



# ALKAMMONIA

AMMONIA-FUELLED ALKALINE FUEL CELLS FOR REMOTE POWER APPLICATIONS

<b>Project ID:</b>	<b>325343</b>
<b>Call topic:</b>	<b>SP1-JTI-FCH.2012.3.5 -</b> System level proof of concept for stationary power and CHP fuel cell systems at a representative scale
<b>Project total costs:</b>	<b>€ 2,884,512.59</b>
<b>FCH JU max. Contribution:</b>	<b>€ 1,962,548</b>
<b>Project start - end:</b>	<b>01/05/2013- 30/06/2018</b>
<b>Coordinator:</b>	<b>AFC ENERGY PLC, UK</b>
<b>Website:</b>	<b>alkammonia.eu</b>



**BENEFICIARIES:** PAUL SCHERRER INSTITUT, UNIVERSITAET DUISBURG-ESSEN, FAST - FEDERAZIONE DELLE ASSOCIAZIONI SCIENTIFICHE E TECNICHE, ACTA SPA, ZENTRUM FUR BRENNSTOFFZELLEN-TECHNIK GMBH, UPS SYSTEMS PLC, FUEL CELL SYSTEMS LTD

## PROJECT AND OBJECTIVES

In project ALKAMMONIA a proof-of-concept system designed to provide power in remote areas has been developed and is being tested, focusing on diesel generator displacement opportunities.

The project integrates three innovative and proven technologies: a highly efficient and low-cost alkaline fuel cell system, plus a novel ammonia fuel system which consists of a fuel delivery system and a cracker system for generation of a hydrogen rich gas. The project formally ended in 2018 but testing continues on the integrated system and the results will be shared with potential end-users.

## NON QUANTITATIVE OBJECTIVES

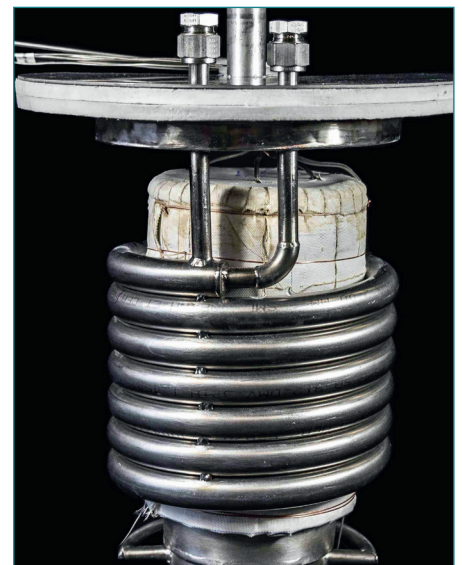
- Partner ZBT proceeded with the more strict and onerous process of TUV Certification for the ammonia cracker instead → Achieved
- The long-term testing of the integrated system is still in progress at AFCEN, despite the project formally ending. PSI LCA, total system cost and sustainability analyses completed with interim data → Achieved.

## PROGRESS & MAIN ACHIEVEMENTS

- Successful short-term testing of the alkaline fuel cell balance of plant and stack
- Successful testing of the ammonia cracker and fuel delivery system
- Successful integration of sub-systems into the ALKAMMONIA system.

## FUTURE STEPS & PLANS

- Project finished
- Longevity testing of the integrated system, funded commercially
- Scale-up of ALKAMMONIA prototype to address EV charging and other diesel generator displacement opportunities.



## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's Own Objective	Cracker efficiency (based on LHV)	%	80	90	✓	N/A	N/A
	AFC Stack Weight	kg/kW	150	28	✓	200kg, based on a 5kWe stack	2013
	Projected Cracker costs	€/kW	1,000	2,183	✗	N/A	N/A

<b>Project ID:</b>	<b>671396</b>
<b>Call topic:</b>	<b>FCH-02.5-2014</b> - Innovative fuel cell systems at intermediate power range for distributed combined heat and power generation
<b>Project total costs:</b>	<b>€ 4,464,447.25</b>
<b>FCH JU max. Contribution:</b>	<b>€ 3,496,947.00</b>
<b>Project start - end:</b>	<b>01/08/2015 - 30/04/2019</b>
<b>Coordinator:</b>	<b>ALSTOM POWER LTD, UK</b>
<b>Website:</b>	<b><a href="http://www.autore-fch.com">www.autore-fch.com</a></b>



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

### PROJECT AND OBJECTIVES

The main project objective is to create the foundations for commercialising an automotive derivative fuel cell system in the 50 to 100 kWe range, for CHP in commercial and industrial buildings. Specifically:

- develop system components allowing reduced costs, increased durability and efficiency and, ultimately, allowing the levelised cost of electricity to reach grid parity
- build and validate a first 50 kWe PEM prototype CHP system
- create the required value chain from automotive manufacturers

The project was completed in April 2019.

