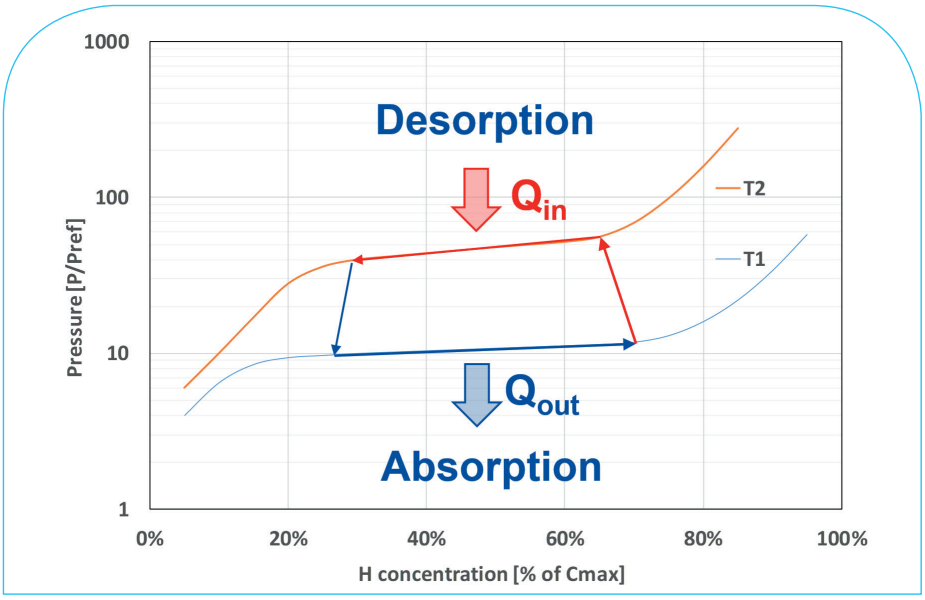
COSMHYC

COMBINED HYBRID SOLUTION OF MULTIPLE HYDROGEN COMPRESSORS FOR DECENTRALISED ENERGY STORAGE AND REFUELLING STATIONS

Project ID:	**736122**
Call topic:	**FCH-01-8-2016 -** Development of innovative hydrogen compressor technology for small scale decentralized applications for hydrogen refuelling or storage
Project total costs:	**€ 2,496,830**
FCH JU max. Contribution:	**€ 2,496,830**
Project start - end:	01/01/2017 - 30/09/2020
Coordinator:	**EIFER EUROPAISCHES INSTITUT FUR ENERGIEFORSCHUNG EDF KIT EWIV, DE**
Website:	**www.cosmhyc.eu**

BENEFICIARIES: STEINBEIS INNOVATION GGMBH, LUDWIG-BOELKOW-SYSTEMTECHNIK GMBH, NEL HYDROGEN AS, MAHYTEC SARL, STEINBEIS 2I GMBH



PROJECT AND OBJECTIVES

COSMHYC develops a hybrid compression solution for hydrogen refuelling stations by combining an innovative metal hydride compressor with a mechanical compressor, for a compression from 1 to 1000bar. The objectives are to decrease investment and operational costs, to reduce noise level, to increase the availability of stations, and thus to increase the efficiency of hydrogen delivery. MAHYTEC, EIFER and NEL are currently focussing on the integration of both technologies, which are tested in a comprehensive way. Techno-economic assessment is performed to ensure competitiveness.

NON QUANTITATIVE OBJECTIVES

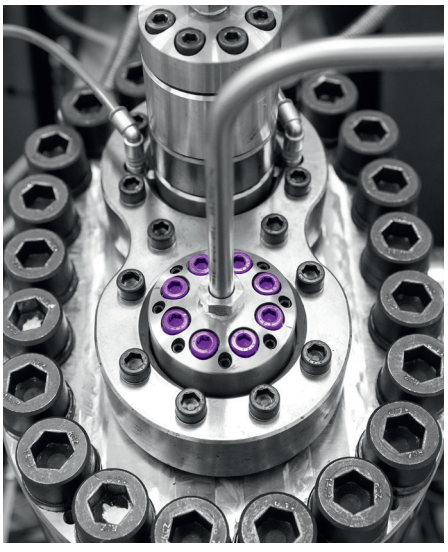
- Modularly scalable
- Increase reliability, currently no moving part in the innovative compressor
- Perform a cost of ownership assessment

PROGRESS & MAIN ACHIEVEMENTS

- Definition of technical requirements for the compression solution for selected applications (refuelling of FC cars, busses and trains, H2 trailers)
- Production of 3 hydrides without rare earth with appropriate features for the innovative compressor which concept has been finalized
- Design of a new concept of mechanical compression due to improved materials for the diaphragm, performing heating/cooling and noise reduction.

FUTURE STEPS & PLANS

- Long-time testing of COSMHYC compression solution as a virtual compressor following joint test programs and protocols of both compressors & analysis
- Collection of operative and performance data and technical economic evaluation comparing processor concepts for selected applications
- Final economic feasibility and costumer value proposition analysis
- Definition of a roadmap toward exploitation of the different compression solutions developed in COSMHYC for preparing market deployment.



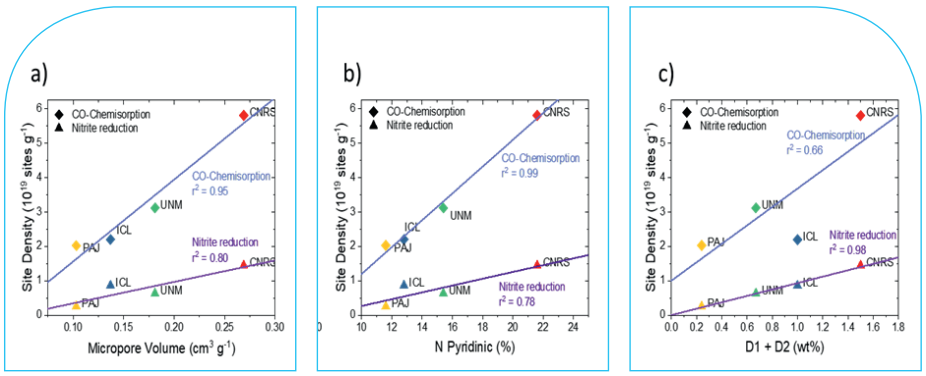
QUANTITATIVE TARGETS AND STATUS

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	Energy consumption	kWh/kg	6	6	✓	N/A	N/A
	Degradation	%/month	1	0.5	✓	N/A	N/A
	Specific costs	k€/kg*day	N/A	3.7	(SoA exceeded)	5-12	2015
	Electricity consumption	kWh/kg	N/A	<1.5	(SoA exceeded)	3	2017
	Noise	DB	N/A	<60	(SoA exceeded)	85	2017

CRESCENDO

CRITICAL RAW MATERIAL ELECTROCATALYSTS REPLACEMENT ENABLING DESIGNED POST-2020 PEMFC

Project ID:	**779366**
Call topic:	**FCH-01-2-2017** - Towards next generation of PEMFC: Non-PGM catalysts
Project total costs:	**€ 2,739,602.5**
FCH JU max. Contribution:	**€ 2,739,602.5**
Project start - end:	01/01/2018 - 31/12/2020
Coordinator:	**CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS, FR**
Website:	**www.crescendo-fuelcell.eu**



BENEFICIARIES: UNIVERSITA DEGLI STUDI DI PADOVA, IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE, COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, TECHNISCHE UNIVERSITAT BERLIN, JOHNSON MATTHEY PLC, BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT, PRETEXO, JOHNSON MATTHEY FUEL CELLS LIMITED, UNIVERSITÉ DE MONTPELLIER

PROJECT AND OBJECTIVES

CRESCENDO aims to progress research on non-PGM fuel cell catalysts, develop diagnostic methods to characterise their active site density and turnover frequency and realise successful approaches for the stabilisation on operation of non-PGM cathode catalysts, as well as advancing research on non-PGM and ultra-low PGM hydrogen oxidation catalysts.
The reasons for high losses with current non-PGM cathode catalyst layers are analysed, and the learning used to re-design the catalyst layer, with the objective of achieving 0.42 W/cm2 at 0.7 V and 1000 h operation with the finally configured MEA.

