CHIC

Clean Hydrogen in European Cities

AIP / APPLICATION AREA	AIP 2009 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2009.1.1 Large-scale demonstration of road vehicles and refuelling infrastructure II
START & END DATE	01 Apr. 2010 - 31 Dec. 2016
TOTAL BUDGET	€ 81,8 million
FCH JU CONTRIBUTION	€ 26 million
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: EVOBUS GMBH

Partners: AIR PRODUCTS PLC, AZIENDA TRASPORTI MILANESI, BERLINER VERKEHRSBETRIEBE, ELEMENT ENERGY LIMITED, AIR LIQUIDE ADVANCED BUSINESS, HyCologne - Wasserstoff Region Rheinland e.V., INFRASERV GMBH & CO. HOCHST KG, BRITISH COLUMBIA TRANSIT, LINDE AG, LONDON BUS SERVICES LIMITED, THINKSTEP AG, PLANET PLANUNGSGRUPPE ENERGIE UND TECHNIK GBR, POSTAUTO SCHWEIZ AG, SHELL DOWNSTREAM SERVICES INTERNATIONAL BV, Spilett new technologies GmbH, SUEDTIROLER TRANSPORTSTRUKTUREN AG, TOTAL DEUTSCHLAND GMBH*TD, UNIVERSITAET STUTTGART, Vattenfall Europe Innovation GmbH, RUTER AS, Wrightbus Ltd, hySOLUTIONS GmbH

PROJECT WEBSITE/URL

www.chic-project.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

- Implementation of clean urban mobility in 5 major EU regions through the deployment of 26 fuel cell electric buses (provided by different bus manufacturers) and hydrogen refueling stations
- Collaboration, transfer and securing of significant key learning from experimented cities included in the project (4 cities and 34 buses)
- Facilitation of the development of clean urban public transport systems into new EU regions
- Greater community understanding of "green" H2 powered fuel cell buses, leading to increased political acceptance and commitment

PROGRESS/RESULTS TO-DATE

The CHIC project has demonstrated that the 36 fuel cell buses currently in operation can offer:

- Same operating range as a diesel bus demonstrated (up to 400km)
- Successful integration of hydrogen refuelling stations into busy bus depots, the stations show short refuelling (<10 min to completely refuel a bus) and high availability (>95%)
- High fuel efficiency with an average of 9kg of hydrogen/100km for 12m buses – which makes them 25 to 30% more energy efficient than their diesel counterparts
- Fuel cell buses achieve lower CO2 emissions than diesel buses of between 10 and 100%, depending on the primary energy source used for hydrogen generation.
- Most of the CHIC technical target have been hit (status April 2015):

PARAMETERS	TOTAL PHASE 1	PROJECT TARGET
Number of hours on the fuel cell system	166,250	160,000
Average fuel cell runtime per bus (hours)	6,394	6,000
Replacement of diesel fuel (litres)	1,054,210	500,000

FUTURE STEPS

- The CHIC cities are currently assessing the opportunity to continue the operation of fuel cell buses after the end of the project in December 2016 and to add fuel cell buses to their current bus fleet. Most of them are participating in the FCH JU Fuel Cell Bus Commercialisation Study, which is making plans to deploy a larger pan-European fleet of 500- buses by 2020, with the explicit aim of realising cost reduction
- Three additional EU-funded projects deploying fuel cell buses have started since the inception of CHIC: High V.LO-City, HyTransit and 3Emotion, while other fuel cell buses are in operation in Germany and worldwide. The CHIC project partners have developed materials ready to be shared with them and with cities interested in fuel cell bus deployment on HRS implementation procedures and investments, analysis on bus workshops investments, lessons learnt on trainings etc.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

CHIC has proved that fuel cell buses have the potential to be operated with the same operational flexibility as a conventional diesel bus, whilst offering: zero tailpipe emissions, contribution to decarbonisation of transport, reduced noise and vibration levels.