### PROGRESS & MAIN ACHIEVEMENTS

- Prototype test system has been built and commissioned and systems testing undertaken
- Modelling of the CHP concept with improved reformer to include membranes has been completed
- An initial engineering configuration for the improved reformer has been proposed.

### FUTURE STEPS & PLANS

Project finished.

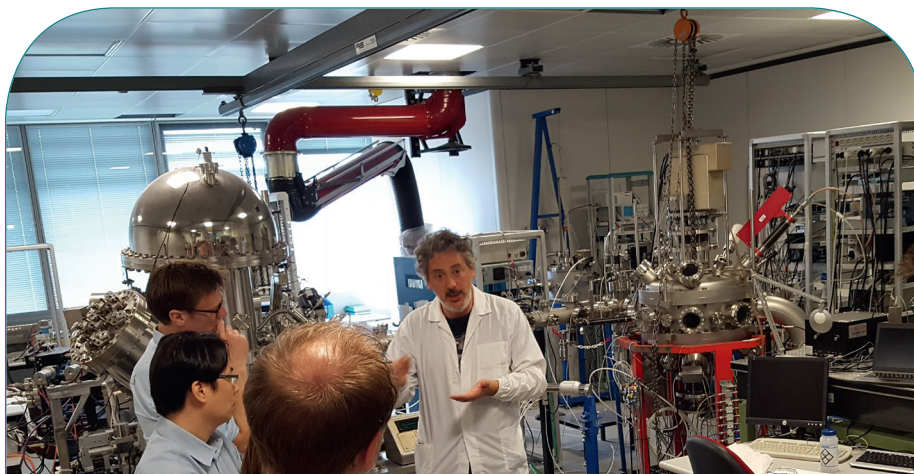


## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
MAWP 2014-2020	electrical efficiency	% LHV	40	47	✓	52-60	2018
	thermal efficiency	% LHV	45	45	✓	40	n/a
	durability	hours	16,000	N/A	✗	20,000	2018



<b>Project ID:</b>	<b>735692</b>
<b>Call topic:</b>	<b>FCH-02-4-2016</b> - Co-generation of Hydrogen and Electricity with High-Temperature Fuel Cells (>50 kW)
<b>Project total costs:</b>	<b>€ 6,868,158.75</b>
<b>FCH JU max. Contribution:</b>	<b>€ 3,999,896</b>
<b>Project start - end:</b>	<b>01/02/2017- 31/07/2020</b>
<b>Coordinator:</b>	<b>FONDAZIONE BRUNO KESSLER, IT</b>
<b>Website:</b>	<b>www.ch2p.eu</b>



**BENEFICIARIES:** DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV, ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE, SHELL GLOBAL SOLUTIONS INTERNATIONAL BV, HYGEAR BV, HyGear Fuel Cell Systems B.V., SOLIDPOWER SA, SOLIDPOWER SPA, VERTECH GROUP, HYGEAR TECHNOLOGY AND SERVICES BV

### PROJECT AND OBJECTIVES

CH2P is focused on polygeneration of hydrogen, power and heat using novel SOFC technology fuelled by methane-rich gases. Objectives of CH2P are:

1. Distribution of hydrogen and power compliant with the EU DAFI Directive using one single technology
2. Flexible production of hydrogen and power following end user demand at the station
3. H<sub>2</sub> purity level compliant with the use in fuel cell electric vehicles
4. Bring the cost of hydrogen production below 4.5€/kg, using an innovative cost model.

### NON QUANTITATIVE OBJECTIVES

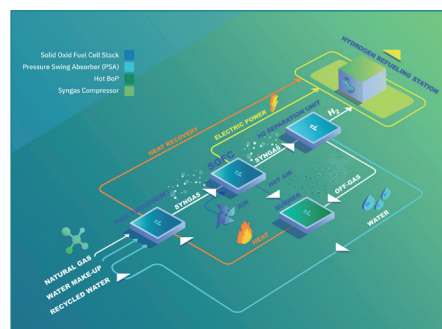
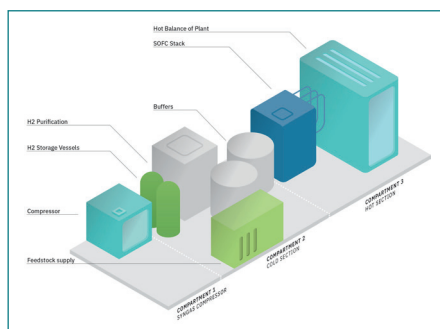
- CH2P will contribute to create new jobs in EU
- CH2P with one single technology will deliver gas, H<sub>2</sub> and power, the fuels of EU DAFI
- CH2P will be able to reach hydrogen generation costs far below 4 €/kgH<sub>2</sub>.

