-JU Construction changes still ongoing	100 %	Quick connectors for tubes available; for key components like reformer, stack etc.: to be developed	Optimization of the construction still ongoing. Quick connectors to be included in the new Dantherm unit. Risk assessment performed.
Adaptation/harmonization of overall setup and components with same service lifetime for increasing the service interval time.	Increase the service interval time	Implementation of FIX and/or FLEXIBLE interval times - still ongoing	100 %	Fix & FLEXIBLE service interval time is SoA in many industries e.g. cars or household heating systems Product-specific service strategies to be developed.	Still analysing different components and materials including gas compositions in Europe. Components harmonization to same/longer interval time leads to cost reduction, but designs have to be adjusted.
Development of a graphical service manual for easy and cheap service & maintenance, foolproof installation	Simplify service operation so that normally trained installers/ technicians can accomplish task using "service manual"	To be started shortly	100 %	Manuals available for many commercial CHP systems.	The process will start in few weeks/month
Reduce service costs by reducing service downtime and enhance lifetime of components	Reduce the service cost	All mentioned objectives 1-4 results	100 %		Development of useful intervals incl. specific procedures during the service, easy maintenance and reduction of time by unification of service aspects and components, remote diagnosis

DEMCOPEM-2MW

Demonstration of a combined heat and power 2 MW_e PEM fuel cell generator and integration into an existing chlorine production plant

PANEL 3
Technology validation in stationary applications

ACRONYM	DEMCOPEM-2MW
CALL TOPIC	SP1-JTI-FCH.2013.3.5: Field demonstration of large scale stationary power and CHP fuel cell systems
START DATE	1/01/2015
END DATE	31/12/2018
PROJECT TOTAL COST	€10,5 million
FCH JU MAXIMUM CONTRIBUTION	€5,4 million
WEBSITE	http://www.demcopem-2mw.eu

PARTNERSHIP/CONSORTIUM LIST

Akzo Nobel Industrial Chemicals B.V., NEDSTACK FUEL CELL TECHNOLOGY BV, MTSA TECHNOPOWER BV, JOHNSON MATTHEY FUEL CELLS LIMITED, POLITECNICO DI MILANO

MAIN OBJECTIVES OF THE PROJECT

The main objective of the four years DEMCOPEM-2MW project is to design, build and operate a 2 MW power generator, with the following attributes: Full integration of heat and power – High net conversion efficiency – Long lifetime of system and fuel cells – Fully automated way of operation and remote control – Economical design to reach a competitive price – Contribute to the general goals of the Joint Technology Initiative (JTI) FCH, as stated in the revised Multi Annual Implementation Plan.

PROGRESS/RESULTS TO-DATE

- Complete design of the 2 MW plant according to the project targets of high conversion efficiency and CHP integration.
- Successful design and manufacturing of PEM fuel cell MEA and stacks for the 2 MW plant.
- Building of the plant with all electric, hydraulic and gas circuits, auxiliaries and control system.
- Successful factory acceptance test of the 2 MW plant at MTSA, plant disassembly and shipping to China.
- Complete modelling and preliminary simulations of the 2 MW plant confirming the project efficiency targets.

FUTURE STEPS

- Plant installation at final site (Ynnovate Chlor-Alkali plant – China).
- Plant startup and testing.
- Plant operation and remote monitoring, data acquisition, long-term performance analysis.
- Measurements collection and calibration of plant simulations.
- Supply of improved MEA's and stacks for field testing.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Demonstration of a multi-MW PEM plant in a fully industrial environment.
- Demonstration of enhanced fuel cell lifetime (>16,000 h) and durability according to FCH-JU targets.
- Demonstration of 2 MW PEM plant high conversion efficiency and CHP potential, waste hydrogen use and energy integration with the production process.
- Demonstration of improvements in plant design to achieve perspective economic targets.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAIP 2008-2013
2 MW and potential for 20 more similar sized PEM power plants	2015 target: >5 MW / €3,000/kW	1 MW	100 %	1 MW	Proceeding according to plan
<€2,500/kW	2015 target: €3,000/kW		100 %		
Commercial Introduction in 2017 and stepwise cost reductions to reach <€1,500/kW	2020 target: >50 MW / €1,500/kW	System not yet operative	100 %		
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AWP 2014
100 kW with on-stream	100 kW with on-stream	System not yet operative			Proceeding according to plan
On stream availability >95 %	Availability of 95 % or higher	System not yet operative			Proceeding according to plan
16,000 h up to 40,000 h (for fuel cell stacks) on the long term	Minimum of 16,000 h	System not yet operative			Proceeding according to plan
(c) Other project objectives:					
Full integration of heat and power with existing chlorine production plant	Not applicable	On track for power (heat recovery possibility is ready)	50 %	On track for power (heat recovery possibility is ready)	
High net conversion efficiency (>50 % electric energy on system level)	Not applicable				
Fully automated way of operation and remote control	Not applicable	On track	100 %	On track	Proceeding according to plan

DEMOSOFC

Demonstration of large SOFC system fed with biogas from WWTP

PANEL 3

Technology validation in stationary applications

ACRONYM	DEMOSOFC
CALL TOPIC	FCH-02.11-2014: Large scale fuel cell power plant demonstration in industrial/commercial market segments
START DATE	1/09/2015
END DATE	31/08/2020
PROJECT TOTAL COST	€5,9 million
FCH JU MAXIMUM CONTRIBUTION	€4,4 million
WEBSITE	www.demosofc.eu

PARTNERSHIP/CONSORTIUM LIST

POLITECNICO DI TORINO, CONVION OY, Società Metropolitana Acque Torino S.p.A., Teknologian tutkimuskeskus VTT Oy, IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE

MAIN OBJECTIVES OF THE PROJECT

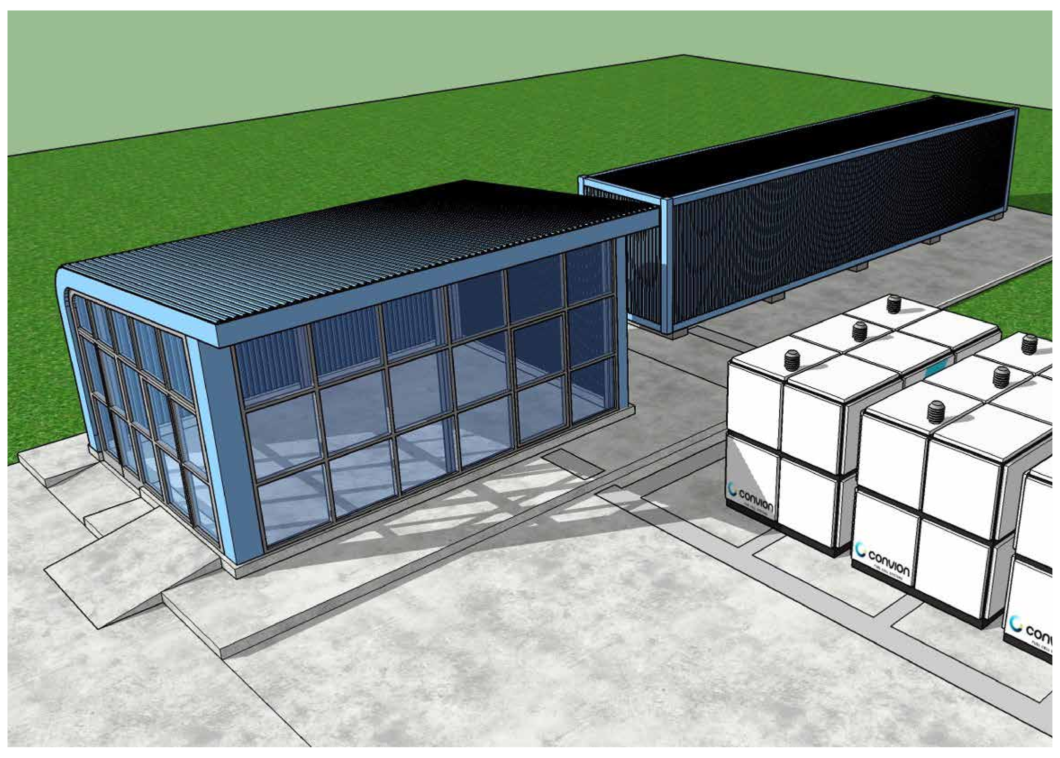
DEMO and analysis of a solution of distributed CHP based on SOFC, in the industrial/commercial application, the best solution in the sub-MW distributed CHP in terms of efficiency and emissions.
DEMO of a distributed CHP system fed by a biogenous CO_2 neutral fuel: biogas.
DEMO in a real industrial installation.
DEMO of the achievements: electrical efficiency, thermal recovery, low emissions, plant integration, economic interest.
EXPLOITATION and BUSINESS analysis of replication of this type of innovative energy systems.
DISSEMINATION of the interest (energy and economic) of such systems.

PROGRESS/RESULTS TO-DATE

- Energy planning and Optimization of the DEMO.
- Detailed engineering of the DEMO.
- Site preparation for the installation of the DEMO: under development, conclusion foreseen at M13 (September 2016).
- Cost/benefit analysis of the system.
- Dissemination of the results;§: workshops, conferences, social media, press releases.

FUTURE STEPS

- Installation of the SOFC system in the DEMO: foreseen in M14 (October 2016) and M15 (November 2016); last SOFC module foreseen in M19 (March 2017).
- Connection of the SOFC system to the DEMO (fuel supply, electrical connection, thermal recovery): foreseen in M14-M15 (October – November 2016).
- Development of the control system of the complete DEMO (electrical and thermal sections): completion in M14 (October 2016).
- Start-up of the complete DEMO (October-November 2016).
- Update of the cost/benefit analysis of this kind of systems (SOFC CHP distributed systems fed by biogas from different biological sources).



CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Main finding so far: detailed engineering of the complete DEMO (structure, electrical, thermal, clean-up section).
- Demonstrate the high efficiency of SOFC-based CHP systems fed by biogas.
- DEMO of an industrial size FC system fed by biogas, completely integrated in a real industrial process.
- Reduction of the CAPEX of SOFC systems to less than €7,000/kW thanks to higher volume of production.
- Strong dissemination for public awareness.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAWP 2014-2020
DEMO of a SOFC-based distributed CHP system fed by a biogenous CO_2-neutral fuel	Boost the share of FCH technologies in a sustainable, low-carbon energy system	Under construction	100 %	No industrial size SOFC-based systems in EU	The installation is evolving according to the expressed schedule
Build technical knowledge, customer confidence, about the introduction of SOFC technology	To ensure a world leading, competitive European FCH industry	Under construction	80 %	CAPEX €6,000-1,000/kW	Foresaw the installation of 1 module (out of 3) based on a new generation stack
Demonstrate the high efficiency of SOFC-based CHP systems fed by biogas	Increase electrical efficiency and durability of FC systems	Under construction	100 %	50 %	We foresee an electrical efficiency ~53%, and an overall efficiency ~80-90%
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AWP 2014
Reduce CO_2 emission and other contaminants compared to competing technologies	Meaningfully reduce harmful emissions.	Under construction	100 %	422 gCO_2/kWhe in case of NG fuel	The CO_2 emissions will be neutral (biogas fuel) but also significantly lower compared to an ICE (reduction of 27%).
DEMO of an industrial size FC system fed by biogas, integrated in a industrial process	(a) 50 kW up to several MW capacity; (b)Integration of a FC power plant in industrial processes	Under construction a plant of 174 kW_e (+ 89 kWth) fed by biogas from WWTP	100 %	No industrial size SOFC-based systems in EU	Installation on-going, to be completed by November 2016 (last SOFC module in March 2017).
Reduction of CAPEX <€7,000/kW thanks to higher volume of production	CAPEX <€7,000/kW (systems <1 MW)	Under construction	80 %	CAPEX €6,000-1,000/k	Foresaw the installation of 1 module (out of 3) based on a new generation stack
(c) Other project objectives:					
Strong dissemination for public awareness	Not applicable	Dissemination plan already produced	100 %	Not applicable	Press release, social media and website. Next actions on workshops and seminars.