NON QUANTITATIVE OBJECTIVES

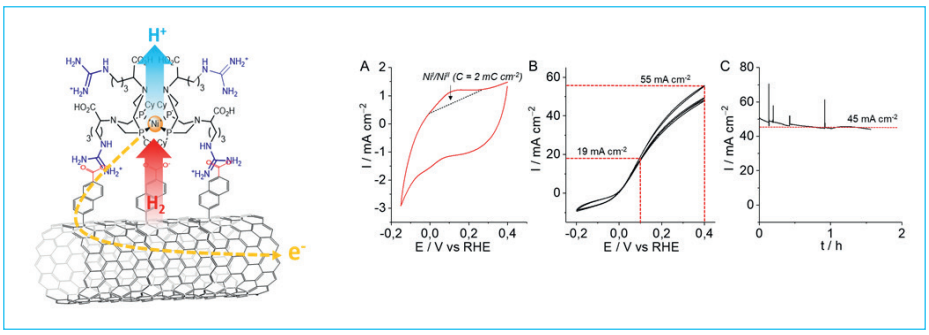
International collaboration with IPHE countries. Two meetings between CRESCENDO and scientists working in IPHE countries (mainly USA) were held in the first 12 months of the project.

PROGRESS & MAIN ACHIEVEMENTS

- Two diagnostic methods were developed to determine active site density and turnover frequency of non-PGM catalysts, so facilitating materials design
- A project catalyst reached ~ 0.92 A g-1 at 0.9 V vs. RHE, nearly reaching the M12 stage-gate target of 1.0 A g-1 at 0.9 V vs. RHE
- Analysis of the losses in MEAs with the reference non-PGM catalyst has led to layer redesign and improved performance.

FUTURE STEPS & PLANS

- Improve cathode non-PGM catalyst activity and stability to reach AWP targets
- Implement the most prospective cathode non-PGM catalysts in improved catalyst layers to reach AWP targets
- Demonstrate H2S tolerance of anode non-PGM catalysts
- Implement most prospective CRESCENDO anode and cathode catalyst in an all-non-PGM MEA
- Accelerate catalyst development by further study of the relation between site density, turnover frequency, catalyst physical properties and activity.



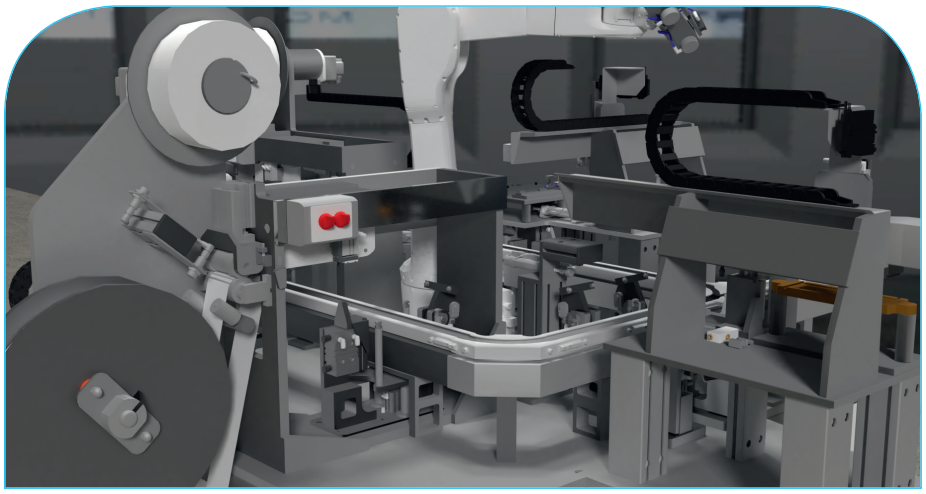
QUANTITATIVE TARGETS AND STATUS

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 month 18 ex situ performance target from RDE or floating electrode for non-PGM cathode catalyst	Mass activity at 0.9 V IR free	A/g	1	0.92	✗	Mass activity SoA not available. SoA current density at 0.9 V IR free reported as 36 mA/cm2	2019
AWP 2018 for non-PGM cathode catalyst	Cell voltage at 600 mA/cm2, on H2/air	V	0.7	0.47	✗	0.49	2019
	Durability at 1.5 A/cm2	hours	1000	Planned for RP2	✗	No data available at 1.5 A/cm2	N/A
Project's own objective for non-PGM anode catalyst	Mass activity at 0.9 V IR free	A/mg non-PGM	35	25	✓	7	2016

DIGIMAN
MW FUEL CELL MICRO GRID AND DISTRICT HEATING AT KING'S CROSS

Project ID:	**736290**
Call topic:	**FCH-01-1-2016** - Manufacturing technologies for PEMFC stack components and stacks
Project total costs:	**€ 3,486,965**
FCH JU max. Contribution:	**€ 3,486,965**
Project start - end:	01/01/2017 - 31/12/2019
Coordinator:	**COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, FR**
Website:	**digiman.eu**

BENEFICIARIES: FREUDENBERG PERFORMANCE MATERIALS SE & CO KG, INTELLIGENT ENERGY LIMITED, PRETEXO, THE UNIVERSITY OF WARWICK, TOYOTA MOTOR EUROPE



PROJECT AND OBJECTIVES

The project advances (MRL4 > MRL6) the critical steps of the PEM fuel cell assembly processes and associated in-line QC and demonstrates a route to automated volume process production capability within an automotive best practice context. This includes characterization and digital codification of physical attributes of key materials (e.g. GDLs) to establish yield impacting digital cause and effects relationships within the value chain Industry 4.0 standards. Main outputs are a Proof of Process and a blueprint design for beyond current state automotive PEM fuel cell manufacturing in Europe.

NON QUANTITATIVE OBJECTIVES

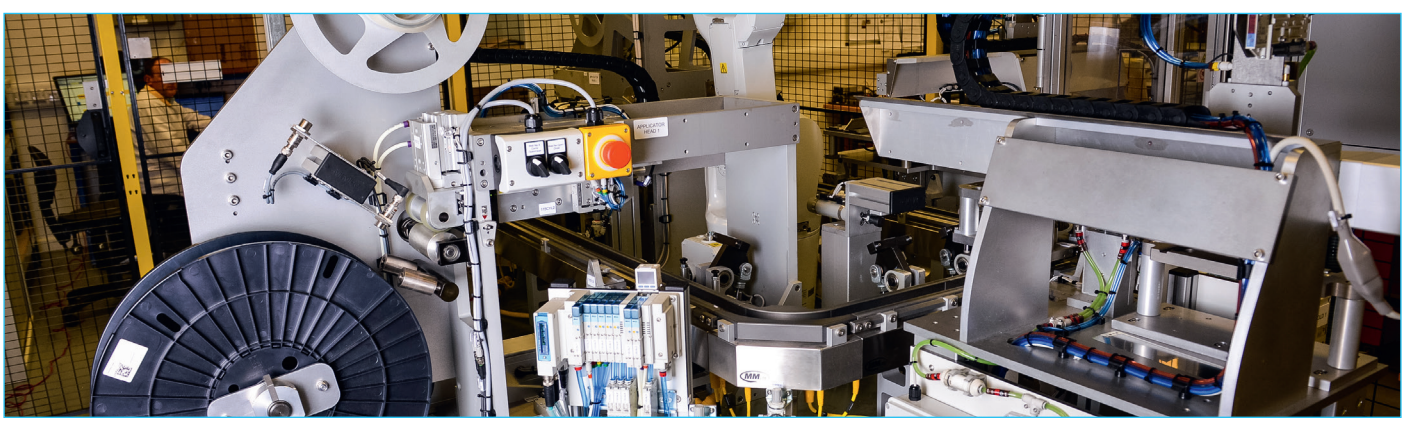
- Inline digital detection and marking of Surface non-uniformities via Vision line
- Integration of inline non-destructive quality control tools
- Development of beyond state technologies, specific to PEMFC stack production
- Improvement, modification, adaptation, of component production steps
- Development of digital boundary limits to empirically derived homogeneity data have been developed process.

PROGRESS & MAIN ACHIEVEMENTS

- KPIs for i) fully automated stack assembly / test via automotive best practice and ii) stack performance at handover into an automotive production lin
- Proof-of-process demonstrator equipment for the uplifted cell assembly automation has been manufactured and is under validation tests
- Deep characterisation of GDL properties has enabled the development of meaningful automatic scanning techniques for digital QC and upstream/ downstream.