### PROGRESS & MAIN ACHIEVEMENTS

- The CH2P project covers a large range of H<sub>2</sub> and power production. The total efficiencies depend on the operating mode, expecting to exceed 65%
- Hydrogen purity. CH2P system produce 5N purity level, compliant with the use in the transport sector, for on-board PEMFC
- Hydrogen cost estimation equals to 4.5 euro/kg with novel cost model.

### FUTURE STEPS & PLANS

- The project CH2P is in delay. A new revised plan has been drafted. The new plan is recovering part of the delay in the project with end on 12/2020
- The full 20 kgH<sub>2</sub>/day system will be tested completely by October 2019. This alfa version will be tested in Hygear
- A second 20 kgH<sub>2</sub>/day system will be realized by Hygear as a beta version by July 2020
- A 40 kgH<sub>2</sub>/day CH2P system, combining alfa and beta version of 20 kgH<sub>2</sub>/day each, will be tested in SHELL by December 2020
- A final full LCA and LCC will be delivered by December 2020.



## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
AWP 2016	System Size	kgH <sub>2</sub> /day	20	N/A	✗	N/A	2019
	Flexible cogeneration of H <sub>2</sub> and POWER	%	50 + 50	50 + 50	✓	N/A	2019
	System efficiency	%	65	79	✓	65	2017

<b>Project ID:</b>	<b>303458</b>
<b>Call topic:</b>	<b>SP1-JTI-FCH.2011.3.6</b> - Field demonstration of large stationary fuel cell systems for distributed generation and other relevant commercial or industrial applications
<b>Project total costs:</b>	<b>€ 8,578,142.6</b>
<b>FCH JU max. Contribution:</b>	<b>€ 4,590,095</b>
<b>Project start - end:</b>	<b>01/05/2012- 30/09/2020</b>
<b>Coordinator:</b>	<b>BALLARD POWER SYSTEMS EUROPE AS, DK</b>
<b>Website:</b>	<b>www.cleargen.eu</b>



**BENEFICIARIES:** CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS, BUDAPESTI MUSZAKI ES GAZDASAGTUDOMANYI EGYETEM, LOGAN ENERGY LIMITED, LINDE GAS MAGYARORSZAG ZARTKORUEN MUKODO RESZVENYTARSASAG, JEMA ENERGY SA, HYDROGENE DE FRANCE, AQUIPAC SAS

### PROJECT AND OBJECTIVES

- The development and construction of a large-scale fuel cell system for conversion of by-product hydrogen, purpose-built for the European market
- The validation of the technical and economic readiness of the fuel cell system power generation at the megawatt scale
- The field demonstration and deployment.

The site construction is progressing. All equipment was delivered on site (Martinique) including fuel cell, PSA system, cooler for hydrogen flow, tanks, analyser and valves. The system will be put in operation in the fall 2019.

### NON QUANTITATIVE OBJECTIVES

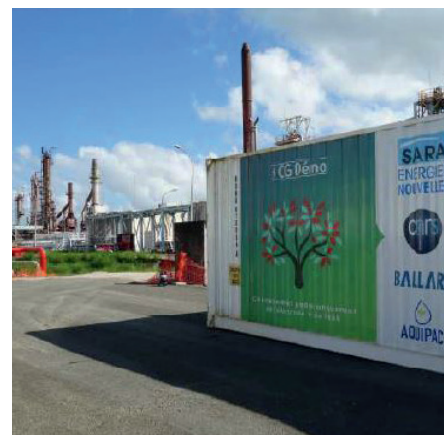
- Training of technician
- Safety Improvements, due to the refinery environment, the safety requirements are extraordinary high.

### PROGRESS & MAIN ACHIEVEMENTS


- All equipment has been manufactured and shipped to Martinique
- The civil work on site is in full swing and progressing
- Sara Martinique entered as 100% investor in Aquipac, the company in charge of operating the fuel cell.

### FUTURE STEPS & PLANS

- Installation and Commissioning is expected in September 2019
- Midterm conference is planned for 5th of December
- Business Model for large stationary fuel cell.



## QUANTITATIVE TARGETS AND STATUS

Target Source	Parameter	UNIT	Target	Achieved to date by the project	Target Achieved?
AIP 2011	Lifetime (between FC refurbishment)	hour	>10,000	40,000	 Work in progress
	Performance Loss	%	< 3	0	
Project's own objective	Electrical Efficiency	%	50	48	
	Cost	€/MW	<3.0 mil.	3.0 mil/euro/MW	
	Availability	NA	NA	90-95%	



<b>Project ID:</b>	<b>779481</b>
<b>Call topic:</b>	<b>FCH-02-11-2017</b> - Validation and demonstration of commercial-scale fuel cell core systems within a power range of 10-100kW for selected markets/applications
<b>Project total costs:</b>	<b>€ 10,277,897.50</b>
<b>FCH JU max. Contribution:</b>	<b>€ 7,486,954.75</b>
<b>Project start - end:</b>	<b>01/01/2018 - 30/06/2021</b>
<b>Coordinator:</b>	<b>TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, FI</b>
<b>Website:</b>	<b>www.comsos.eu</b>