The following aspects will need to be tackled to allow a wider deployment:

1. Cost reductions, technical availability improvement (including spare parts availability) and harmonisation of regulations: The purchasing cost of a bus has been cut by 50% since 2011. Further cost reductions are required to allow for widespread deployment; these will be achieved within the FCH JU Fuel Cell Bus Commercialisation Study, a partnership between industry and local authorities (most of the CHIC cities are partners), which plans an expansion of the European fuel cell bus fleet to 500 by 2020
2. Further increase in availability: numerous technology teething issues have been resolved within CHIC and partners expect a diesel equivalent availability to be reached with increased scale in the supply chain
3. Regulations on designs for large hydrogen fuelling station, construction and safety need to be harmonised at an EU and international level– Key stakeholders are working on EU/international standards to simplify procedures and decrease cost

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
H2-Infrastructure				
AIP 2009	H2-Fuelling capacity	200 kg/day	200kg/day	All Phase 1 cities have reached the required refuelling capacity
AIP 2009	Availability of H2-Refuelling station	98%	98%	> 98% at most sites > 92% at all sites about 96% across all sites
AIP 2009	H2 OPEX (Operational Expenses)	<10EURO/kg	<10EURO/kg	All available OPEX figures from the Phase 1 Sites currently exceed the 10 €/kg target. This is partly due to low capacity factors of the units for on-site generation and therefore likely to improve with expected higher availabilities of the buses.
AIP 2009	H2 purity and vehicle refuelling time	According to SAE or analogous specification	According to SAE or analogous specification	Not all contaminants can currently be measured with the accuracy stipulated in SAE J2719.
AIP 2009	H2-Production efficiency	50-70%	50-70%	> 50% except one site
Additional target	Replacement of Diesel fuel		500.000 l	Phase 0 cities: 3.083.202 (as for April 2015) Phase 1 cities: 1.041.337 (as for April 2015)
Fuel Cell Buses				
AIP 2009	Fuel Cell life time	>6000 h	>6000 h	7306 h/bus (as for Apr 2015) excluding ICE buses in Berlin
AIP 2009	Fuel Cell Bus availability	>85%	>85%	68% based on operation time (as for Apr 2015)
AIP 2009	H2-Consumption	<11-13kg/100km depending on drive cycle	<13kg/100km depending on drive cycle	12,0 kg/100km (only FC buses) (as for Apr 2014)
Additional target	Minimum running distance of fleet		2,75 Million km	7,89 Million km (as for Apr 2015)
Additional target	Minimum operation hours of fleet		160.000 h	394.541 h (as for Apr 2015)

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

DESTA

Demonstration of 1st European SOFC Truck APU

AIP / APPLICATION AREA	AIP 2010 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2010.1.5: Auxiliary Power Units for Transportation Applications
START & END DATE	01 Jan. 2012 - 30 Jun. 2015
TOTAL BUDGET	€ 9,841,007
FCH JU CONTRIBUTION	€ 3,874,272
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: AVL List GmbH

Partners: Eberspächer Climate Control Systems, GmbH & Co KG, Topsoe Fuel Cell A/S, Volvo Technology, AB, Forschungszentrum Jülich

PROJECT WEBSITE/URL

www.desta-project.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

Demonstration of the first European SOFC APU on a Volvo HD truck, 1 year testing of 6 APU systems (3 of Eberspächer and 3 of AVL), Development and assembly of the final DESTA SOFC APU system, merging the most promising approaches of AVL and Eberspächer SOFC APU concepts, Significant improvements of SOFC stacks operated on diesel fuel.