ENE.FIELD

European-wide field trials for residential fuel cell micro-CHP

PANEL 3
Technology validation in stationary applications

ACRONYM	ENE.FIELD
CALL TOPIC	SP1-JTI-FCH.2011.3.7: Field demonstration of small stationary fuel cell systems for residential and commercial applications
START DATE	1/09/2012
END DATE	31/08/2017
PROJECT TOTAL COST	€52,4 million
FCH JU MAXIMUM CONTRIBUTION	€25,9 million
WEBSITE	http://enefield.eu/

PARTNERSHIP/CONSORTIUM LIST

THE EUROPEAN ASSOCIATION FOR THE PROMOTION OF COGENERATION VZW, BAXI INNOTECH GMBH, BOSCH THERMOTECHNIK GMBH, DANTHERM POWER A.S, ELCORE GMBH, Riesaer Brennstoffzellentechnik GmbH, SOLIDPOWER SPA, VAILLANT GMBH, DOLOMITI ENERGIA SPA, BRITISH GAS TRADING LIMITED, ELEMENT ENERGY LIMITED, ENGIE, ITHO DAALDEROP GROUP BV, HYDROGEN, FUEL CELLS AND ELECTRO-MOBILITY IN EUROPEAN REGIONS, IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE, RAZVOJNI CENTER ZA VODIKOVE TEHNOLOGIJE, PARCO SCIENTIFICO E TECNOLOGICO PER L'AMBIENTE – ENVIRONMENT PARK SPA, POLITECNICO DI TORINO, DBI – GASTECHNOLOGISCHES INSTITUT GMBH FREIBERG, THE ENERGY SAVING TRUST LTD BY GUARANTEE, GASWARME-INSTITUT ESSEN EV, DANMARKS TEKNISKE UNIVERSITET, EIFER EUROPAISCHES INSTITUT FUR ENERGIEFORSCHUNG EDF-KIT EWIV, DONG ENERGY WIND POWER HOLDING AS, HEXIS AG, DONG ENERGY OIL & GAS AS, SENERTEC KRAFT-WARME ÉNERGIESYSTEME GMBH, VIESSMANN WERKE GMBH & CO KG, CERES POWER LIMITED

MAIN OBJECTIVES OF THE PROJECT

The ene.field project will deploy and monitor 867 new installations of residential fuel cell CHP across 11 key European countries. It represents a step change in the volume of fuel cell deployment for this sector in each country. By learning the practical implications of installing, operating and supporting a fleet of fuel cells with real world customers, ene.field will demonstrate the environmental and economic imperative of micro FC-CHP, and lay the foundations for market exploitation.

PROGRESS/RESULTS TO-DATE

- 507 out of 867 units have been installed/delivered, 670 contracts signed.
- 69 units with detailed monitoring.
- Non-economic barriers: preliminary report has been prepared and presented at the Hannover Fair 2016.
- 16 press releases and 7 newsflashes published.
- European Supply Chain Analysis Report completed.

FUTURE STEPS

- All 867 units to be installed by the end of 2016.
- Non-economic barriers: final report to be published by the end of 2016.

- Report on technical performance of all mCHP units in the trial.
- National dissemination workshops.
- Report on economics of micro-CHP to 2030 and uptake scenarios.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- FC micro-CHPs are capable of and ready for smart grid integration.
- Financial support for FC mCHP have a determining impact on the geographic localisation of systems in Europe.
- FC mCHP are already competitive with regards to OPEX and GHG emissions compared to other heating technologies, but CAPEX needs to be reduced.
- A lack of common standards across Europan countries poses a large barrier for market uptake.
- Development of recommendations for the way in which FC mCHP can play a role in Europe's energy mix.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:			MAIP 2008-2013
867 units by Q4 2016	Target 2015 – 1,000 units / €10,000 per system (1 kW_e + household heat)	507 units installed/delivered	98 %
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:			AIP 2011
39-174 identical units from each manufacturer will be installed across a number of different sites	Install sufficient numbers of systems to give confidence by redundancy	Between 6 and 150 identical units from each manufacturer will be installed.	100 %
9 FC CHP products trialed in up to 1,000 demo sites. Monitoring for up to 2 year period	Increase the operational experience (including installation and maintenance)	10 FC CHP products trialled in >500 demo sites. Installations and monitoring ongoing	100 %
Optimised series production techniques will be developed	Provide proof of a suitable supply chain and increase capability	Consolidation of the sector has strengthened the position of key suppliers	100 %
The systems will be installed in customer homes, as a permanent replacement	Show commitment to running the systems after the end of the support phase	All manufacturers continue to install with the intention of life for the product	100 %
A full life cycle cost (LCC) and life cycle environmental assessment (LCA) will be delivered	Estimate full life cycle costs, carry out an environmental sustainability assessment	A first draft of the LCA has been done. First draft of LCC expected 6th of June	100 %
A Utility Working group will provide position papers on micro-CHP in future grid systems	Understand the benefits and risks of smart grid integration	A position paper on smart grid capabilities of FC micro-CHPs has been delivered	100 %

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

FCPOWEREDRBS

Demonstration project for power supply to telecom stations through FC technology

PANEL 3

Technology validation in stationary applications

ACRONYM	FCPOWEREDRBS
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	1/01/2012
END DATE	31/12/2015
PROJECT TOTAL COST	€10,5 million
FCH JU MAXIMUM CONTRIBUTION	€4,2 million
WEBSITE	www.fcpoweredrbs.eu

PARTNERSHIP/CONSORTIUM LIST

ERICSSON TELECOMUNICAZIONI, DANTHERM POWER A.S, GREENHYDROGEN DK APS, MES SA, JRC -JOINT RESEARCH CENTRE- EUROPEAN COMMISSION, UNIVERSITA DEGLI STUDI DI ROMA TOR VERGATA, FUNDACION TECNALIA RESEARCH & INNOVATION, TECHNISCHE UNIVERSITEIT EINDHOVEN, COMMISSARIAT À L'ÉNERGIE ATOMIQUE ET AUX ÉNERGIES ALTERNATIVES, POLITECNICO DI MILANO, STIFTELSEN SINTEF, ICI CALDAIE SPA, HyGear B.V., SOPRANO INDUSTRY, HYBRID CATALYSIS BV, Quantis Sàrl, JRC -JOINT RESEARCH CENTRE- EUROPEAN COMMISSION, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE,L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE, Processi Innovativi SRL, ACKTAR LTD., TECHNION – ISRAEL INSTITUTE OF TECHNOLOGY., FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V, UNIVERSITA DEGLI STUDI DI SALERNO, CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS, ARISTOTELIO PANEPISTIMIO THESSALONIKIS, UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA, STICHTING ENERGIEONDERZOEK CENTRUM NEDERLAND, GKN SINTER METALS ENGINEERING GMBH, UNIVERSITA CAMPUS BIO MEDICO DI ROMA, CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS

MAIN OBJECTIVES OF THE PROJECT

Scope of the project is to demonstrate the advantages of a stationary application combining renewable energy and Fuel Cell in term of total cost of ownership (TCO), comparing to the solutions used today in Telecommunication off-grid Radio Base Station (Diesel Gen Set). Assess the market readiness of the Fuel Cell technology vs the TLC reliability demanding targets integrating the solution into real live operation.