**BENEFICIARIES:** POLITECNICO DI TORINO, SOLIDPOWER SA, SOLIDPOWER SPA, SUNFIRE GMBH, CONVION OY, ENERGY MATTERS BV

### PROJECT AND OBJECTIVES

The objective project is to validate and demonstrate fuel cell based CHP solutions in the mid-sized power ranges. The outcome gives proof of the advantages of such systems, business models, and benefits for the customer. The overall target amount of installations is 23 units with a total power output of 450 kW, distributed as follows: Convion, 2 units of 60 kW each (total 120 kW), Sunfire, 6 units of 25kW each (total 150 kW) and SOLIDpower, 15 units of 12kW each (total 180kW).

### NON QUANTITATIVE OBJECTIVES

Business models for niche markets to understand business drivers. The development of a techno-economic model of the three considered SOFC-CHP systems of the project has been started by collecting data from manufacturers.

### PROGRESS & MAIN ACHIEVEMENTS

- System design and engineering has been finalized as scheduled in regard of term and results
- First site chosen of each manufacturer and site preparation started
- Business case analysis for the 10-50 kW units has been finalised.

### FUTURE STEPS & PLANS

- All system should be installed and in operation
- Installed systems are filling performance and emission targets
- All systems have at least gathered 6 months of data.



## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
AWP 2017	Amount of installed power	kW	450	✂ Work In progress	N/A	N/A
	Availability	%	97		97	2017
MAWP Addendum (2018-2020)	Cost	€/kW	<4,000		>15,000	2017
	Lifetime	years	10		3-5	2017
Project's own objective	OEMs pays 30% from the cost of installed SOFC system	%	30		N/A	N/A

<b>Project ID:</b>	<b>671473</b>
<b>Call topic:</b>	<b>FCH-02.9-2014</b> - Significant improvement of installation and service for fuel cell systems by Design-to-Service
<b>Project total costs:</b>	<b>€ 3,636,797.5</b>
<b>FCH JU max. Contribution:</b>	<b>€ 2,953,790.75</b>
<b>Project start - end:</b>	<b>01/09/2015 - 31/03/2020</b>
<b>Coordinator:</b>	<b>DLR-INSTITUT FÜR VERNETZTE ENERGIESYSTEME EV, DE</b>
<b>Website:</b>	<b>project-d2service.eu</b>

**BENEFICIARIES:** BALLARD POWER SYSTEMS EUROPE AS, BOSAL EMISSION CONTROL SYSTEMS NV, ZENTRUM FÜR BRENNSTOFFZELLEN-TECHNIK GMBH, SOLIDPOWER SPA, BRITISH GAS TRADING LIMITED, ENERGY PARTNER SRL



## PROJECT AND OBJECTIVES

D2Service project aims at improving serviceability of residential and commercial fuel cell systems. Installation and maintenance procedures of SOFC and PEM fuel cell-based units are analysed and optimised to reduce service times and costs, and to avoid mistakes during installation and service. Design and the components of the units are optimised towards simplified exchangeability, increased longevity and standardisation, thus decreasing service frequency and duration. The main improvements have been realised and are currently tested in a dedicated field trial.

## NON QUANTITATIVE OBJECTIVES

- Elaboration of guidelines for easily understandable service manuals

- Life-time desulphurisation (type HDS). Suitable catalyst and adsorbed materials identified for 60,000h. Laboratory verification is currently being performed
- Water treatment optimisation. Better material identified leading to extended service intervals.

## PROGRESS & MAIN ACHIEVEMENTS

- Improvement of design of SOFC mCHP units with respect to efficiency, serviceability, durability and cost reduction
- Identification of suitable catalyst and absorber materials for 60,000h lifetime of hydrodesulphurisation component
- Elaboration of guidelines for designing easily understandable service manuals.

## FUTURE STEPS & PLANS

- Execution and analysis of field trial
- Project achievements dissemination and communication
- Laboratory long-term tests of mCHP units
- Development of BlueGEN variant prototype.

## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
AWP 2014	Service time / presence time of maintenance technician (SOFC)	hours	<4	4	✓
	Total down time for servicing (SOFC)	hours	<48	48	✓
	Service interval (SOFC)	1/a	<1	1	✓
	Service costs (SOFC)	€/(kW*a)	<600	1,000	✗



<b>Project ID:</b>	621256
<b>Call topic:</b>	SP1-JTI-FCH.2013.3.5 - Field demonstration of large scale stationary power and CHP fuel cell systems
<b>Project total costs:</b>	€ 10,524,200.4
<b>FCH JU max. Contribution:</b>	€ 5,466,525
<b>Project start - end:</b>	01/01/2015- 31/12/2018
<b>Coordinator:</b>	AKZO NOBEL INDUSTRIAL CHEMICALS B.V., NL
<b>Website:</b>	demcopem-2mw.eu

**BENEFICIARIES:** JOHNSON MATTHEY FUEL CELLS LIMITED, MTSA TECHNOPOWER BV, NEDSTACK FUEL CELL TECHNOLOGY BV, POLITECNICO DI MILANO



### PROJECT AND OBJECTIVES

The aim of the project was to design, construct and demonstrate a combined heat and power PEM fuel cell power plant and integration into a chlor-alkali production plant.