FUTURE STEPS & PLANS

- Finalize PoP validation and blueprint design
- Finalize QC analysis and recommendations
- Identify inline defect marking concept for AC64 GDL-type
- Complete automation uplift and provide proof of MRL6 attainment
- Complete specification of blue-print design and technical cost model demonstrator.



QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
Project's own objective	Stack weight	kg	2.9	2.9	✓
	Stack volume	l	2.85	2.85	✓
	Stack capacity	t	2.1	2.1	✓

Fit-4-AMandA

FUTURE EUROPEAN FUEL CELL TECHNOLOGY: FIT FOR AUTOMATIC MANUFACTURING AND ASSEMBLY

Project ID:	**735606**
Call topic:	**FCH-01-1-2016** - Manufacturing technologies for PEMFC stack components and stacks
Project total costs:	**€ 2,999,185**
FCH JU max. Contribution:	**€ 2,999,185**
Project start - end:	01/03/2017- 29/02/2020
Coordinator:	**UNIRESEARCH BV, NL**
Website:	**www.fit-4-amanda.eu**

BENEFICIARIES: FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V., TECHNISCHE UNIVERSITAET CHEMNITZ, IRD FUEL CELLS A/S, PROTON MOTOR FUEL CELL GMBH, UPS EUROPE SA, AUMANN LIMBACH-OBERFROHNA GMBH

PROJECT AND OBJECTIVES

Fit-4-AMandA's ambition is to modify the current design of PEMFC stacks and stack components, and build an entirely new equipment facilitating automation of the stack assembly process (including inline non-destructive tests). Furthermore, it will demonstrate the resulting mass-produced stacks in real environment – by integration the output into a Light- (and Medium-) Commercial-Vehicle. The project will offer the mass production machine innovative solutions, which effect process, product and tools with the objective to bring the MRL from 5 to 7.

NON QUANTITATIVE OBJECTIVES

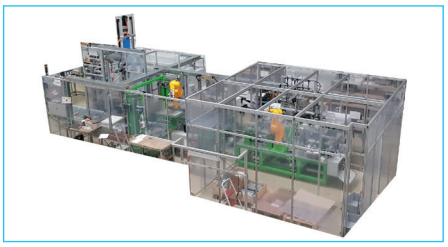
- Feasibility-study for commercial FC electrical vehicle completed
- Consolidate the technical requirements in detail for standard FC operation and need for special demands.

PROGRESS & MAIN ACHIEVEMENTS

- FAT acceptance test of the mass manufacturing machine for automatic fuel cell stack assembling
- BPP design for moulding verified
- Concept of FC integration into a UPS base vehicle is complete and performance requirements of the vehicle are ready.

FUTURE STEPS & PLANS

- Solve BPP sealing - currently replaced with adhesive bonding methods
- Statistical analysis and optimisation of the inline testing methods & validation of the in-line testing methods
- Continue to see suppliers of relevant hydrogen storage tanks and evaluating proposed solutions, including ensuring specification update and engineering available.



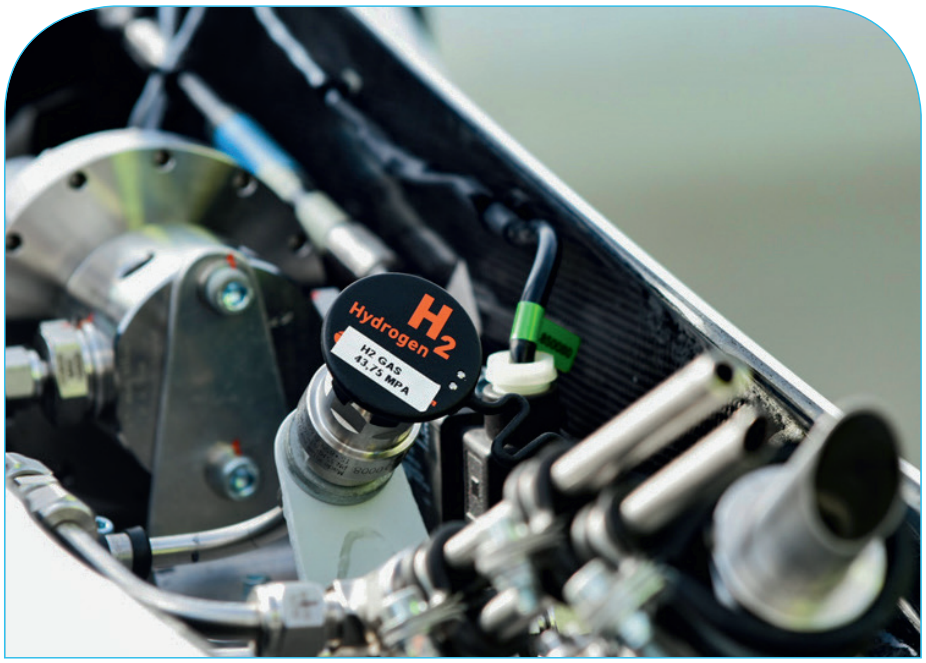
QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objective	Project process: Energy per MW	Kwh/MW	200	✓
	FC system lifetime	hours	6,000	✗
	Specific FC system cost	€/kW	100	✗

FLHYSAFE
FUEL CELL HYDROGEN SYSTEM FOR AIRCRAFT EMERGENCY OPERATION

Project ID:	**779576**
Call topic:	**FCH-01-1-2017** - Development of fuel cell system technologies for achieving competitive solutions for aeronautical applications
Project total costs:	**€ 7,365,901.25**
FCH JU max. Contribution:	**€ 5,063,023**
Project start - end:	01/01/2018 - 31/12/2020
Coordinator:	**SAFRAN POWER UNITS, FR**
Website:	**www.flhysafe.eu**

BENEFICIARIES: COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV, UNIVERSITAET ULM, ARTTIC, INSTITUTO NACIONAL DE TECNICA AEROESPACIAL ESTEBAN TERRADAS, ZODIAC AEROTECHNICS SAS



PROJECT AND OBJECTIVES

FLHYSAFE overall objectives:

- To demonstrate that the current Ram Air Turbine (RAT) of a commercial aircraft can be replaced by a fuel cell based modular system able to increase functionality and safety while reducing costs
- Virtually demonstrate that such FC based modular system can be integrated into current aircraft design and comply with mass and volume requirements and maintenance constraints.

NON QUANTITATIVE OBJECTIVES

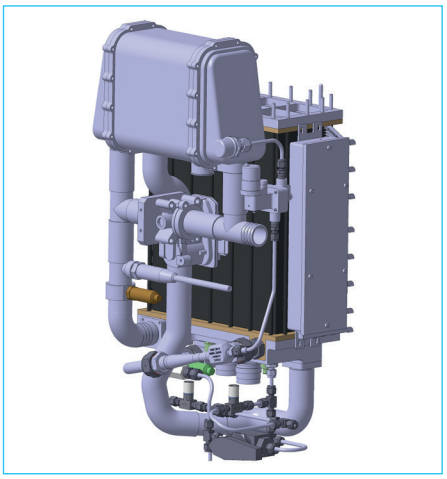
- Prepare a plan of environmental tests to get airworthiness qualification. INTA has initiated the regulations study and the test plan is under work
- Compliance with current regulation codes and standards. Design is ongoing, based on functional analysis and FHA results.

PROGRESS & MAIN ACHIEVEMENTS

- Delivery of the Emergency Power Unit system specification
- Delivery of the Functional analysis
- All subsystems developments are in progress.

FUTURE STEPS & PLANS

- Derive the functional analysis and the FHA to a System Technical Specification and to Sub-systems Technical Specifications
- Design System and Sub-Systems Validate System and Sub-Systems in accordance with corresponding Technical Specification by testings, analysis or similarity
- Demonstrate procedures for maintenance training with VR tool
- Project the complete fuel cell system into aircraft integration area.



QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objective	EPU weight	kg	150	design is ongoing here
	EPU volume	L	200	
	EPU efficiency at rated power	%	40	
	Power density FC subsystem	kW/kg	2	
	Power density FC subsystem	kW/L	2.5	

Giantleap

GIANTLEAP IMPROVES AUTOMATION OF NON-POLLUTING TRANSPORTATION WITH LIFETIME EXTENSION OF AUTOMOTIVE PEM FUEL CELLS

Project ID:	**700101**
Call topic:	**FCH-01.2-2015** - Diagnostics and control for increased fuel cell system lifetime in automotive applications
Project total costs:	**€ 3,260,297.5**
FCH JU max. Contribution:	**€ 3,260,297.5**
Project start - end:	01/05/2016 - 31/10/2019
Coordinator:	**SINTEF AS, NO**
Website:	**giantleap.eu**

BENEFICIARIES: STIFTELSEN SINTEF, UNIVERSITÉ DE FRANCHE-COMTE, SVEUCILISTE U SPLITU, FAKULTET ELEKTROTEHNIKE, STROJARSTVA I BRODOGRADNJE, BOSCH ENGINEERING GMBH, ECOLE NATIONALE SUPERIEURE DE MECANIQUE ET DES MICROTECHNIQUES, ELRINGKLINGER AG, INSTITUT FRANCAIS DES SCIENCES ET TECHNOLOGIES DES TRANSPORTS, DE L'AMENAGEMENT ET DES RESEAUX, VDL BUS & COACH BV, VDL BUS ROESELARE, VDL BUS CHASSIS BV, VDL ENABLING TRANSPORT SOLUTIONS BV

PROJECT AND OBJECTIVES

Giantleap's objectives are to develop advanced diagnostic, prognostic and control systems for automotive PEM fuel cell stacks and systems, and to test them in a demonstration of a hybrid battery bus connected to a detachable fuel-cell range extender.
The project has delivered results, with improved understanding of rejuvenation phenomena to revert fuel-cell degradation, prognostics applied to critical BoP components such as compressors, estimator algorithms able to run a pseudo-EIS with no extra equipment, and a demonstration that has been extended from TRL 6 to 7.

NON QUANTITATIVE OBJECTIVES

- Report being written for Evaluation of business case for H2 ranger extenders for battery buses
- Report published for Rejuvenation techniques
- Concept demonstrated, further experiments ongoing for on-board diagnostics without need for extra equipment.

PROGRESS & MAIN ACHIEVEMENTS

- Systematic study of fuel-cell rejuvenation
- Prognostic analysis of compressors in FC systems
- Fast, automatic low-frequency EIS with no extra equipment.

FUTURE STEPS & PLANS

- Demonstration of prototype on track (TRL 6)
- Demonstration of prototype on road (TRL 7)
- Analysis of data from demonstration
- Collection and publication of data.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
Project's own objectives	Energy Consumption of EHP Stack	kWh/kg H2	3	3	✓
	Recovery Rate EHP Short-Stack	%	>90	90	✓
	Recovery Rate Single Cell	%	>90	90	✓
	Energy Consumption at Targeted Recovery Rate	kWh/kg H2	3	5	✗

H2REF

DEVELOPMENT OF A COST EFFECTIVE AND RELIABLE HYDROGEN FUEL CELL VEHICLE REFUELLING SYSTEM

Project ID:	**671463**
Call topic:	**FCH-01.5-2014** - Development of cost effective and reliable hydrogen refuelling station components and systems for fuel cell vehicles
Project total costs:	**€ 7,127,941.25**
FCH JU max. Contribution:	**€ 5,968,554**
Project start - end:	01/09/2015- 31/12/2019
Coordinator:	**CENTRE TECHNIQUE DES INDUSTRIES MECANIQUES, FR**
Website:	**www.h2ref.eu**

BENEFICIARIES: UNIVERSITÉ DE TECHNOLOGIE DE COMPIEGNE, LUDWIG-BOELKOW-SYSTEMTECHNIK GMBH, THE CCS GLOBAL GROUP LIMITED, HEXAGON RAUFOSS AS, H2NOVA, HASKEL FRANCE, HASKEL EUROPE LTD

PROJECT AND OBJECTIVES

H2REF addresses compression & buffering of H2 for refuelling of 70 MPa vehicles and aims to bring a novel cost effective, high-performance, and reliable hydraulics-based system from TRL 3 to 6. Following design of the process and the core compression device, a full-scale prototype compression & buffering module (CBM) was built in test area. Following the compression device testing, the full CBM including the number of compression devices for the complete compression and the dispensing cycle will be tested in a closed loop operation. The CBM will be interfaced with a vehicle dispenser for demo.

NON QUANTITATIVE OBJECTIVES

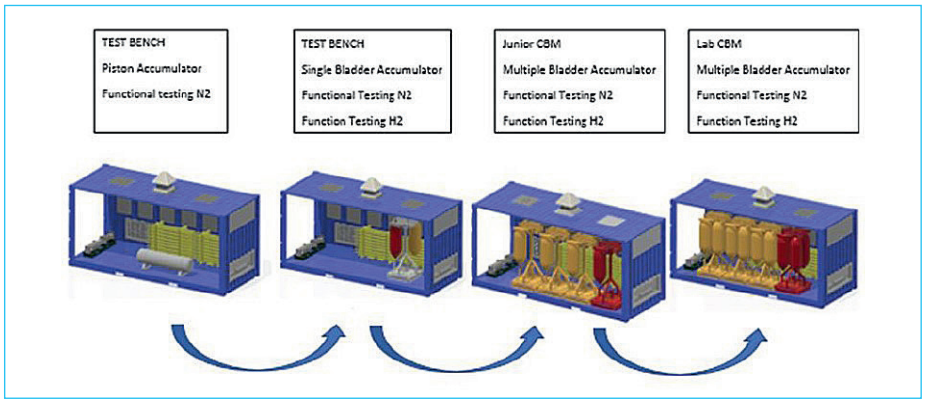
- Techno economical analysis based on project results
- Have the technology covered by the RCS framework (CEN TC 54).

PROGRESS & MAIN ACHIEVEMENTS

- CBM process developed, full scale prototype system built, and compression device hydraulic actuation successfully tested in hydrogen
- Suitable bladder material identified, and accumulator developed and qualified successfully for functional and endurance testing in CBM
- New hydrogen test area set up within Haskel premises for testing of system in hydrogen service.

FUTURE STEPS & PLANS

- Closed loop functional testing of the CBM process
- Dispensing tests with mock vehicle tank
- Certify the purity of hydrogen dispensed by the system
- Endurance testing of the CBM.



QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
Project's own objective	TRL	n/a	6	4	
	Unit cost	k€	300	N/A	
	Capacity	kg/hour	30	N/A	
	Consumption	kWh/kg	1.5	N/A	

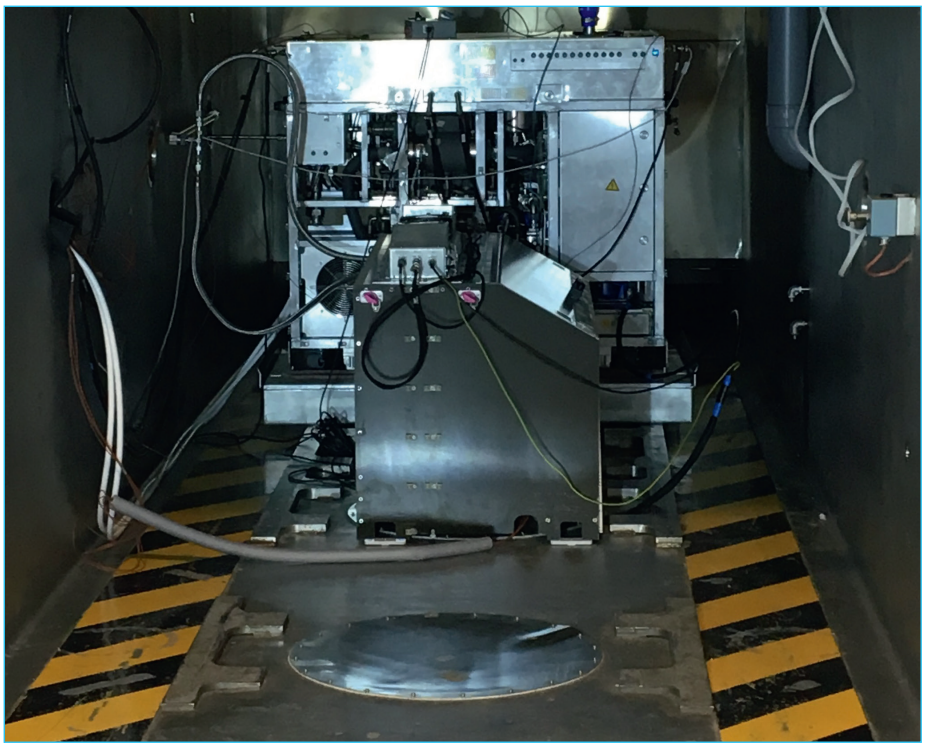
HYCARUS
HYDROGEN CELLS FOR AIRBORNE USAGE