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 successfully implemented.
- H_2 supply solution and safety procedures implemented.
- Real Radio sites powered successfully for months.

FUTURE STEPS

- The project is finished.
- Commercial proposition of other Fuel Cell based application for telecommunication (TLC) market.
- System scalability.
- Dissemination in TLC industry.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The project results gave an immediate picture with respect to the market readiness of the proposed solution.
- The TCO calculated is in line with expectations and of a proper market proposition may be already available for TLC off-grid sites.
- 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

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:				MAIP 2008-2013
Number of units 15 radio sites+ 2 Lab sites	Early Market application area 1-6 kW back-up power system Volume in the EU 2015: 8,000 units (1,000 electr)	Up & Running: 13 + 2 Lab sites		
Durability 10,000 h	AA4 Early Market – 1-6 kW back-up power system Durability 2015: 10,000 h	>12,000 h for the first deployed site		
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:				AIP 2010
Increasing the hours of unattended operation due to the higher efficiency	Demonstrate the advantages of hydrogen and fuel cells compared to the solutions used today	Av. # yearly refuelling at site: 21 with FC Methanol 28 with FC H_2 35 with today Diesel	100 %	
TCO analysis with real business case approach	Show the commercial operator value proposition	TCO analysis performed based on measurements from field trial	100 %	
(c) Other project objectives:				
Demonstrate a viable hydrogen supply solution for this application	Not applicable	The hydrogen logistic for refuelling of H_2 and Methanol is in place. The processes have been agreed and implemented with supplier.	98 %	Some improvements in viability could be done in order to guarantee a safe increasing of volumes in the future.

INNO-SOFC

Development of innovative 50 kW SOFC system and related value chain

PANEL 3
Technology validation in stationary applications

ACRONYM	INNO-SOFC
CALL TOPIC	FCH-02.5-2014: Innovative fuel cell systems at intermediate power range for distributed combined heat and power generation
START DATE	1/09/2015
END DATE	28/02/2018
PROJECT TOTAL COST	€3,9 million
FCH JU MAXIMUM CONTRIBUTION	€3,9 million
WEBSITE	http://www.innosofc.eu/

PARTNERSHIP/CONSORTIUM LIST

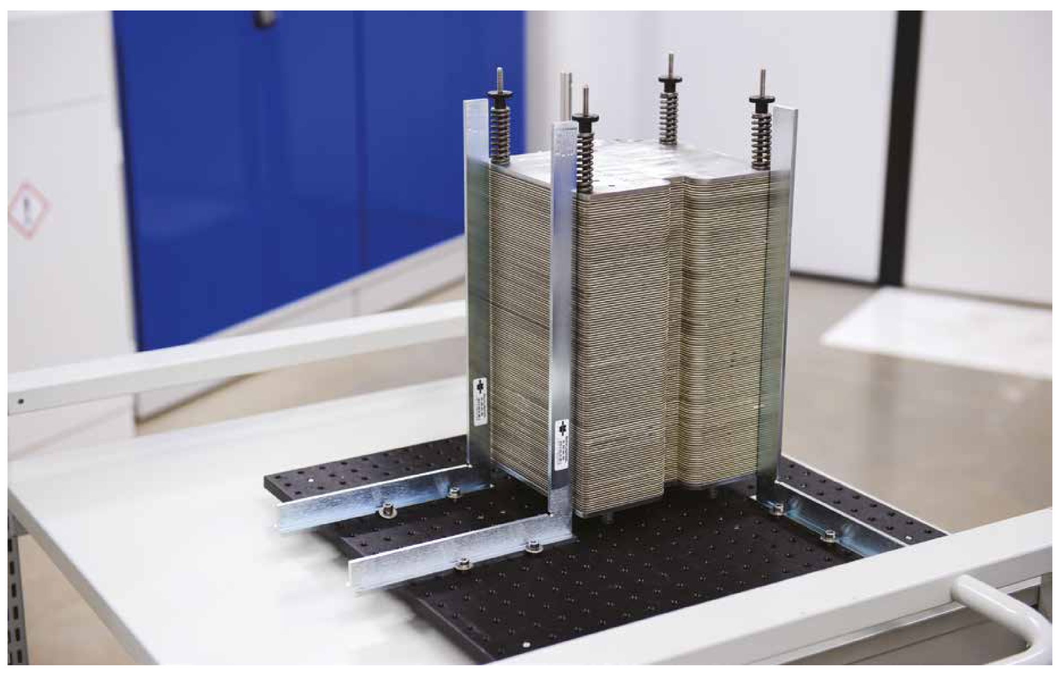
Teknologian tutkimuskeskus VTT Oy, ELCOGEN OY, CONVION OY, ELRINGKLINGER AG, FORSCHUNGSZENTRUM JULICH GMBH, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE, ENERGY MATTERS BV, AIR PRODUCTS GMBH, ELEMENT ENERGY LIMITED, ABENGOA HIDROGENO SA, ABERDEEN CITY COUNCIL*, AIR PRODUCTS PLC, AKERSHUS FYLKESKOMMUNE, BIRMINGHAM CITY COUNCIL, Vlaamse Vervoersmaatschappij De Lijn, EMPRESA MUNICIPAL DE TRANSPORTES DE MADRID SA, EVOBUS GMBH, H2 Logic A/S, HAMBURGER HOCHBAHN AG, HYDROGENICS GMBH, HYOP AS, INGENIEURTEAM BERGMEISTER SRL, ISTITUTO PER INNOVAZIONI TECNOLOGICHE BOLZANO SCARL, ITM POWER (TRADING) LIMITED, KUNNSKAPSBYEN LILLESTROM FORENING, LINDE AG, LONDON BUS SERVICES LIMITED, McPhy Energy Deutschland GmbH, THINKSTEP AG, RIGAS SATIKSME SIA

MAIN OBJECTIVES OF THE PROJECT

INNO-SOFC project aims to design and manufacture a State of the Art 50 kW solid oxide fuel cell (SOFC) system with 60 % electrical and 85 % total efficiency. The planned system and component lifetime is 3,0000 h with two-years of continuous operation without planned shut downs. System costs will be below €4,000/kW. Secondary objectives include the identification and analysis of most promising end-users and applications for stationary SOFC systems.