The project has been completed in December 2018, the PEM system has been installed since September 2016 at the chlor-alkali plant in Yingkou, China.

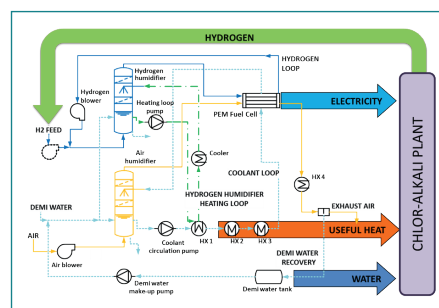
The planned capacity of 2MW has been reached, even if some technical problems (related to air and hydrogen quality) have been encountered.

### PROGRESS & MAIN ACHIEVEMENTS

- 2 MW system operational for over 2 years (heat recovery available) with remote monitoring and control
- Modelling of the complete system performed, with good accuracy (BoL)
- Analysis and basic design for roll out phase performed showing significantly reduced costs.

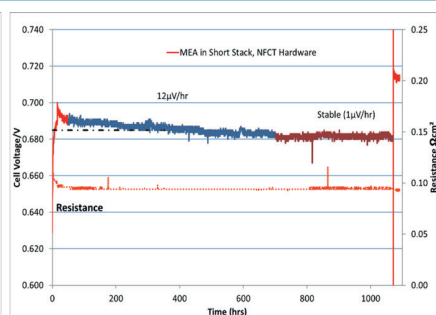
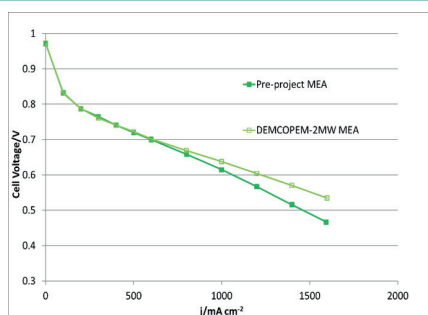
### FUTURE STEPS & PLANS

Project finished.



### NON QUANTITATIVE OBJECTIVES

- Training of system operators in China achieved
- More than 850 tons of hydrogen have been recovered avoiding emission of 15,000 tCO<sub>2</sub>
- Developed open-source calculation tool for preliminary economical assessment.



## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objective (aligned with MAWP addendum 2018-2020)	System operation energy	MW	2	✓ (even if temporarily)
	System operation lifetime	hours	16,000	✗
	Costs per kW	Euro/kW	3,000	✓



# DEMOSOFC

## DEMONSTRATION OF LARGE SOFC SYSTEM FED WITH BIOGAS FROM WWTP

**Project ID:** 671470

**Call topic:** FCH-02.11-2014 - Large scale fuel cell power plant demonstration in industrial/ commercial market segments

**Project total costs:** € 5,905,336.25

**FCH JU max. Contribution:** € 4,492,561

**Project start - end:** 01/09/2015 - 31/08/2020

**Coordinator:** POLITECNICO DI TORINO, IT

**Website:** [demosofc.wordpress.com](http://demosofc.wordpress.com)



**BENEFICIARIES:** CONVION OY, IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE, RISORSE IDRICHE S.P.A., SOCIETÀ METROPOLITANA ACQUE TORINO S.P.A., TEKNOLOGIAN TUTKIMUSKESKUS VTT OY

### PROJECT AND OBJECTIVES

The EU-funded DEMOSOFC project demonstrates the technical and economic feasibility of operating a 174 kW<sub>e</sub> SOFC system in a wastewater treatment plant. The present work is related to the results of the operation of the SOFC system: the first SOFC module has been activated in October 2017 and the second in October 2018. More than 6300 hours of operation have been reached onsite. Measured SOFC efficiency from compressed biogas to AC power has always been higher than 50-53%, with peaks of 56%. Emissions show NO<sub>x</sub> < 20 mg/m<sup>3</sup>, SO<sub>2</sub> < 8 mg/m<sup>3</sup> and particulate lower than ambient air values (0.01 mg/m<sup>3</sup>).