Project ID:	**325342**
Call topic:	**SP1-JTI-FCH.2012.1.6** - Fuel cell systems for airborne application
Project total costs:	**€ 12,064,473.93**
FCH JU max. Contribution:	**€ 5,219,265**
Project start - end:	01/05/2013 - 31/03/2019
Coordinator:	**ZODIAC AEROTECHNICS SAS, FR**
Website:	**www.hycarus.eu**

BENEFICIARIES: COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, JRC -JOINT RESEARCH CENTRE- EUROPEAN COMMISSION, DASSAULT AVIATION SA, ARTTIC, INSTITUTO NACIONAL DE TECNICA AEROESPACIAL, ZODIAC ECE, DRIESSEN AEROSPACE CZ SRO, ZODIAC CABIN CONTROLS GMBH, AIR LIQUIDE ADVANCED TECHNOLOGIES SA

PROJECT AND OBJECTIVES

The main objective of HYCARUS is to develop a Generic Fuel Cell System (GFCS) in order to power non-essential aircraft applications such as a galley in a commercial aircraft or to be used as a secondary power sources on-board business jets. Demonstration of GFCS performances in relevant and representative cabin environment (TRL6) will be achieved through flight tests on-board a Dassault Falcon aircraft. In addition, HYCARUS will assess how to valorize the by-products (heat and ODA) produced by the fuel cell system to increase its global efficiency. The project is now completed.



NON QUANTITATIVE OBJECTIVES

- Demonstrate operational capacity at ranges of altitude an in-flight variations typical for such packaged systems in aircrafts
- Fuel Cell system specification and qualification plan completed. Environmental tests (DO160) run successfully in 2018.

PROGRESS & MAIN ACHIEVEMENTS

- Demonstration in the 20-100 kW power range: 12.5 kW demonstrated. Only one configuration for one targeted application was tested
- TRL6 demonstration: done successfully.

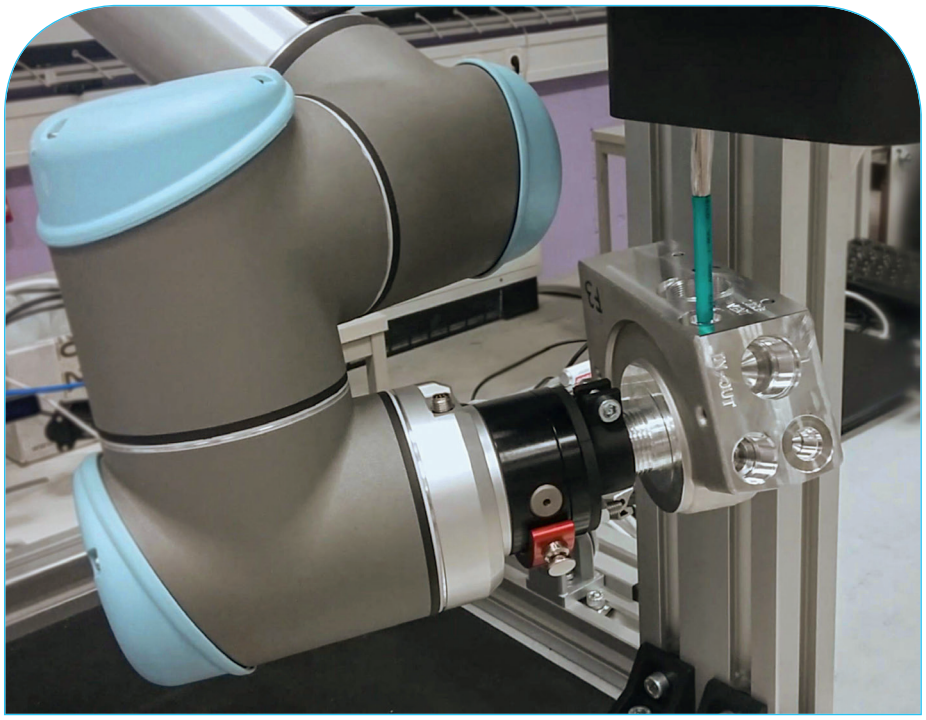
FUTURE STEPS & PLANS

Project finished.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
AIP 2011	Technology Readiness Levels for demonstrator	TRL	6	6	✓
	Power range	kW	20	12.5	✗
	Stack Durability	hours	2,500	2,000	✗
	Fuel Cell system efficiency (LHV) at 25% of rated power	%	55	45	✗

INLINE
DESIGN OF A FLEXIBLE, SCALABLE, HIGH QUALITY PRODUCTION LINE FOR PEMFC MANUFACTURING



Project ID:	**735367**
Call topic:	**FCH-01-3-2016** - PEMFC System Manufacturing technologies and quality assurance
Project total costs:	**€ 3,286,068.75**
FCH JU max. Contribution:	**€ 3,286,068.75**
Project start - end:	01/02/2017 - 31/01/2020
Coordinator:	**PROFACTOR GMBH, AT**
Website:	**www.inline-project.eu**

BENEFICIARIES: ELRINGKLINGER AG, FRONIUS INTERNATIONAL GMBH, KARLSRUHER INSTITUT FUER TECHNOLOGIE, OMB SALERI SPA

PROJECT AND OBJECTIVES

The project INLINE aims to design a flexible, scalable, high quality production line for PEMFC manufacturing. The three objectives are: Objective (A): Redesign of the media supply unit, Objective (B): Development of automated quality inspection methods to improve the end of line test, Objective (C): Scalability of the manufacturing process. The project is heading to the Demonstration number 3 where all of the developed components and processes are put together to produce 20 HyLOG Fleet Systems.

NON QUANTITATIVE OBJECTIVES

- The System enhances the Safety for the worker in preventing short circuit during mounting the batteries in the accu pack
- The projection based assembly instructions shortens the training time of the worker
- The built chamber and installed semi automation provides a safety enhancement for the worker who executes the end-of line test.

PROGRESS & MAIN ACHIEVEMENTS

- The manufacturing process of the MSU and the tank valve have both significantly been improved, this means a reduction in cycle time and costs
- The end-of-line test of the whole fuel cell system has been semi-automated, which also means a reduction in cycle time
- The assisted assembly station supports the worker through projection of the assembly steps and a robot supports through parallel screwing.

FUTURE STEPS & PLANS

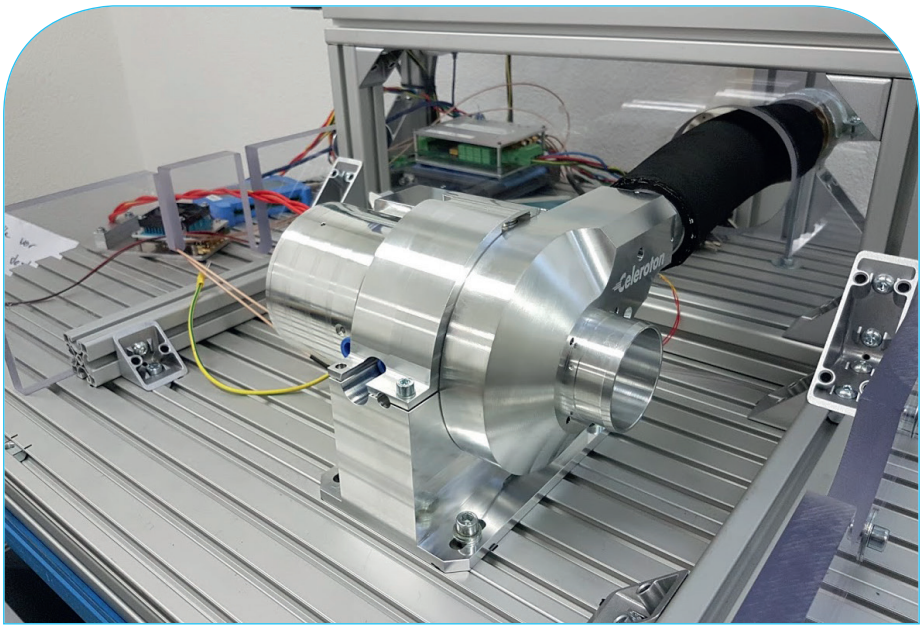
- Integration of all developed components and quality control systems in production lines
- Manufacturing of 20 sample fuel cell systems including the new designed components
- Simulation of the scalability of the production process up to 50,000 pcs/year.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
Project's own objective	Smart Camera: detection rater	%	99	95	✗
	Simulation Model: scalability factor	%	100	100	✓
	Endoscope Sensor: detection rate	%	100	85	✗
	Screwing time	seconds	5	4.82	✓