PROGRESS/RESULTS TO-DATE

- Interfaces with multi-stack and system manufacturers defined and optimized with computational fluid dynamic (CFD) and FEM calculations.
- System cost reduction by implementing advanced model based estimators to replace physical instrumentation.
- Analysis for most feasible end-user applications made.



FUTURE STEPS

- Manufacturing cost and quality optimization of interconnect plates.
- Stack conditioning process development, performance and lifetime tests.
- System control and diagnostics development.
- Full system demonstration an validation.
- Techno-economic analysis of SOFC systems.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Open cathode by-pass leakage reduced by 60 % with new sealing structure around multi-stack system.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:				MAWP 2014-2020
Total system cost of less than €4,000/kW	Techno-economic objective 2; increase electrical efficiency and the durability while reducing costs	Progressing as planned	75 %	€6,000 -10,000/kW in MAWP
(b) Other project objectives:				
Reduction of fuel cell stack cost to less than €2,000/kW	Not applicable	Progressing as planned	95 %	
System and components enabling life-time of 30,000 hours	Not applicable	Validation of stack lifetime in real system environment starting later	82 %	

ONSITE

Operation of a novel SOFC-battery integrated hybrid for telecommunication energy systems

PANEL 3

Technology validation in stationary applications

ACRONYM	ONSITE
CALL TOPIC	SP1-JTI-FCH.2012.3.4: Component and sub-system cost and reliability improvement for critical path items in stationary power and CHP fuel cell systems & SP1-JTI-FCH.2012.3.5: System level proof of concept for stationary power and CHP fuel cell systems at a representative scale
START DATE	1/07/2013
END DATE	31/03/2017
PROJECT TOTAL COST	€5,5 million
FCH JU MAXIMUM CONTRIBUTION	€3 million
WEBSITE	http://www.onsite-project.eu/

PARTNERSHIP/CONSORTIUM LIST

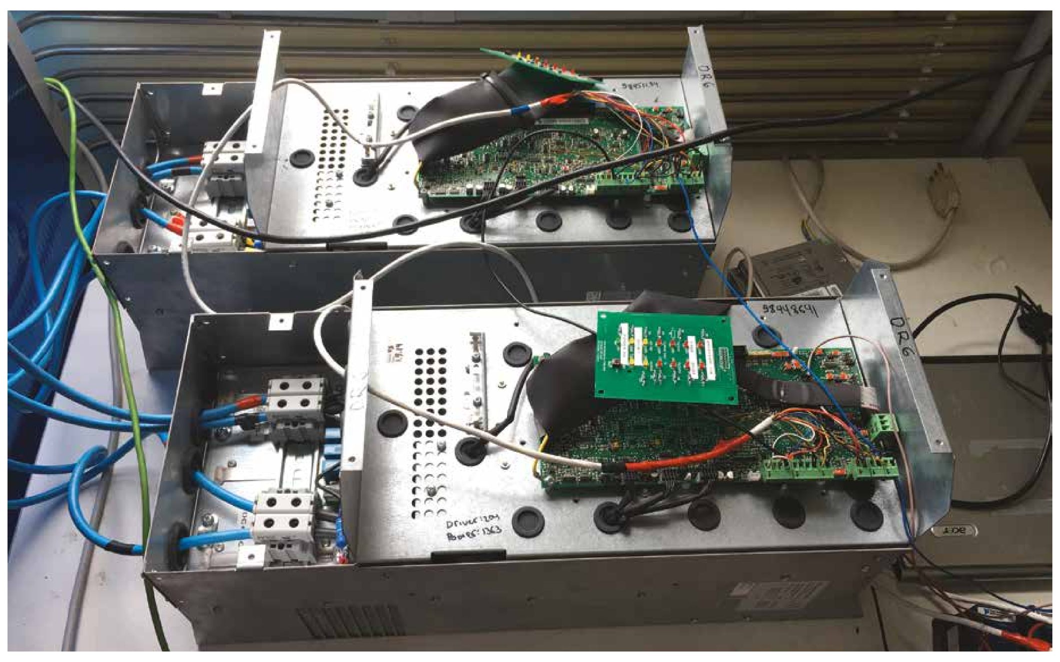
CONSIGLIO NAZIONALE DELLE RICERCHE, ERDLE ERICH KONRAD, ERICSSON TELECOMUNICAZIONI, FIAMM ENERGY STORAGE SOLUTIONS SRL, HTceramix SA, BONFIGLIOLI VECTRON GMBH, INSTYTUT ENERGETYKI, HAUTE ÉCOLE SPÉCIALISÉE DE SUISSE OCCIDENTALE, CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE, STIFTELSEN SINTEF, DANMARKS TEKNISKE UNIVERSITET, COMMISSARIAT À L'ÉNERGIE ATOMIQUE ET AUX ÉNERGIES ALTERNATIVES, MXPOLYMERS BV, BASIC MEMBRANES BV, L'AIR LIQUIDE S.A

MAIN OBJECTIVES OF THE PROJECT

The overall objective of ONSITE is the construction and operation of a containerized system, based on SOFC/NaNiCl battery hybridisation, that generates more than 20 kW at high efficiency and economically competitive costs.
The demonstration of the system shall take place on a real site of an existing telecom station. Starting from SOFC previous research results, commercially available power electronics and NaNiCl batteries will improve next generation SOFC systems and adapt them to the requirements for telecom stations and datacentres.

PROGRESS/RESULTS TO-DATE

- 2.5 kW SOFC subsystem realised and tested: 40 % electrical efficiency at 230 Vac, fed with natural gas.
- 5 kW SOFC / Battery hybrid system realised and tested in laboratory: 2.5 kW SOFC, 2.5 kW battery, telecom load at 48Vdc, grid connection 230 Vac.
- Final design of the sheltered 5 kW SOFC / Battery hybrid system.
- Final design of the 10 kW SOFC / Battery prototype.
- Site (Radio Base Station) for demonstration of the sheltered SOFC/Battery hybrid system selected.



