CH2P

COGENERATION OF HYDROGEN AND POWER USING SOLID OXIDE BASED SYSTEM FED BY METHANE RICH GAS

Project ID:	**735692**
Call topic:	**FCH-02-4-2016** - Cogeneration of hydrogen and electricity with high-temperature fuel cells (>50 kW)
Project total costs:	**€6 868 158.75**
FCH JU max. Contribution:	**€3 999 896**
Project start - end:	01/02/2017 - 31/07/2021
Coordinator:	**FONDAZIONE BRUNO KESSLER, IT**
Website:	**www.ch2p.eu**

BENEFICIARIES: DEUTSCHES ZENTRUM FUER LUFT- UND RAUMFAHRT EV, ECOLE POLYTECHNIQUE FEDERALE DE LAUSANNE, SHELL GLOBAL SOLUTIONS INTERNATIONAL BV, HYGEAR BV, HYGEAR Fuel Cell Systems BV, SOLIDPOWER SA, SOLIDPOWER SPA, HYGEAR TECHNOLOGY AND SERVICES BV, HYGEAR OPERATIONS BV

PROJECT AND OBJECTIVES

The CH2P project is developing an innovative technology prototype for HRS. The new system cogenerates hydrogen, heat and electricity using solid oxide cell technology fuelled by carbon-lean natural gas (NG) or biomethane. The CH2P system is a transition technology for an early infrastructure deployment of HRS, operating with higher efficiency, lower costs and reduced environmental footprint compared with conventional technologies. The CH2P system is currently under development.

NON-QUANTITATIVE OBJECTIVES

- Job creation. By contributing to transition technology for the hydrogen economy, CH2P will help create new employment opportunities in the EU
- Alternative fuels station. With one single technology, CH2P will be fed with natural gas or biogas and will deliver hydrogen and power , the fuels of the European Directive on Alternative Fuels Infrastructure
- Cost model. CH2P will reach hydrogen generation costs far below 4 €/kg of hydrogen
- Use cases. CH2P can generate hydrogen for six different uses.

PROGRESS AND MAIN ACHIEVEMENTS

- The LSM1 was tested and validated at DLR in 2019
- Hydrogen purity. CH2P system produce 5N purity level, compliant with transport sector use, for on-board PEMFC
- Hydrogen cost estimate of 4.5 €/kg with a novel cost model.

FUTURE STEPS AND PLANS

- CH2P has been delayed and an amendment submitted to ask for a 9-month extension, with the project ending in April 2022. The amendment process is ongoing and will help mitigate delays due to the COVID-19 pandemic and technical challenges
- The full 20 kg H_2/day system, the alpha version, will be tested completely by HyGear by September 2021. The alpha system is close to finalisation and is expected to be shipped from SOLIDpower to HyGear in the coming months
- The second 20 kg H_2/day module will be built with improved components (gamma system), allowing operation in electrolysis mode (not tested in this project). The gamma system should be ready for shipment from SOLIDpower to HyGear in July 2021
- The full 40 kg H_2/day system will integrate the gamma and alpha modules into a modular and flexible prototype. The assembly, planned for November 2021, represents a key milestone for CH2P
- The full system will be tested in a real operating environment.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
AWP 2016	System size	kg H_2/day	20	80 %	✗
	Flexible cogeneration of H_2 and power	%	50 + 50	80 %	✗
	System efficiency	%	65	79	✓

CLEARgen Demo

THE INTEGRATION AND DEMONSTRATION OF LARGE STATIONARY FUEL CELL SYSTEMS FOR DISTRIBUTED GENERATION

Project ID:	**303458**
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
Project total costs:	**€10 343 142.60**
FCH JU max. Contribution:	**€4 590 095**
Project start - end:	01/05/2012 - 30/09/2020
Coordinator:	**BALLARD POWER SYSTEMS EUROPE AS, DK**
Website:	**www.cleargen.eu**

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

PROJECT AND OBJECTIVES

The main objectives of the CLEARgen demo project are:

- the development and construction of a large-scale fuel cell system, purpose-built for the European market
- the validation of the technical and economic readiness of the fuel cell system at megawatt scale
- the field demonstration and development of a megawatt-scale system at a European chemical production plant.

The demonstration site was chosen for its ability to provide a strong reference and to convince future operators of the relevance of large-scale stationary fuel cell applications.

PROGRESS AND MAIN ACHIEVEMENTS

- Delivery of a European-compliant ClearGenTM fuel cell system
- Fuel purification system design produced and installed
- Fuel cell system and components installed and ready for operation.