INN-BALANCE

INNOVATIVE COST IMPROVEMENTS FOR BALANCE OF PLANT COMPONENTS OF AUTOMOTIVE PEMFC SYSTEMS



Project ID:	**735969**
Call topic:	**FCH-01-4-2016** - Development of Industrialization-ready PEMFC systems and system components
Project total costs:	**€ 6,156,288.75**
FCH JU max. Contribution:	**€ 4,994,538.75**
Project start - end:	01/01/2017- 31/12/2019
Coordinator:	**FUNDACION AYESA, ES**
Website:	**www.innbalance-fch-project.eu**

BENEFICIARIES: DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV, UNIVERSITAT POLITECNICA DE CATALUNYA, AVL LIST GMBH, VOLVO PERSONVAGNAR AB, STEINBEIS INNOVATION GGMBH, POWERCELL SWEDEN AB, CELEROTON AG, BROSE FAHRZEUGTEILE GMBH & CO. KOMMANDITGESELLSCHAFT WURZBURG, STEINBEIS 2I GMBH

PROJECT AND OBJECTIVES

The aim of INN-BALANCE is to develop a novel and integrated development platform for developing advanced Balance of Plant components in current fuel cell based vehicles, in order to improve their efficiency and reliability, reducing costs and presenting a stable supply chain to the European car manufacturers and system integrators.

NON QUANTITATIVE OBJECTIVES

- Develop different types of system models under development
- Advanced supervisory control strategies under development
- Test the fuel cell system into a vehicle powertrain
- Develop of technology plan as well as undertake communication and dissemination activities.

PROGRESS & MAIN ACHIEVEMENTS

- Develop an air turbo-compressor and test it in a tailored cathode subsystem
- Design of the anode module composed of the BoP components that allow to regulate the hydrogen flow supplied to the stack
- Anti-freeze procedure for an optimized start-up of the fuel cell system.

FUTURE STEPS & PLANS

- Full validation of the air turbo-compressor at system level
- Validation of the anode module at system level Validation of thermal management module at system level
- On-board diagnostics software
- Vehicle integration of the fuel cell system.

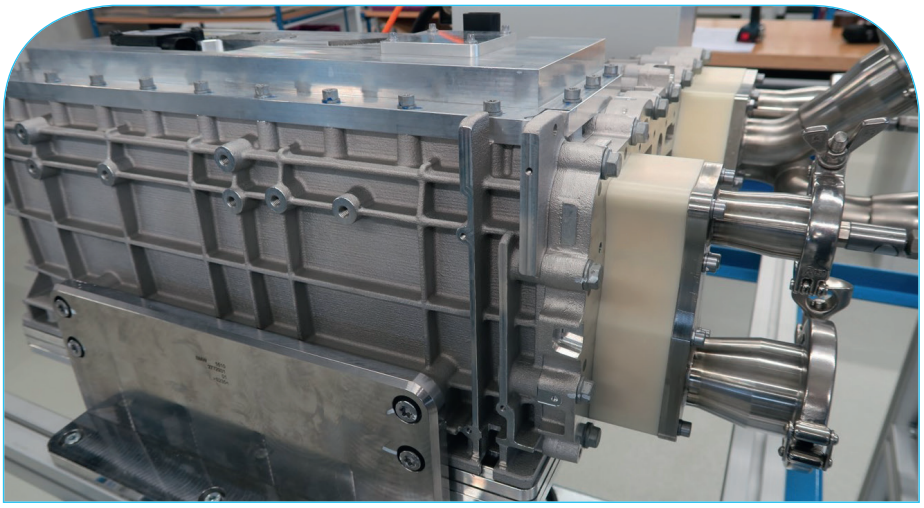
QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objective	Cold start	Celsius degrees	-40	
	Air compressor power	kW	10-12	
	Manufacturing cost of the air compressor	€/unit	250	
	Manufacturing cost of the anode	€/unit	220	
	Manufacturing cost of BoP	€/kW	100	

PRD 2019 PANEL
NEXT GENERATION OF PRODUCTS - TRANSPORT

INSPIRE

INTEGRATION OF NOVEL STACK COMPONENTS FOR PERFORMANCE, IMPROVED DURABILITY AND LOWER COST



Project ID:	**700127**
Call topic:	**FCH-01.1-2015** - Low cost and durable PEMFCs for transport applications
Project total costs:	**€ 6,878,070.01**
FCH JU max. Contribution:	**€ 6,877,869.75**
Project start - end:	01/05/2016 - 31/10/2019
Coordinator:	**JOHNSON MATTHEY PLC, UK**
Website:	**www.inspire-fuelcell.eu**

BENEFICIARIES: CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS, TECHNISCHE UNIVERSITAT BERLIN, TECHNISCHE UNIVERSITAET MUENCHEN, REINZ-DICHTUNGS GMBH, ALBERT-LUDWIGS-UNIVERSITAET FREIBURG, SGL CARBON GMBH, BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT, PRETEXO, JOHNSON MATTHEY FUEL CELLS LIMITED, UNIVERSITÉ DE MONTPELLIER, TEKNOLOGIAN TUTKIMUSKESKUS VTT OY

PROJECT AND OBJECTIVES

The overall aim of INSPIRE is to develop and integrate together the most advanced MEA components (electrocatalysts, membranes, gas diffusion layers and bipolar plates) into 3 generations of automotive stacks meeting a beginning-of-life power density of 1.5 W/cm2 at 0.6 V, durability of over 6,000 hours operation with less than 10% power degradation, and a stack assessment showing production costs below 50 €/kW for an annual production rate of 50,000 units.
The third generation, 150kW stack is now in operation and the leading new catalyst meeting the 0.44 A/mgPt target has been scaled up.

NON QUANTITATIVE OBJECTIVES

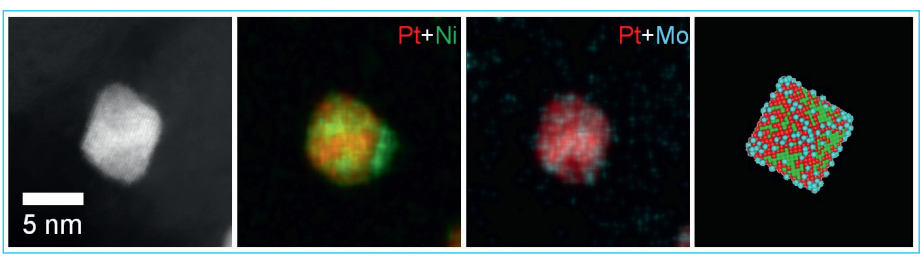
- New catalysts have passed through the performance and durability stage gates in WP3 and are being scaled up for MEA optimisation & testing in WP4
- INSPIRE workshop held, bringing together several FCH JU H2020 projects focused on PEM fuel cell components.

PROGRESS & MAIN ACHIEVEMENTS

- Catalyst meeting the project mass activity target (>0.44 A/mg Pt) and stability requirements (equal to benchmark) now scaled up
- 1.41 W/cm2 was achieved with the GEN 2.5 MEA design in the GEN 2.0 hardware at BMW
- GEN 3.0 383-cell stack manufactured and demonstrated.

FUTURE STEPS & PLANS

- Full performance and durability testing of GEN 3.0 383-cell stack
- Assessment of best catalyst and catalyst layers in large single cell
- Economic assessment of GEN 3.0 components
- Accelerated degradation testing in short stacks.