FUTURE STEPS

- Site arrangement (Radio Base Station) for demonstration of the sheltered SOFC/Battery hybrid system.
- Realisation and test in laboratory of the sheltered 5 kW SOFC / Battery hybrid system.
- Demonstration at real site (Radio Base Station): at least 1,000 hours.
- Realisation and test in laboratory of the 10 kW SOFC / Battery hybrid system (including an adsorption heat pump).
- Project workshop.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Tests showed natural gas fed SOFC generator electrical efficiency = 40 %.
- Hybridization (SOFC + sodium nickel chloride batteries) allows final system costs reduction (in terms of €/kW).
- The final system should enable Telecom energy station integration in the future Smart Grids / Smart Buildings scenarios.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:				MAWP 2008-2013
FC system efficiency (%)	55 %+ (elec); 85 %+ (total)	40 % (elec); 85 % (total)	100 %	52-60 % of electrical efficiency (SOFC for on-grid Telecom/datacentre applications (Bloom energy – USA)
FC system cost (€)	€4,000/kW	N/A (cost evaluation not finalized yet)	100 %	
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:				AIP 2012
Development of Proof-of-concept prototype systems	Development of Proof-of-concept combining advanced components into complete, fully integrated system	5 kW SOFC / Battery hybrid system realised and tested in laboratory	100 %	SOFC generator for telecom and datacentres: 250 kW @ 480 V ac 60 Hz (Bloom energy – USA)
Final application and market assessment	Assessment of the fuel cell system's ability to compete with existing technologies	Demonstration of the prototype at a real site. A final Market evaluation is expected.	100 %	
(c) Other project objectives				
Prototype ability to exchange power with the grid	Not applicable	The developed bidirectional converters (DC/DC and DC/AC) enable the prototype power exchanging with the grid	100 %	
Prototype capable to operate in islanding mode	Not applicable	The developed bidirectional converters (DC/DC and DC/AC) enable the prototype islanding mode (increasing the supply availability)	100 %	

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

PEMBEYOND

PEMFC system and low-grade bioethanol processor unit development for back-up and off-grid power applications

PANEL 3
Technology validation in stationary applications

ACRONYM	PEMBEYOND
CALL TOPIC	SP1-JTI-FCH.2013.4.4: Development of 1-30kW fuel cell systems and hydrogen supply for early market applications
START DATE	1/05/2014
END DATE	31/10/2017
PROJECT TOTAL COST	€4,5 million
FCH JU MAXIMUM CONTRIBUTION	€2,3 million
WEBSITE	http://pembeyond.eu/

PARTNERSHIP/CONSORTIUM LIST

Teknologian tutkimuskeskus VTT Oy, Powercell Sweden AB, GENPORT SRL – SPIN OFF DEL POLITECNICO DI MILANO, FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V, UNIVERSIDADE DO PORTO, GREATER LONDON AUTHORITY

MAIN OBJECTIVES OF THE PROJECT

PEMBeyond project aims to develop a bioethanol fuelled integrated PEMFC based power system for back-up and off-grid applications. Main targets include: – Using crude (80-95 %) 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 h system lifetime) Extensive techno-economic and life-cycle analyses are performed to ensure the concept attractiveness, further leading a roadmap to volume production.

PROGRESS/RESULTS TO-DATE

- Complete system specifications and hydrogen quality specifications defined.
- Reformate PEMFC stack design ready and stack supply started. Stack CO tolerance and cold start capability evaluated.
- Market Analysis for Telecom back-up systems completed, data collection for techno-economic and life-cycle analysis started.
- Fuel processor, Pressure Swing Adsorption (PSA) unit & FC system development/design completed. Subsystem assembly on-going.
- Complete system container acquired, transported to test site and installed with automation and control system.

FUTURE STEPS

- Functional testing of the subsystems: FP, PSA and FCS.
- Complete system integration, testing and field-trial.
- Development of ejector control system and evaluation in FCS scale.
- Completion of the techno-economic and life-cycle analyses.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- High interest from potential end-users. According to Market Analysis 60 % of telecom backup market can be served by system.
- Both local and EU level regulation affect significantly the telecom back-up market and the system requirements.
- Reformate PEMFC stack developed in the project capable of unassisted start-up from -25 °C.
- Very attractive non-noble metal based low-temperature water gas shift (LT-WGS) catalyst developed.
- No major technical obstacles foreseen at this point.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAIP 2008-2013
1 new back-up power unit prototype built & field-tested	2015 target: 1,000 new UPS/back-up power units in the EU market	Subsystem design ready, assembly in progress.	100%		Subsystems sent to VTT. System integration from 09/2016, commissioning Q12017, then field trial.
System: <€3,3k/kW @>500 units/5 kW <€2,5k/kW @>500 units/25 kW	Cost: €1,5-2,5k/kW for industrial/commercial units. Annual obj. €2,5 k/kW @ >500 units for FC & H_2 system (incl. H_2 generator)	€7,000/kW, estimated based on the current prototype	90%	Est. €8-10 k/kW for combined electrolyser/PEMFC & €9k/kW for bioethanol	Cost red. potential on PSA unit & stack w/prod. to other markets not included yet. Further assessment of cost red. by elimination of overlapping control systems, cabinets, etc...
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AIP 2013-1
System: <€3,3k/kW @>500 units/5 kW <€2,5k/kW @>500 units/25 kW	FC & H_2 system cost €2,5 k/kW @ >500 units (incl. H_2 generator)	€7,000/kW, estimated based on the prototype	90%	Est. €8-10k/kW for combined electrolyser/PEMFC & €9k/kW for bioethanol	Cost reduction potential on PSA unit and stack with production to other markets not included yet. Further assessment of cost reductions by elimination of overlapping control systems, cabinets, etc...
FC system efficiency >45%	FC system efficiency >45%	44%	100%		Optimization of stack operation, 2nd gen. MEAs
System lifetime >20,000 h	System/stack lifetime 20,000 h	Est. lifetime >5,000 h (fuel processor), >10,000 h (stacks, system)	90%	10,000 h est. for reformate system	No long-term durability testing in project, possible conclusions from 1,000 h field trial.
System efficiency >30 %	System efficiency >30 % w/integrated H_2 generator	~28% from data/simulations on subsystems: Fuel processor: 90 %, PSA: 80 %, FC system: 44 %	95 %		2nd gen. MEAs & FC system optimization for efficiency over 30 %, but CO level effect needs verification.
(c) Other project objectives					
Quality of bioethanol as primary fuel	Not applicable	Crude bioethanol (80-95 %), distilled but not purified	100%	Purified bioethanol	Bioethanol reformer design still in progress. No major problems foreseen.
Quality of H_2 used in PEMFC system: >98% H_2 , <25 ppm CO	Not applicable	Current MEAs can take 5 ppm CO in long term. Hygear PSA can reach <20 ppm.		Industrial grade 99.9% (non- reformate compatible systems)	~3 h of operation at nominal power, then at partial load w/increased CO tolerance. 2nd gen. MEAs & new in-project-developed adsorbent will help bridge the gap.
System operation ambient temp.: -25 °C to +50 °C	Not applicable	700 W 10-cell reformate S2 stack successfully cold started from -25 °C without external heaters.	100%	-5 °C	Stack cold start is key achievement. With 100-cell 7 kW stack, cold start-up is much easier to achieve.