PROGRESS/RESULTS TO-DATE

- Optimized DESTA APU systems developed and assembles
- Automotive laboratory tests performed (vibration, salt spray)
- APU integrated into Volvo heavy duty truck
- Truck daily operation test performed
- SOFC APU technology successfully demonstrated for heavy duty trucks

FUTURE STEPS

Project ended (30th of June 2015)

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Sucessful truck demonstration
- Proven daily use of APU products
- Technical performance targets demonstrated
- Difficult business case for application in heavy duty trucks
- ASC stack technology seems to have some limitations towards start-up time & cost

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Electric System Efficiency	35%	35%	30%
AIP 2010	Anticipated Lifetime	>20.000h	>10.000h	2000h
MAIP 2008-2013	Emmission Reduction	Less than current	75%	70%
AIP 2010	Technology cost	<1000€/kW	<1000€/kW	~1500€/kW

FCGEN

FCGEN

Fuel Cell Based Power Generation

AIP / APPLICATION AREA	AIP 2010 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2010.1.5 Auxiliary Power Units for transportation applications
START & END DATE	01 Nov. 2011 - 31 May 2015
TOTAL BUDGET	€ 9,309,998
FCH JU CONTRIBUTION	€ 4,010,884
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Jožef Stefan Institute

Partners: Powercell Sweden AB, Forschungszentrum Juelich GMBH, Volvo Technology AB, Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung E.V, Johnson Matthey PLC, Modelon AB

PROJECT WEBSITE/URL

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PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The main objective of the Fuel Cell based Power Generation (FCGEN) project is to develop and demonstrate a proof-of-concept diesel-powered PEM fuel cell based 3 $kW_{(net\ el.)}$ auxiliary power unit (APU) in the laboratory in close to real conditions.

Other objectives are to produce PEFC quality reformate, high efficiency, size / weight reduction and very clean exhaust (less, CO, NMHC).

Moreover, the project also seeks to further develop key components and subsystem technologies that have been advanced by the project partners in previous collaborations and move them closer towards commercially viable solutions.

PROGRESS/RESULTS TO-DATE

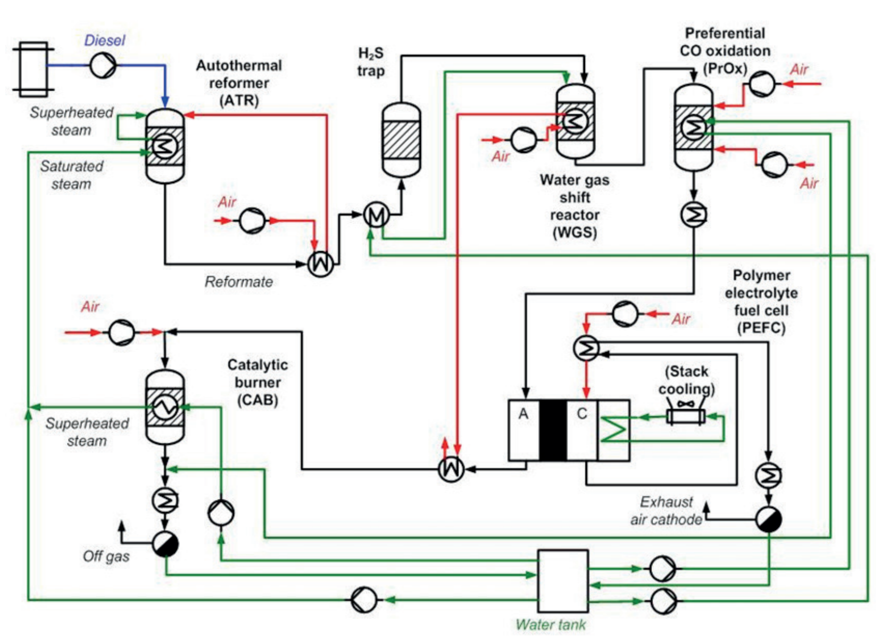
- Fuel processor developed and operation demonstrated with required reformate quality (10ppm CO, 1 ppm NHC, 1ppm S)
- High efficiency, designed to cost power conditioning and control system developed and integrated
- BoP components for maximizing efficiency and cost reduction found or prototypes obtained
- Complete APU built and autonomous APU operation demonstrated (~3kW net electric, battery charging, self sustained start-up & shutdown)