### NON QUANTITATIVE OBJECTIVES

- Training on end-user (SMAT) technicians to know the new fuel cell system
- Visits to the DEMO sites organized with a standardized format, for people from all over the world
- Build technical knowledge, customer and investor confidence. Lessons learned for replication of detailed engineering, construction, installation, management on the long run

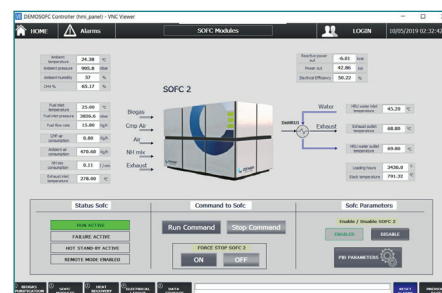
- A complete FMEA of the DEMO has been developed. This can represent a lesson learned experience for the future
- Dissemination using press release, social media, website, workshops at DEMO site and elsewhere, conferences, public events, technical papers.

### PROGRESS & MAIN ACHIEVEMENTS

- High electrical efficiency, always higher than 50% with peaks at 56%
- Zero emissions to atmosphere, NO<sub>x</sub> SO<sub>2</sub> and PM below detection limits
- >7000 hours of operation on site.

### FUTURE STEPS & PLANS

- First and Second SOFC modules operation in parallel (long term operation)
- First SOFC module stacks repair activity
- Third SOFC module delivery to the site
- Exploitation plan to maximize the project impact
- Analysis of the potential replication impacts in other WWTPs.



## QUANTITATIVE TARGETS AND STATUS

Target Source	Parameter	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	Target Achieved?
MAWP 2014-2020	Electrical efficiency	% LHV	42-60	50-56	✓
	NO <sub>x</sub> Emissions	mg/kWh	< 40	(Measured value onsite was < 20 mg/m <sup>3</sup> )	✓
	Availability of the plant	%	97	60	✗
	Thermal efficiency	% LHV	24-42	30-35	✓
	Lifetime	years of plant operation	8 - 20	2	✗





# EVERYWH2ERE

MAKING HYDROGEN AFFORDABLE TO SUSTAINABLY OPERATE EVERYWHERE IN EUROPEAN CITIES



<b>Project ID:</b>	779606
<b>Call topic:</b>	FCH-02-10-2017 - Transportable FC gensets for temporary power supply in urban applications
<b>Project total costs:</b>	€ 6,762,324.46
<b>FCH JU max. Contribution:</b>	€ 4,999,945.76
<b>Project start - end:</b>	01/02/2018 - 31/01/2023
<b>Coordinator:</b>	RINA CONSULTING SPA, IT
<b>Website:</b>	www.everywh2ere.eu

**BENEFICIARIES:** ACCIONA CONSTRUCCION SA, PARCO SCIENTIFICO TECNOLOGICO PER L'AMBIENTE ENVIRONMENT PARK TORINO SPA, ICLEI EUROPEAN SECRETARIAT GMBH (ICLEI EUROPASEKRETARIAT GMBH)\*, FUNDACION PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGIAS DEL HIDROGENO EN ARAGON, POWERCELL SWEDEN AB, THT CONTROL OY, GENPORT SRL - SPIN OFF DEL POLITECNICO DI MILANO, IREN SPA, IREN ENERGIA SPA, IREN RINNOVABILI S.P.A., MAHYTEC SARL, TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, SWISS HYDROGEN SA, DELTA1 GUG (HAFTUNGSBESCHRANKT), LINDE GAS ITALIA SRL, FRIEM S.P.A.

## PROJECT AND OBJECTIVES

EVERYWH2ERE project aims to demonstrate how FC can replace diesel fuelled internal combustion engines in temporary gensets. The project will realize 4x25 kW + 4x100 kW gensets to be tested in music festivals, construction sites, and temporary events and to evaluate thanks to demonstration campaign results, logistic and techno-economic feasibility of gensets marketability.

## NON QUANTITATIVE OBJECTIVES

- Demonstration of economic viability, safety and environmental sustainability of the novel solutions. HSE assessment performed for what it concerns design and operation, LCA started, market and competitors analysis performed
- Promote FC gensets among cities. Realization of a dedicated event and connection with FCH JU City and Regions initiative.

## PROGRESS & MAIN ACHIEVEMENTS


- Design of the FC based gensets layout: FC SuSy, H2Bottles, Power converters, containerization
- Interaction with several stakeholders for demonstration engagement, regulation and business models insights
- Starting the manufacturing of FC SuSy and H2 Storage.

## FUTURE STEPS & PLANS

- Realization of the first prototypes
- Validation testing in lab of the gensets
- Validation testing in lab of Hydrogen bottles
- First demonstration in ACCIONA construction sites and in some already identified festival.