POWER-UP

Field demonstration of large scale stationary power and CHP fuel cell systems

PANEL 3

Technology validation in stationary applications

ACRONYM	POWER-UP
CALL TOPIC	SP1-JTI-FCH.2012.3.7: Field demonstration of large scale stationary power and CHP fuel cell systems
START DATE	1/04/2013
END DATE	30/06/2017
PROJECT TOTAL COST	€13,6 million
FCH JU MAXIMUM CONTRIBUTION	€6,1 million
WEBSITE	http://project-power-up.eu/

PARTNERSHIP/CONSORTIUM LIST

AFC ENERGY PLC, AIR PRODUCTS PLC, G.B. INNOMECH LIMITED, ZENTRUM FÜR BRENNSTOFFZELLEN-TECHNIK GMBH, PAUL SCHERRER INSTITUT, FAST – FEDERAZIONE DELLE ASSOCIAZIONI SCIENTIFICHE E TECNICHE

MAIN OBJECTIVES OF THE PROJECT

A 500 kW$_e$ 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

- Utilities and building completed.
- Alkaline fuel cell system installed and operational.
- Electricity fed and sold into the local grid.
- Automated stack assembly complete.
- Fuel cell production line upgraded.

FUTURE STEPS

- Operational data to confirm cost of ownership, system performance, and economic/environmental/social impacts.
- Automation of stack disassembly.
- Recycling of components.
- CE certification.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Upgrades to first generation fuel cell stack necessary and underway.
- Automation of fuel cell production has increased volumes without reducing quality.
- Scaled-up system design will be basis of future commercial product.
- Commercial interest in system from beyond Europe.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAIP 2008-2013
500 kW$_e$ by June 2017	>5 MW by 2015	1st KORE system installed	80 %	200 kW$_e$ achieved in January 2016	2nd KORE system to be installed pending further tests and upgrades of 2nd generation stack
€3,000/kW is the target cost (CapEx and OpEx), using demonstration systems	€3,000/kW assuming supported deployment from 2013+	The first system had a number of one-off high-cost items which will not be repeated	100 %	€5,000/kW	Target cost for the post-funding period will be significantly lower
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AIP 2012
58-59 %	Conversion efficiency of 58 % (elec)	electrical efficiency of the fuel cell system has increased significantly	100 %	45 %	On track to achieve by end of project
Lifetime / duration of 15,000 h	Lifetime / duration of 15,000 h	several days of operation achieved	0 %	XX hours to be achieved in 2016	XX hours to be achieved until end of project

STAGE-SOFC

Innovative SOFC system layout for stationary power and CHP applications

PANEL 3
Technology validation in stationary applications

ACRONYM	STAGE-SOFC
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 DATE	1/04/2014
END DATE	31/03/2017
PROJECT TOTAL COST	€3,9 million
FCH JU MAXIMUM CONTRIBUTION	€2,1 million
WEBSITE	http://www.stage-sofc-project.eu/

PARTNERSHIP/CONSORTIUM LIST

Teknologian tutkimuskeskus VTT Oy, SUNFIRE GMBH, ICI CALDAIE SPA, LAPPEENRANNAN TEKNILLINEN YLIOPISTO, ZACHODNIOPOMORSKI UNIWERSYTET TECHNOLOGICZNY W SZCZECINIE

MAIN OBJECTIVES OF THE PROJECT

The project aims to develop a 5 kWel 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.

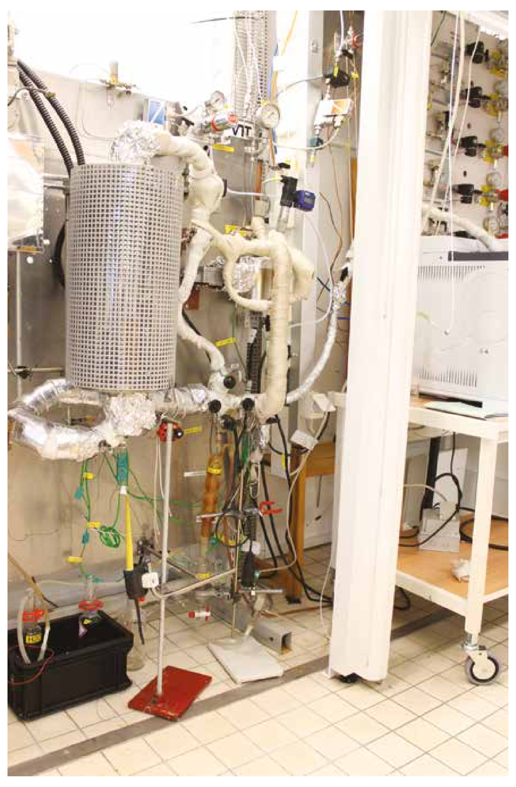
The system combines the benefits of the simple and robust catalytic partial oxidation layout with the high efficiencies obtained by the steam reforming process. A staged cathode air supply allows an individual control of stack temperatures and saving of costly heat exchanger area. The system will be designed for small-scale CHP and off-grid applications in the power range of 5 to 50 kW.

PROGRESS/RESULTS TO-DATE

- The Proof-of-Concept system was designed based on extensive theoretical and experimental investigations.
- Optimized reforming units, heat exchangers, burners and power electronics were developed.
- Detailed market studies were done to define cost targets and operation strategies.
- Dissemination activities include participation in 22 exhibitions, participation in 12 conferences and publications of 15 research papers.
- Prototype 1 has been successfully started. System is in operation and works well. The experiences clearly verify the feasibility of the basic layout.