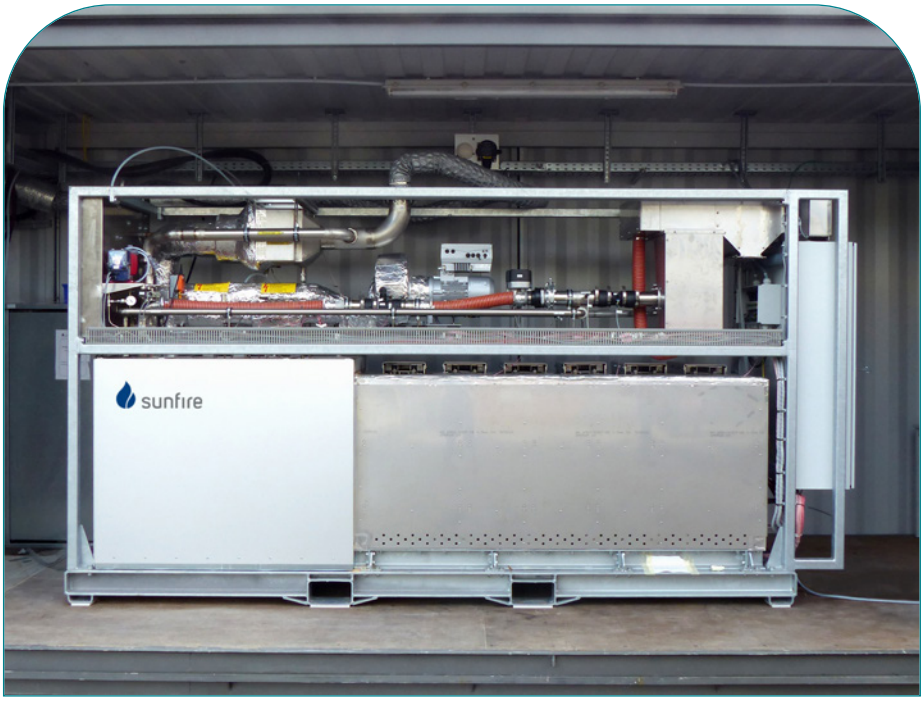
FUTURE STEPS AND PLANS

- Commissioning of PSA was delayed due to coronavirus travel restrictions, which prevented the commissioning team from Xebec, Canada, from travelling
- Commissioning of the fuel cell system was delayed due to coronavirus travel restrictions, which prevented the commissioning team from Ballard, Canada, from travelling
- System operation was delayed
- Monitoring and reporting were delayed.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
AIP 2011	Lifetime (between FC refurbishment)	Hours	40 000	N/A	✗
	Performance loss	%	<3	N/A	✗
	Service and maintenance cost	€ cents/kW	4.5	N/A	✗
Project's own objectives	Electrical efficiency	%	48	50	✓
	Cost	Euro	300 000	300 000	✓
	Availability	%	90-95 %	N/A	✗

COMSOS
COMMERCIAL-SCALE SOFC SYSTEMS



Project ID:	**779481**
Call topic:	**FCH-02-11-2017** - Validation and demonstration of commercial-scale fuel cell core systems within a power range of 10-100 kW for selected markets/applications
Project total costs:	**€10 277 897.50**
FCH JU max. Contribution:	**€7 486 954.75**
Project start - end:	01/01/2018 - 31/08/2022
Coordinator:	**TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, FI**
Website:	**www.comsos.eu**

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

PROJECT AND OBJECTIVES

The key objective of the ComSos project is to validate and demonstrate fuel cell-based combined heat and power (CHP) solutions in the mid-sized power ranges of 10-12 kW, 20-25 kW and 50-60 kW (referred to as Mini FC-CHP). The core of the consortium consists of three SOFC system manufacturers aligned with individual strategies along the value chain: SOLIDpower, Sunfire and Convion.

PROGRESS AND MAIN ACHIEVEMENTS

- Convion C60 product design has been refined for serial manufacturing
- The design phase of the SOLIDpower BG-60 unit is almost complete
- First Sunfire CHP has been shipped to Taiwan and installed for customer use.