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 2015	Areal power density	W/cm2	1.5	1.4	SoA achieved	1.3 (50 cm2 cell, 250 kPaabs, outlet, 94 °C, 65% RH)	2018
Project's own objective	Catalyst	A/mg	0.6	0.6	✓	0.6 (GM)	2016
MAWP 2014-2020	Performance loss over 6,000 hours	%	10%	N/A		5,605 hrs (NREL)	2015
	<0.125 mg/cm2	mg/cm2	0.125	0.3		0.125 (GM)	2017
	CAPEX@ 50,000 units/year	€/kW	50	N/A		50 $/kW @100,000 units/year 45 $/kW @ 500,000 units/year (USDOE analysis)	2017

MARANDA

MARINE APPLICATION OF A NEW FUEL CELL POWERTRAIN VALIDATED IN DEMANDING ARCTIC CONDITIONS

Project ID:	**735717**
Call topic:	**FCH-01-5-2016** - Develop new complementary technologies for achieving competitive solutions for Marine applications at an economic scale of implementation
Project total costs:	**€ 3,704,757.5**
FCH JU max. Contribution:	**€ 2,939,457.5**
Project start - end:	01/03/2017- 28/02/2021
Coordinator:	**Teknologian tutkimuskeskus VTT Oy, FI**
Website:	**www.vtt.fi/sites/maranda**

BENEFICIARIES: SUOMEN YMPARISTOKESKUS, ABB OY, POWERCELL SWEDEN AB, OMB SALERI SPA, PERSEE, SWISS HYDROGEN SA

PROJECT AND OBJECTIVES

In MARANDA project an emission-free hydrogen fueled PEMFC based hybrid powertrain systems (3 x 82.5 kW AC) is developed for marine applications and validated both in test benches and on board the research vessel Aranda.
The project will increase the market potential of hydrogen fuel cells in marine sector. General business cases for different actors in the marine and harbor or fuel cell business will be created.
The project has passed the system design phase and fuel cell stack, system and key BoP components are being characterized.

NON QUANTITATIVE OBJECTIVES

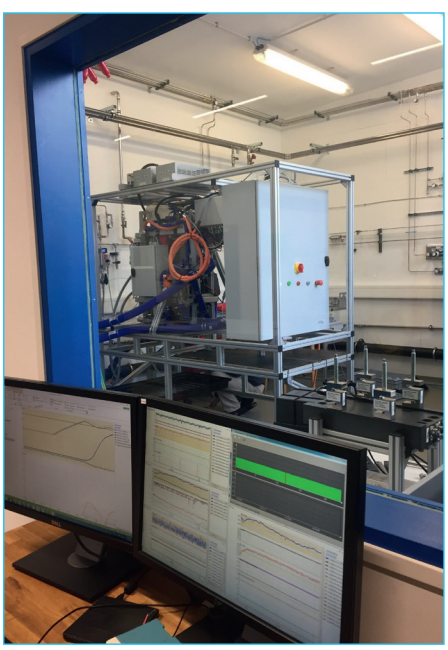
- MARANDA project has already provided significant impact on the development of RCS on maritime applications
- Fuel cell systems should be able to withstand the shocks, vibrations, saline environment and ship motions
- The evaluation of the economic and environmental impact for a prospective customer
- Report on business analysis tool design and use has been prepared
- The formulation of an initial go-to market strategy
- The mapping of opportunities for future demonstration actions.

PROGRESS & MAIN ACHIEVEMENTS

- Three 100 kW S3 stacks have been assembled and delivered for the use in fuel cell systems
- First 82.5 kW systems has been assembled and delivered for the durability testing
- Regulations, codes and standards for fuel cells in marine applications has been reviewed and gaps identified.

FUTURE STEPS & PLANS

- Commissioning of the first fuel cell system at durability test site. (M28)
- Acceptance from Finnish Transport Safety Agency (Trafi) for the installation of FC system and hydrogen storage in Aranda (M36)
- Field trial start in target vessel (M38)
- 1st FC system complete 4380 testing (M36)
- Field trial start in target vessel completed (M45).



QUANTITATIVE TARGETS AND STATUS

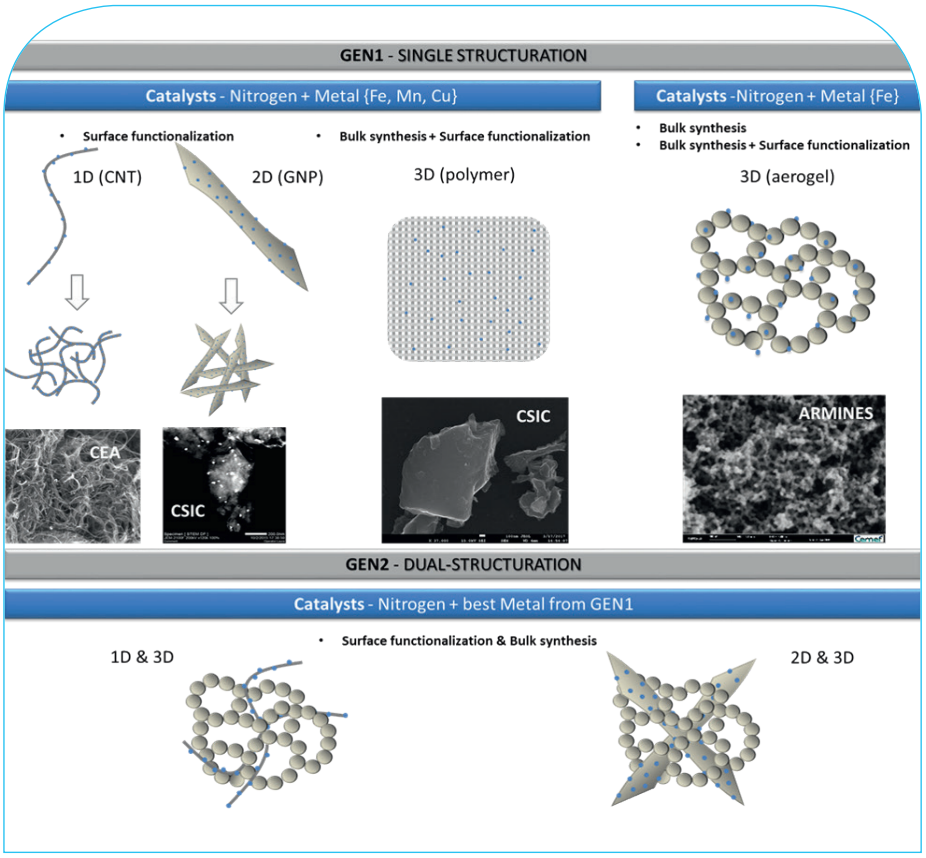
TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
AWP 2016	Fuel cell system effect	kW	75	82.5	✓
	Freeze start capability	C	-35	N/A	✗
	stack durability	mV/1,000h	4.6	1.7	✗
	Fuel to electric efficiency (AC)	%	48	45	✗

PEGASUS

PEMFC BASED ON PLATINUM GROUP METAL FREE STRUCTURED CATHODES

Project ID:	**779550**
Call topic:	**FCH-01-2-2017** - Towards next generation of PEMFC: Non-PGM catalysts
Project total costs:	**€ 2,829,016.88**
FCH JU max. Contribution:	**€ 2,829,016.88**
Project start - end:	01/02/2018 - 31/01/2021
Coordinator:	**COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, FR**
Website:	**www.pegasus-pemfc.eu**

BENEFICIARIES: AGENCIA ESTATAL CONSEJO SUPERIOR DEINVESTIGACIONES CIENTIFICAS, DEUTSCHES ZENTRUM FUER LUFT - UND RAUMFAHRT EV, ASSOCIATION POUR LA RECHERCHE ET LE DEVELOPPEMENT DES METHODES ET PROCESSUS INDUSTRIELS, TECHNISCHE UNIVERSITAET MUENCHEN, ECOLE NATIONALE SUPERIEURE DES MINES DE PARIS, IRD FUEL CELLS A/S, TOYOTA MOTOR EUROPE NV, HERAEUS FUEL CELLS GMBH



PROJECT AND OBJECTIVES

PEGASUS is exploring a promising route towards the removal of Pt and other critical raw materials (CRM) from PEMFC and their replacement by non-critical elements & structures enabling efficient and stable electro-catalysis conditions for an appropriate use as Pt-alternative competitive cathodic catalysts. The overall aim of this project is to bring up the experimental proof of concept for novel catalysts materials & structures.