FUTURE STEPS

- Design of Prototype 2 will be finished in the beginning of July.
- Experimental work is still ongoing to finalize the design of the steam reformer.
- Prototype 2 will be operated 3,000 hours for final system validation.
- Optimization of the design, operation and manufacture of the system against market expectations.



CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Prototype 1 has been successfully started. System is in operation and works well. The experiences clearly verify the feasibility of the basic layout.
- System optimization ongoing: main targets will be simplification of layout and improvement of start-up process as well as dynamical operation.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAIP 2008-2013
$\eta_{el,Sys}$ >45 % η_{Sys} >80 %	Efficiencies shall be >45 % for power only units and >80 % for CHP units	$\eta_{el,Sys}$ >45 % η_{Sys} >80 %	100 %	Stage-SOFC investigates an innovative system layout, where high electrical efficiencies can be achieved without water processing or anode off-gas recirculation. SoA cannot be directly compared	Extensive simulation has verified that the target will be met. Experimental verification has been done with first system prototype (PT). Development of an optimized Proof-of-Concept prototype ongoing
40,000 h stack lifetime	Lifetime requirement of 40,000 hours for cell and stack	>20,000 h achieved at stack and system level, investigations are ongoing	80 %	SoA are system results with more than 20,000 h lifetime. SUNFIRE stacks could achieve this in several µCHP systems of Vaillant	Stack development is a continuous process to achieve lifetime targets. However, long testing times are required and materials for cells and stacks are not finally frozen
40,000 h stack lifetime + Costs per Unit: €4,000/kW @ 100+ €2,000/kW @ 5	Improved performance, endurance, robustness, durability and cost	Work in progress, new materials tested, improvement of production	80 %	Cost targets not achieved yet with SOFC technology. Costs are currently in the range of €7,000-25,000/kW	Costs targets to be achieved by increase of power density, higher production volume and improved production technologies
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AIP 2013-1
5 kW complete prototype will be built and tested	Development of fully integrated advanced PoC systems	Design is ready. Prototype 1 has been successfully commissioned and operated	100 %	Power (>5 kW) and efficiency (>45 %el) targets have been achieved. This is a very encouraging result for this type or waterless system	Experiences from PT1 operation are currently used to design the final prototype
The PoC prototype is expected to be operated for at least 3,000 h	Successful duration of run times of several hundreds of hours	Tests with the first prototype have been finalized. Design of PoC ongoing	100 %		Since PT1 worked stable, it is expected that 3,000 h are reachable

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

TRISOFC

Durable solid oxide fuel cell tri-generation system for low carbon buildings

TriSOFC

PANEL 3

Technology validation in stationary applications

ACRONYM	TRISOFC
CALL TOPIC	SP1-JTI-FCH.2011.3.4: Proof-of-concept fuel cell systems
START DATE	1/08/2012
END DATE	31/07/2015
PROJECT TOTAL COST	€2,7 million
FCH JU MAXIMUM CONTRIBUTION	€1,4 million
WEBSITE	www.trisofc.com

PARTNERSHIP/CONSORTIUM LIST

THE UNIVERSITY OF NOTTINGHAM, KUNGLIGA TEKNISKA HOEGSKOLAN, THE UNIVERSITY OF BIRMINGHAM, INSTITUTO DE ENGENHARIA MECANICA, GETTFUELCELLS INTERNATIONAL AB, Vestel Savunma Sanayi A.S., PRZEDSIEBIORSTWO INNOWACYJNO-WDROZENIOWE COMPLEX SP ZOO, SWEREA IVF AB, INEGI – INSTITUTO DE CIENCIA E INOVACAO EM ENGENHARIA MECANICA E ENGENHARIA INDUSTRIAL

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.

PROGRESS/RESULTS TO-DATE

- Desiccant unit simulation complete.
- 1100W/cm^2 achieved- 12W power output from 2 cell stack.
- Integration of 250We microtubular SOFC tri-generation system.
- Microtubular SOFC efficiency ~ 12 % Overall Trigeneration efficiency ~ 24 %.

FUTURE STEPS

- Develop and demonstrate long term performance of single component LT SOFC membranes.
- Develop and demonstrate long term performance of single component LT SOFC stacks.
- Develop prototype LT SOFC fuel cell.
- Demonstrate long term (>1 year) SOFC trigeneration system.
- Investigate low cost/high volume manufacture of single component SOFC membranes and stacks.

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.
- A single component low temperature SOFC cell and stack have been proved in lab condition.
- Demonstrated integration of 250We microtubular SOFC.
- Single component fuel cells working at low temperatures (500-600C) will enable cost reductions in BoP and improvement in performance.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

PROJECT OBJECTIVES / TARGETS	CORRESPONDING PROGRAMME OBJECTIVE / QUANTITATIVE TARGET (SPECIFY TARGET YEAR)	CURRENT PROJECT STATUS	PROBABILITY OF REACHING INITIAL TARGET	STATE OF THE ART 2016 – VALUE AND REFERENCE	COMMENTS ON PROJECT PROGRESS / STATUS
(a) Project objectives relevant to multi-annual objectives (from MAIP/MAWP) – indicate relevant multi-annual plan:					MAIP 2008-2013
Power range	200-1500 We	250 We	100 %	1500 We	The project has met the minimum power output, however the single component LT SOFC has demonstrated 1100W/cm^2 and 12W from 2 cells
Efficiency	35 % to 45 % (elec) 75 % to 85 % total	Testing of microtubular SOFC tri-generation 12 % elec – 48 % total.	80 %	45 % elec – 75 % overall	The electrical efficiency of the microSOFC was very low at ~ 12 %, but trigeneration more then doubled overall efficiency
(b) Project objectives relevant to annual objectives (from AIP/AWP) if different than above – indicate relevant annual plan:					AIP 2008
Durability	30,000 h	100-300 h	80 %	30,000 h	a single component LT SOFC cell has operated at over 100h and the trigeneration system using a microSOFC has been operating for over 3 months (300h) with no degradation in performance
Costs	€2,000/kW	€2,500-4,000/kW	80 %	€1,750-2,100/kW	costs reflect manufacture of single/lab scale membranes and stacks. Mass manufacture and scales of production will reduce costs to target