FUTURE STEPS AND PLANS

- Assembly and testing of the beta prototype of the BG-60 unit. FAT test will be finalised in 2021
- Manufacturing of both Convion units and their FAT tests will be done in 2021
- The commissioning and installation of two additional Sunfire units will be done in 2021.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
MAWP Addendum (2018-2020)	SME participation	%	25	50	✓
	NOx emission	mg/kWh	40	<40	
	Electrical efficiency	%	42-55	> 50	

DEMOSOFC

DEMONSTRATION OF LARGE SOFC SYSTEM FED WITH BIOGAS FROM WWTP

DEMOSOFC
FCH2-JU PROJECT

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 - 31/10/2020
Coordinator:	**POLITECNICO DI TORINO, IT**
Website:	**demosofc.wordpress.com/**

BENEFICIARIES: CONVION OY, IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE, RISORSE IDRICHE SPA, SOCIETA METROPOLITANA ACQUE TORINO SPA, TEKNOLOGIAN TUTKIMUSKESKUS VTT OY

PROJECT AND OBJECTIVES

The DEMOSOFC project demonstrates the technical and economic feasibility of operating a 110 kWe SOFC system in a wastewater treatment plant. The final plant layout includes only 2 SOFC modules (1 x 58 kWe and 1 x 44 kWe). The first SOFC module was activated in October 2017 and the second in October 2018. More than 14 100 hours of on-site operation have been reached (SOFC 1 operation, followed by SOFC 2 operation, and finally some months of SOFC 1 and 2 running in parallel).

NON-QUANTITATIVE OBJECTIVES

- Training end-user (SMAT) technicians on the new fuel cell system. Three training courses have been held
- Visits to the demo sites organised with a standardised format, for people from all over the world
- Technical experience. Build technical knowledge, customer and investor confidence. Lessons learned for replicating detailed engineering, construction, installation and management in the long run. Definition of optimal detailed engineering at minimum cost
- A complete FMEA of the demo: this was developed and offers lessons and experience for the future
- Dissemination via press releases, webinars, social media (Facebook, Twitter, etc.), website, workshops at demo site and elsewhere, conferences, public events and technical papers.

PROGRESS AND MAIN ACHIEVEMENTS

- High electrical efficiency, always higher than 50 %, with peaks at 56 %
- Zero emissions to atmosphere, NOx, SOx, VOC and PM below detection limits
- >14 100 hours of on-site operation (7 100+ for SOFC 1 and 10 200+ for SOFC 2).

FUTURE STEPS AND PLANS

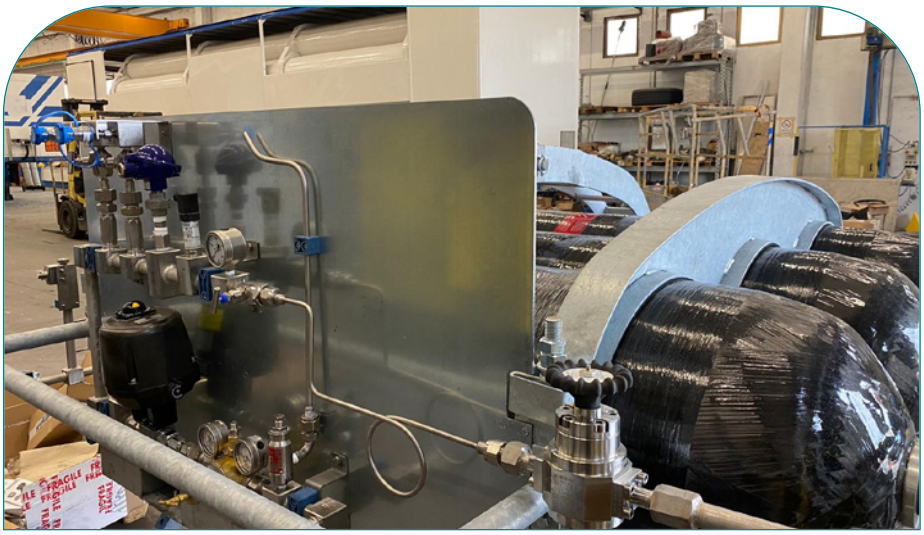
The project finished at the end of October 2020.

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	✓
	NOx emissions	mg/kWh	<40	<160	✗
	Availability of the plant	%	97	60	✗
	Thermal efficiency	% LHV	24-42	30-35	✓
	Lifetime	Years of plant operation	8-20	3.5	✗

EVERYWH2ERE

MAKING HYDROGEN AFFORDABLE TO SUSTAINABLY OPERATE EVERYWHERE IN EUROPEAN CITIES



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

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

PROJECT AND OBJECTIVES

EVERYWH2ERE's goal is to integrate PEMFC subsystems and intrinsically safe pressurised hydrogen storage technologies into FC-based transportable gensets that are easy to install and transport. Eight FC containered 'plug and play' gensets (4 x 25 kW - 4 x 100 kW) will be realised and tested at construction sites, music festivals and urban public events all around Europe. The first two prototypes have been realised and are being commissioned. Environmental, economic, safety and regulatory aspects have been analysed to inform and promote the demonstration campaign and the project's road-to-market strategy.