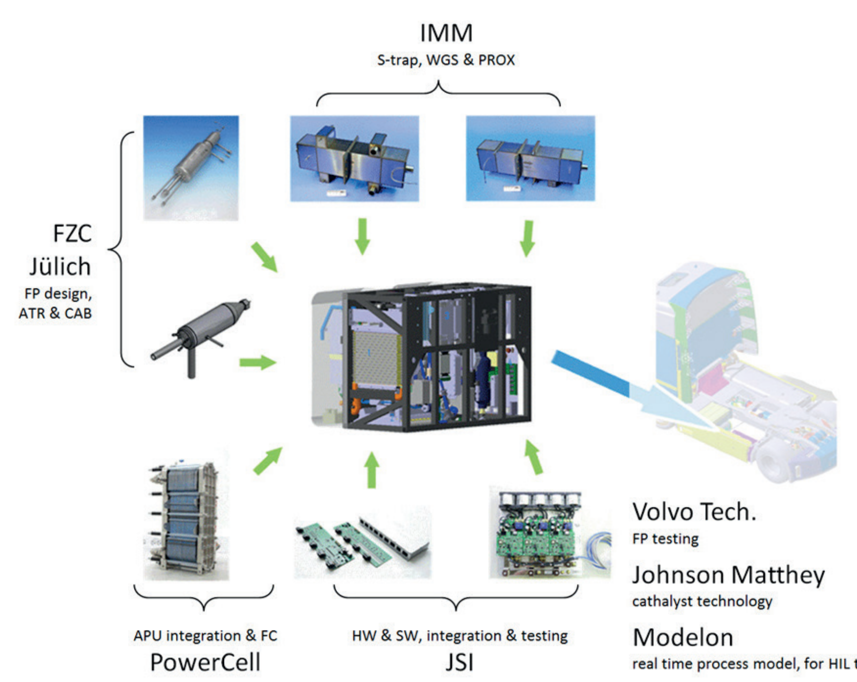
FUTURE STEPS

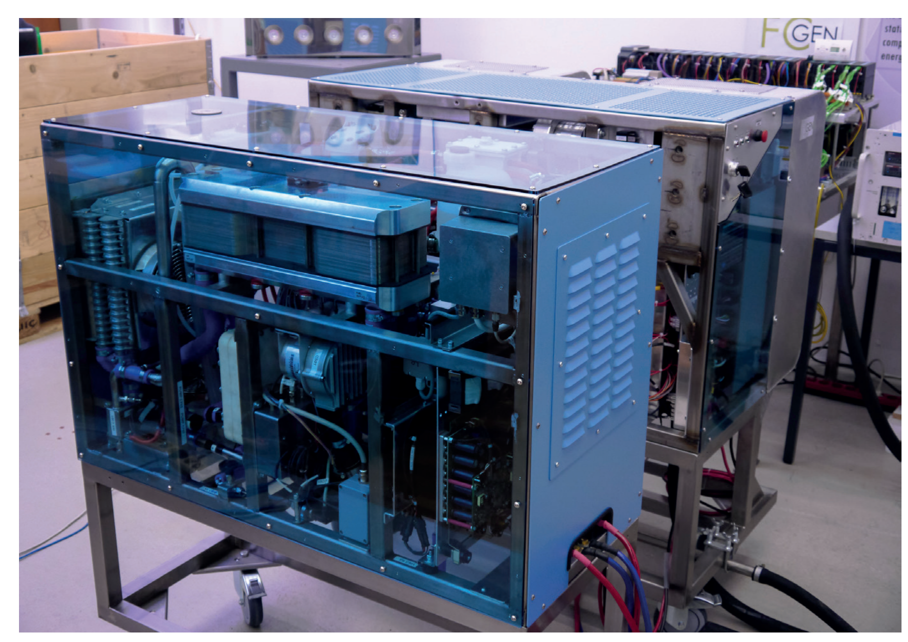
- increase TRL to high level,
- increase efficiency and lifetime
- further reduce cost, size & weight,
- implement serviceability