NON QUANTITATIVE OBJECTIVES

- Contribution to determination of active site structure, characterization of catalyst active centre using XAS
- Intrinsic performance of catalyst, implementation of Scanning Electrochemical Spectroscopy to characterize the PGM-free catalyst
- International Benchmark, cooperation with US-DoE and Japan NEDO.

PROGRESS & MAIN ACHIEVEMENTS

- Synthesis of PGM free catalysts with different routes (4 different pathways). Benchmark of different non-noble metals as active centres
- Integration of PGM free catalyst in MEA. Impact of the printing process on the MEA performances. Thin (50 µm) active layer deposition achieved
- Set up Scanning Electrochemical Microscopy to benchmark material via ex situ fine electrochemical measurement.

FUTURE STEPS & PLANS

- Measurement of the active layer porosity by FIB-SEM and the ionomer coverage rate on PGM catalyst, then structure optimization to improve perf
- Cartography of the performance of catalyst Vs agglomeration state at submicro scale to optimise the 3D structure of the developed catalysts
- Improving the number of active site on the catalyst, and better definition of the active site structure
- Operando characterization of the water distribution in the PGM free based cathode.
- Reduction of Pt loading. Development of PGM free catalysts (both for anode and cathode).

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	Catalyst activity @ 0.9 V under O2	mA/cm2	77	-	✗	21	2018
		mA/cm2	44	-	✗	-	-
	Cell perfomance - current density @ 0.7 V	mA/cm2	600	140	✗	320	2018
	MEA durability - performance loss	%	30	not started	✗	-	-

TAHYA
TANK HYDROGEN AUTOMOTIVE

Project ID:	779644
Call topic:	FCH-01-3-2017 - Improvement of compressed storage systems in the perspective of high-volume automotive application
Project total costs:	€ 3,996,943.75
FCH JU max. Contribution:	€ 3,996,943.75
Project start - end:	01/01/2018 - 31/12/2020
Coordinator:	OPTIMUM CPV, BE
Website:	tahya.eu

BENEFICIARIES: VOLKSWAGEN AG, TECHNISCHE UNIVERSITAET CHEMNITZ, BUNDESANSTALT FUER MATERIALFORSCHUNG UND -PRUEFUNG, RAIGI SAS, ANLEG GMBH, POLARIXPARTNER GMBH, ABSISKEY

PROJECT AND OBJECTIVES

1. Preparatory work to provide a compatible H2 storage system with high performances, safe and Health Safety Environment responsible.
2. Provide a compatible H2 storage system with mass production and cost competitive.
3. Regulation Codes and Standards (RCS) activities to propose updates on GRT13 and EC79 according to tests results obtained over the duration of the project.

Currently, the first prototypes are delivered to VW for first implementation into car before launching the optimisation developments.

NON QUANTITATIVE OBJECTIVES

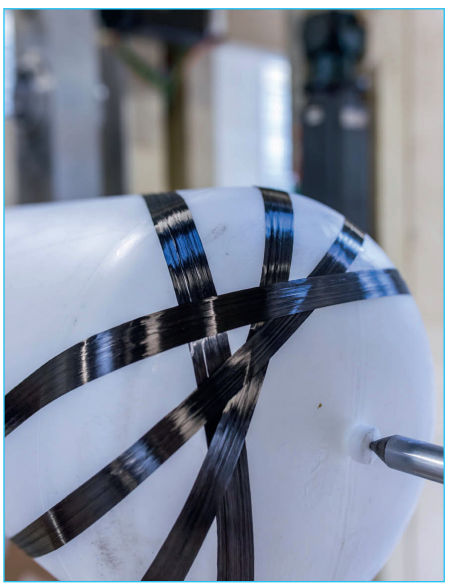
- Tools with massive speed improvements in calculation of Monte-Carlo-Simulations for the assessment and analysis of RCS
- Common determination of the accepted risk level
- Monte-Carlo-Simulation for the analysis of RCS
- Understanding the statistical nature of the initial testing.

PROGRESS & MAIN ACHIEVEMENTS

- Development of a complete and competitive H2 storage system prototype (liner, cylinder, OTV)
- Development of an entirely European system with suppliers from France, Belgium and Germany
- Increased credibility from European OEM's.

FUTURE STEPS & PLANS

- Implementation of the H2 system prototype within R&D car platform
- Optimisation of the 1st prototype (alternative materials and geometries)
- Validation of the probabilistic approach with tests campaign to discuss harmonisation of requirements for RCS
- Validation of optimised manufacturing processes
- Validation of alternative tank geometries.



QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
Project's own objective	Liner: Improved temperature tolerance -40°C to +100°C using combination of materials- Improvement temperature tolerance	Softening Temperature	Glassy Temperature<-40°C, Softening Temperature >110°C	N/A	✓
	Liner: New tests system to be defined for quality control and repeatability - liner thickness, air bubbles, tensile test	N/A	Analysis of the part	N/A	✗
	OTV: Reduction of machining costs (actual use of 56 tools down to 40) -Parts/tools	tools	40	42	✗
	OTV Reduction of OTV mounting time (from 150 down to 30 minutes) and reduction of testing time	Minutes	30	40	✗

VOLUMETRIQ

VOLUME MANUFACTURING OF PEM FC STACKS FOR TRANSPORTATION AND IN-LINE QUALITY ASSURANCE

Project ID:	**671465**
Call topic:	**FCH-01.2-2014** - Cell and stack components, stack and system manufacturing technologies and quality assurance
Project total costs:	**€ 4,988,450.25**
FCH JU max. Contribution:	**€ 4,961,950**
Project start - end:	01/09/2015 - 31/08/2019
Coordinator:	**CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS, FR**
Website:	**www.volumetriq.eu**

BENEFICIARIES: JOHNSON MATTHEY PLC, SOLVAY SPECIALTY POLYMERS ITALY SPA, BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT, PRETEXO, JOHNSON MATTHEY FUEL CELLS LIMITED, ELRINGKLINGER AG, INTELLIGENT ENERGY LIMITED, UNIVERSITÉ DE MONTPELLIER

Automated Stack Assembly Line (ASAL)

PROJECT AND OBJECTIVES

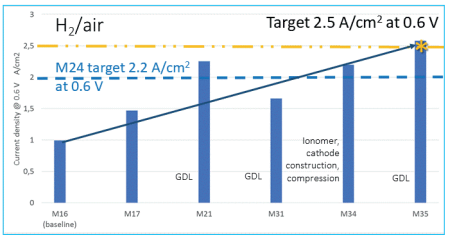
VOLUMETRIQ aims to develop a European supply base for automotive PEM fuel cell stacks and their key components with volume manufacturing capability and embedded quality control. Targets are 1.5 W/cm2 at single cell and stack levels. VOLUMETRIQ has achieved a leading single cell power density of 2.67 A/cm2 at 0.6 V (1.6 W/cm2) with catalyst coated membranes produced at volume in automotive size single cell hardware developed in the project. This power density reduces the number of cells required for the 90 kW stack (under construction) and will positively impact the stack cost.

PROGRESS & MAIN ACHIEVEMENTS

- A novel electrospun nanofibre reinforced membrane has factor 4 improved durability over the previous project state of the art
- VOLUMETRIQ has achieved a leading single cell power density of 2.67 A/cm2 at 0.6 V (1.6 W/cm2)
- Novel automotive size hardware has been manufactured and validated.

FUTURE STEPS & PLANS

- Short stack (project hardware) testing with VOLUMETRIQ CCMs
- Full stack (90 kW) build and testing
- Costs analysis.



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)	Single cell power density	W/cm2	1.5	1.6	✓	1.43	2019
Project's own objective	Stack cost	€/kW	50 (Expect to significantly improve on this target, exceeding SoA)	Expected, given outstanding power density at single cell level	✗	30	2016
	In situ AST RH cycles at OCV, 90 °C	Cycles	20,000	48,000	✓	ca. 40,000	2018