NON-QUANTITATIVE OBJECTIVES

- Higher social acceptance of FCH technology
- Demonstration of FC-based gensets at events, festivals, etc. gives strong visibility to FCH technologies
- Easier permitting
- Development of an HSE guideline (with a mini-HAZOP) to facilitate permitting and maybe a future dedicated regulation/technical norms.

PROGRESS AND MAIN ACHIEVEMENTS

- Realisation of the first two FC-based transportable gensets (1 x 25 kW and 1 x 100 kW) and of related hydrogen storage bundles
- Assessment of the cost of the system and potential related market value proposition/business model
- Assessment of the environmental footprint (via LCA/LCC).

FUTURE STEPS AND PLANS

- Demonstration of gensets
- Enhancement of LCA and LCC analysis
- Refinement of the gensets' executive design
- Testing of ejector solutions
- Finalisation of a road-to-market strategy

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives	**LCOE of the genset** *Identification of replication market with contractual costs in a range of +/-10 % compared to current power supply solutions*	€/kWh	1.1	N/A	✓	1 €/kWh for diesel gensets according to rental market stakeholders. According to LCC, the current €/kWh is very close to 1.10: this value has to be validated and evaluated for contractual/business purposes	2025
	Noise emission *Noise emission of the full genset (not only the FC SuSy)*	dB	<65	60	✗	Diesel gensets insulated if very noisy (first tests guarantee operation at <60 dB), mostly due to the fan of the FC thermal loop	2020
	Future manufacturing CAPEX *CAPEX of the system*	€/kW	5 500	6 850	✗	No FC-based gensets today (according to stakeholders a 1 500-2 000 €/kW may be acceptable)	2025

PACE
PATHWAY TO A COMPETITIVE EUROPEAN FC MCHP MARKET

Project ID:	**700339**
Call topic:	**FCH-02.9-2015** - Large scale demonstration µCHP fuel cells
Project total costs:	**€84 462 140.62**
FCH JU max. Contribution:	**€33 932 752.75**
Project start - end:	01/06/2016 - 31/08/2021
Coordinator:	**THE EUROPEAN ASSOCIATION FOR THE PROMOTION OF COGENERATION VZW, BE**
Website:	**www.pace-energy.eu**

BENEFICIARIES: ELEMENT ENERGY, REMEHA GMBH, REMEHA NV, VIESSMANN ELEKTRONIK GMBH, VIESSMANN WERKE ALLENDORF GMBH, BDR THERMEA GROUP BV, SOLIDPOWER GMBH, SUNFIRE FUEL CELLS GMBH, REMEHA BV, VIESSMANN WERKE GMBH & CO KG, SUNFIRE GMBH, BAXI INNOTECH GMBH, BOSCH THERMOTECHNIK GMBH, SOLIDPOWER SPA, SENERTEC KRAFT-WARME ENERGIESYSTEMEGMBH, EWE AKTIENGESELLSCHAFT, VAILLANT GMBH, ELEMENT ENERGY LIMITED, HEXIS AG, FACHHOCHSCHULE ZENTRALSCHWEIZ - HOCHSCHULE LUZERN, DANMARKS TEKNISKE UNIVERSITET

PROJECT AND OBJECTIVES

The PACE project will deploy more than 2 800 next-generation FC micro-cogeneration units in 10 European countries by 2021. The focus is on private homes and small enterprises. The project brings together the five leading European suppliers. Manufacturers are supported by associations, consultancies and the research community, who provide specific expertise.

NON-QUANTITATIVE OBJECTIVES

Operability of units: the commissioned units are in operation more than 99 % of the time.

PROGRESS AND MAIN ACHIEVEMENTS

- Manufacturers have put models with improved performance on the market
- To date, 2 183 units have been sold and 1,688 installed
- Targeted lobbying activities have led to favourable market conditions in certain countries.

FUTURE STEPS AND PLANS

Complete the deployment of 2 800 units. More than 1 000 units still need to be sold and commissioned by the end of December 2021.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
Project's own objectives	Decrease of FC micro-cogeneration unit cost	%	30	N/A	✗
	Number of commissioned units	-	2 800	1 688	
	Number of manufactured units*	-	1 000	>1 000	✓

*per manufacturer per year

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:	**€6 753 851.25**
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/**

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

PROJECT AND OBJECTIVES

REMOTE will demonstrate the technical and economic feasibility of fuel cell-based H2 energy storage solutions (integrated P2P, non-integrated P2G + G2P systems, customised P2P systems), deployed in 3 demos, based on renewables (solar, wind, hydro) in isolated micro-grid or off-grid remote areas. The analysis of the technical, economic and regulatory framework for the demos was completed in 3.5 years (March 2021).The design, engineering, plan for O&M and permitting procedures have been assessed for all the demos. Two demos have been installed (Norway, Greece) and are now running.