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- 25 % efficiency achieved, means identified to reach above 35%
- good operability, fast power level change, clean exhaust
- startup time still slow
- system still size & weight still need to be reduced
- refined complete system design-to-cost approach required for next generation







CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	APU system efficiency	Demonstrations of increased efficiency of on-board power generation and reduce CO_2 emissions and local pollutions	System efficiency ~ 30% ;	Demonstrated 25% efficiency over entire operating range, required means for reaching above 35% identified and planned for future work. Compared to engine-idling cca 80% consumption (and consequently pollution emissions) reduction
MAIP 2008-2013	Development of Fuel cell based APU systems for mobile applications	Research, development and proof-of-concept demonstration of APU systems for on-board power generation	Develop and demonstrate a PEMFC-APU in laboratory.	Diesel powered PEMFC-APU development successfully finished. A working prototype was built and tested
MAIP 2008-2013	Fuel processing of logistic fuels	*Demonstrated fuel processing technology for logistic fuels*	Design the fuel processor module to handle logistic fuels Emissions: Sulphur < 10 ppb Carbon monoxide < 25 ppm Non-methane hydrocarbons < 1 ppm	Fuel processor module with sulphur tolerant reformer and desulphurization unit downstream the reformer is developed with required operation parameters demonstrated using standard commercially available diesel fuel: Sulphur: Demonstrated during single component testing CO (verified during APU test) NMHC 0-2 ppm (verified during APU test)
AIP 2010	Vehicle demonstration of auxiliary power units	• Research, development and proof-of-concept demonstration of APU systems for on-board power generation. • demonstrated feasibility of using logistic fuels and demonstrated fuel processing technology for logistic fuels • defined requirements for fully integrated systems in the specific application. • full APU system evaluation with respect to application specific requirements and multifunctional usage of fuel cells (heat and water), including cost analysis	Develop and build a stand- alone PEMFC-APU system which can handle low sulphur logistic fuels and demonstrate the performance of the system on-board a truck *Truck demonstration goal has been removed with amendment since the truck-demonstration partner has left consortium and no suitable replacement was found.*	An APU system consisting of a fuel processor module, a PEM FC module and a control module was developed and the complete autonomous operation demonstrated in laboratory environment. The fuel processor as well as fuel-cell modules have been tested separately and finally as a complete APU has been demonstrated. The vehicle integration parameters (mechanical, fuel, electrical, communication) have been defined. The study has been performed, providing the pay-off proof as a truck-anti-idling-application. Furthermore a cost analysis has been performed, showing cost ~ 1500€/kW in high production with current not fully-optimized design.

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

HAWL

Large Scale Demonstration of Substitution of Battery Electric Forklifts by Hydrogen Fuel Cell Forklifts in Logistics Warehouses

AIP / APPLICATION AREA	AIP 2012 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2012.4.1 - Demonstration of fuel cell powered material handling equipment vehicles including infrastructure
START & END DATE	01 Sep. 2013 - 31 Aug. 2016
TOTAL BUDGET	€ 8,523,185.00
FCH JU CONTRIBUTION	€ 4,278,555.00
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Air Liquide

Partners: FM Logistic, Hypulsion SaS, Crown Galbelstapler GmbH, Toyota Material Handling Europe, Diagma Group

PROJECT WEBSITE/URL

www.hawl-project.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

HAWL project aims at deploying 200 fuel cells powered forklift trucks on 2 or 3 logistics warehouses and demonstrating competitiveness (productivity), technical maturity and user acceptance of the technology in Europe, as an alternative to battery powered trucks operation.