## QUANTITATIVE TARGETS AND STATUS

PARAMETER	UNIT	RESULT ACHIEVED TO DATE	TARGET	TARGET ACHIEVED?
Project's own objective	Start in sub-zero of the FC SuSy	°C	-20	 (Demonstration not started yet)
	CAPEX	€/kW	5,500	
	Efficiency of the genset	%	50	
	Lifetime	hours	20,000	
	OPEX Increase if compared with diesel genset	%	15	

<b>Project ID:</b>	<b>700339</b>
<b>Call topic:</b>	<b>FCH-02.9-2015 - Large scale demonstration <math>\mu</math>CHP fuel cells</b>
<b>Project total costs:</b>	<b>€ 83,765,010.07</b>
<b>FCH JU max. Contribution:</b>	<b>€ 33,932,752.75</b>
<b>Project start - end:</b>	<b>01/06/2016 - 31/08/2021</b>
<b>Coordinator:</b>	<b>THE EUROPEAN ASSOCIATION FOR THE PROMOTION OF COGENERATION VZW, BE</b>
<b>Website:</b>	<b><a href="http://www.pace-energy.eu">www.pace-energy.eu</a></b>



**BENEFICIARIES:** DANMARKS TEKNISKE UNIVERSITET, HEXIS AG, ELEMENT ENERGY LIMITED, VAILLANT GMBH, EWE AKTIENGESELLSCHAFT, SOLIDPOWER SPA, BOSCH THERMOTECHNIK GMBH, SUNFIRE GMBH, VISSMANN WERKE GMBH & CO KG, SOLIDPOWER GMBH, BDR THERMEA GROUP BV, VISSMANN WERKE ALLENDORF GMBH, VISSMANN ELEKTRONIK GMBH

### PROJECT AND OBJECTIVES

PACE unlocks the large-scale European deployment of the state of the art smart energy solution for private homes, Fuel Cell micro-Cogeneration. PACE will see 2,800 householders across Europe reaping the benefits of this home energy system. The project enables manufacturers to move towards product industrialisation and fosters market development at national level by working together with building professionals and the wider energy community. The project uses modern FC technology to produce efficient heat and electricity at home, empowering consumers in their energy choices.

### NON QUANTITATIVE OBJECTIVES

Demonstrate in the field in the range of 2,500 units, already 446 units delivered.

### PROGRESS & MAIN ACHIEVEMENTS

- Winner of the 2018 FCH JU Award for Best Success Story
- More than half of the units sold to date (1,416 units sold as of end of March 2019)
- PACE technical workshop for EU Commission "Fuel Cell micro-Cogeneration in the Future Energy System – State of Play & Outlook", 09/10/19, Brussels.

### FUTURE STEPS & PLANS

All the 2,800 units to be deployed in the project will be installed.



## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET	FULL REFERENCE	COMMENTS
Project's own objective	Sold units	N/A	2,800	1,416	✂	1,046	2017	ene.field	n/a





# REMOTE

REMOTE AREA ENERGY SUPPLY WITH MULTIPLE OPTIONS FOR INTEGRATED HYDROGEN-BASED TECHNOLOGIES

**Project ID:** 779541  
**Call topic:** FCH-02-12-2017 - Demonstration of fuel cell-based energy storage solutions for isolated micro-grid or off-grid remote areas  
**Project total costs:** € 6,761,557.50  
**FCH JU max. Contribution:** € 4,995,950.25  
**Project start - end:** 01/01/2018 - 31/12/2021  
**Coordinator:** POLITECNICO DI TORINO, IT  
**Website:** [www.remote-euproject.eu](http://www.remote-euproject.eu)

**BENEFICIARIES:** STIFTELSEN SINTEF, ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS, BALLARD POWER SYSTEMS EUROPE AS, ENEL GREEN POWER SPA, HYDROGENICS EUROPE NV, IRIS SRL, POWIDIAN, ORIZWN ANONYMH TECHNIKI ETAIREIA, TRONDERENERGI AS, EPS ELVI ENERGY SRL, SINTEF AS



## PROJECT AND OBJECTIVES

REMOTE will demonstrate the technical and economic feasibility of two fuel cells-based H<sub>2</sub> energy storage solutions (integrated P2P, non-integrated P2G+G2P systems), deployed in 4 DEMOs, based on renewables (solar, wind, biomass, hydro), in isolated micro-grid or off grid remote areas. In 1.5 year of the project (May 2019), the analysis of the economic and regulatory framework, technical solutions and control strategies for the DEMOs has been performed. Design, engineering, plan for O&M and permitting procedures have been assessed for all the DEMOs and the sites preparation is ongoing.

## NON QUANTITATIVE OBJECTIVES

- Validate real demonstration units in representative applications of isolated micro-grid or off-grid areas, will enable suppliers, end users and general stakeholders to get wide experience for the future deployments of P2P solutions
- Contribution to regulation: identification of gaps
- Through DEMOs design, installation and operation, REMOTE will create a fundamental know-how for the next generation fully integrated P2P chains based on fuel cells and H<sub>2</sub> technologies adapted to market

and society's needs, with scientific advances in the management of off-grid and isolated micro-grids.