NON-QUANTITATIVE OBJECTIVES

- Gain experience of P2P systems throughout the value chain. Validate real demonstration units in representative applications of isolated micro-grid or off-grid areas, to enable suppliers, end users and other stakeholders to gain wide experience for the future deployment of these energy solutions
- Identify gaps in regulations. The lessons learnt from the demo plants' design, installation and operation will help identify gaps in regulations, allowing full-scale exploitation of H2-based energy storage in the energy market (not only for islands or remote areas)
- Creation of know-how for next-generation P2P. Through the demo's design, installation and operation, REMOTE will create fundamental know-how for the next generation of fully integrated P2P chains based on fuel cells and H2 technologies adapted to the market and society's needs, leading to scientific advances in the management of off-grid and isolated micro-grids
- The project will help us understand in detail the complete LCA of RES-fed H2-based P2P systems in remote areas, in terms of metrics such as global GHG reduction, thanks to the adoption of H2 as a local RES storage system on a seasonal level.

PROGRESS AND MAIN ACHIEVEMENTS

- Demo 4 started operating in Norway at the end of 2020 with stored H2. In May, it started running with the electrolyser
- Demo 2 started operating in Greece in autumn 2020 with a temporary load, to be replaced with the real local load
- The new demo 1 in the Canary Islands (Spain) has been defined and is now subject to detailed engineering.

FUTURE STEPS AND PLANS

- Operation and full analysis of demo in Norway: finalise the installation of the electrolyser to have the full plant running
- Operation and full analysis of demo in Greece: finalise the connection to the local load to have the full plant running
- The new demo 1 site has been selected and the new partners are developing the detailed engineering and permitting procedures. Construction and commissioning will follow.

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 electrolyser (PEM)	kWh/kg	55,5	50.5 (rated value, to be measured on demo)	✓	50	2020
	Lifetime	years of plant operation	8 - 20	15 (fuel cell) - 20 (surrounding equipment) estimated	✓ (estimation)	N/A	N/A
	Electrolyser footprint (PEM)	m^2/MW	100	273	✗	10	2018-2020
	Rated efficiency electrolyser (alkaline)	kWh/kg	50	50.6 (rated value, to be measured on demo)	✓	N/A	N/A
	Rated efficiency fuel cell (PEM)	%LHV	42-60	45	✓	51	2018

RoRePower
ROBUST AND REMOTE POWER SUPPLY

Project ID:	**824953**
Call topic:	**FCH-02-3-2018** - Robust, efficient long term remote power supply
Project total costs:	**€4 220 093.75**
FCH JU max. Contribution:	**€2 999 190.26**
Project start - end:	01/01/2019 - 31/12/2022
Coordinator:	**TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, FI**
Website:	**rorepower.com**

BENEFICIARIES: 3E ENERGY OY, SUNFIRE FUEL CELLS GMBH, SUNFIRE GMBH, SOLIDPOWER SPA, EUROPEAN FUEL CELL FORUM AG

PROJECT AND OBJECTIVES

The overall objective of this project is to further develop and demonstrate solid oxide fuel cell (SOFC) systems for off-grid power generation in markets such as gas and oil infrastructure in remote regions with harsh climate conditions (from -40 °C to +50 °C), and to supply power to telecommunication towers (e.g. telecom base stations or microwave transceivers), especially in emerging countries.

FUTURE STEPS AND PLANS

- Finalise certification of fuel cell units according to IEC EN62882-3-100 and CSA/ANSI FC1 before Q3/2021
- Produce the first BG-Remote system prototype (container). These units will be delivered to Finland in Q2-Q3/2021
- SOLIDpower BG-Remote (LNG) units will be delivered to Sardinia in Q2-Q3/2021

PROGRESS AND MAIN ACHIEVEMENTS

- The 12 RoRePower units have been installed at customer sites
- Sunfire-Remote 400 and 900 passed the design freeze process and are on the market
- Sunfire-Remote 400 Gen. 2 provides nominal power after 15 000 hours of operation and 30 on-off cycles.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
AWP 2019	Electrical efficiency	%	>35	>35	✓
	Start-up temperature for propane	°C	-30	-30	✓
	Long-term desulphurisation	Months	15	15	✓