## PROGRESS & MAIN ACHIEVEMENTS

- Detailed analysis of the technical and business cases of the 4 DEMOs of P2P systems based on H<sub>2</sub>
- Definition of detailed engineering of the DEMOs 1, 2 and 3 in South Europe (including construction permits). Milestone 4 of the project
- Detailed Risk Assessment and Permission Procedure for the DEMO 4 in North Europe.

## FUTURE STEPS & PLANS

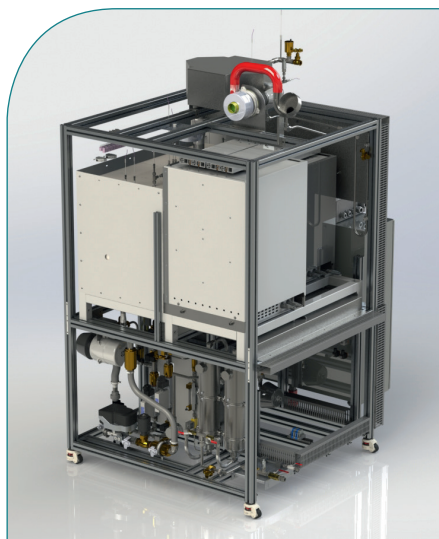
- January 2020: Construction, Installation and Commissioning of Agkistro and Rye DEMOs
- June 2020: Construction, Installation and Commissioning of Ginostra and Ambornetti DEMOs
- January 2021: Performance analysis of the 4 DEMOs
- October 2021: Market analysis and value chain, business cases
- October 2021: Environmental impact, LCA, pre-normative feedbacks from the DEMOs.



## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
MAWP Addendum 2018-2020 (Target Year 2020)	Rated efficiency electrolyzer (PEM)	kWh/kg	55,5	50.5	✓ (rated value)	50	2020
	Lifetime	years of plant operation	8 - 20	15 (fuel cell) - 20 (surrounding equipment)	✓ (rated value)	N/A	N/A
	Electrolyser Footprint (PEM)	m <sup>2</sup> /MW	100	273	✗	10	2018-2020
	Rated efficiency electrolyzer (Alkaline)	kWh/kg	50	50.6	✓ (rated value)	N/A	N/A
	Rated efficiency fuel cell (PEM)	%LHV	42-60	45	✓ (rated value)	51	2018

<b>Project ID:</b>	621213
<b>Call topic:</b>	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
<b>Project total costs:</b>	€ 3,921,223.1
<b>FCH JU max. Contribution:</b>	€ 2,165,724.6
<b>Project start - end:</b>	01/04/2014 - 30/04/2018
<b>Coordinator:</b>	TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, FI
<b>Website:</b>	<a href="http://www.stage-sofc-project.eu">www.stage-sofc-project.eu</a>



**BENEFICIARIES:** ICI CALDAIE SPA, LAPPEENRANNAN TEKNILLINEN YLIOPISTO, SUNFIRE GMBH, TEKNOLOGIAN TUTKIMUSKESKUS VTT, ZACHODNIOPOMORSKI UNIWERSYTET TECHNOLOGICZNY W SZCZECINIE

### PROJECT AND OBJECTIVES

The aim of the STAGE-SOFC project was to develop a Proof-of-Concept (PoC) prototype of a new SOFC concept with a serial connection of one exothermal CPOX stage with one or a multiple of endothermic steam reforming stages. The system combined the benefits of the simple and robust CPOX layout with the high efficiencies obtained by the steam reforming process. The first prototype achieved the set targets on electrical power >5 kW AC and electrical efficiency >45%. The PoC prototype was designed, constructed, and commissioned. The project is now finished.

### NON QUANTITATIVE OBJECTIVES

- New SOFC-concept successfully developed
- Know-how on reforming through a developed control of carbon formation in fuel processing units for SOFC applications and process integration designs
- CFD modelling of planar SOFC through numerical predictions of process efficiency, validated simulations of characteristics of equipment units and dynamic responses.

### PROGRESS & MAIN ACHIEVEMENTS

- The Proof-of-Concept system was successfully designed, constructed and commissioned and all the main design parameters were met
- We studied potential markets, business cases, techno-economic analysis and LCA
- Active dissemination of project results including conferences, exhibitions and scientific papers.

### FUTURE STEPS & PLANS

Project finished.



## QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
MAIP 2008-2013	Electrical efficiency (AC, LHV) at system level	%	45	45	✓	50	2012
	Total efficiency (LHV) at system level	%	80	80	✓	95	2012
	Cost per unit @ 5 kW class	€/kW	4,000	4,000	✓	N/A	2012
	Stack lifetime	hours	40,000	20,000	✗	40,000	N/A
Project's own objective	Prototype running time	hours	3,000	980	✗	N/A	N/A