PROGRESS/RESULTS TO-DATE

- HRS commissioned and installed at site 1 (February 2015)
- 4 types of forklifts qualified to be used with fuel cells (reach trucks and pallet trucks)
- Phase test started at Site 1 (10 forklifts demonstrated) – 5 months to date (July 2015)
- > 1700 fillings performed - Average filling time: 150 seconds
- Official opening took place in March 2015 at FM Logistic premises

FUTURE STEPS

- Decision milestone in September 2015: additional deployment of site 1 in case of productivity and economic business case demonstration
- Phase Test & deployment at site 2
- Phase Test & deployment at site 3

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- MS1 (site 1 identification), MS4 (permiting) and MS7 (Acceptance) have been passed
- Workers satisfied with the innovative solution - improvement of the working conditions
- Valuable return of experience helping to improve the products
- Interest of the solution and cost evaluation to be assessed for a large scale deployment
- A Reference Code on HRS installation and H2 in warehouse distribution might be published by French administration in Autumn 2015, thus facilitating and accelerating local authorizations for permitting or the next 2 sites

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Total cost of FC system (at early volume production) for FC > 3kW:	< 50 units / < 3,500 €/kW	< 3,000 €/kW	Achieved (2,000€/kW for class 2 10 kW fuel cell)
AIP 2012	System lifetime (with service/stack refurbishment)	Not defined	> 7,500 hours	Not demonstrated in the project yet
AIP 2012	FC system efficiency (%)	>40	>45	FC Class 2 (for reach trucks): Project and Program objectives: Achieved FC Class 3 (for Pallet trucks): 40%: inferior to Project objectives (45%) The 45% Project objective is maintained and should be reached thanks to improvements both at the level of the stack and at the level of the software.
AIP 2012	Refuelling time	3 min	3 min	Achieved

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

HyLIFT-EUROPE

Demonstration of Fuel Cell-Powered Materials Handling Vehicles Including Infrastructure

AIP / APPLICATION AREA	AIP 2011 / AA 4: Early Markets
CALL TOPIC	SP-JTI-FCH.2011.4.1: Demonstration of fuel cell-powered Material Handling Equipment vehicles including infrastructure
START & END DATE	01 Jan. 2013 - 31 Dec. 2017
TOTAL BUDGET	€ 22,318,685.20
FCH JU CONTRIBUTION	€ 9,263,194.00
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Ludwig-Bölkow-Systemtechnik GmbH (LBST)

Partners: STILL GmbH (STILL), MULAG Fahrzeugwerk Heinz Wössner GmbH (MULAG), Air Products GmbH (AP; exit JUN 2014), Copenhagen Hydrogen Network AS (CHN; exit JUN 2014), Element Energy Ltd. (EE), Federazione delle Associazioni Scientifiche e Tecniche / European Hydrogen Association (FAST/EHA), European Commission – Directorate-General Joint Research Centre – Institute for Energy and Transport (JRC), Heathrow Airport Ltd. (HAL), H2 Logic A/S (H2L; exit JUL 2014), Air Liquide Advanced Business (AL; entry JUL 2014), Dantherm Power A/S (DTP; entry AUG 2014), Prelocentre (PRE; entry FEB 2015)

PROJECT WEBSITE/URL

www.hylift-europe.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

- Demonstration of more than 200 units of hydrogen powered fuel cell materials handling vehicles at vehicle-user sites across Europe
- Demonstration of state-of-the-art supporting hydrogen refuelling infrastructure at 5-20 vehicle-user demonstration sites throughout Europe
- Validation of Total Cost of Ownership (TCO) & path towards commercial targets
- Planning and ensuring initiation of supported market deployment beyond 2015
- Preparation of best practice guide for hydrogen refuelling station installation
- European dissemination and supporting of the European industry

PROGRESS/RESULTS TO-DATE

- HyLIFT-EUROPE will become one of the leading projects in Europe
- As the project has had to overcome some hick-ups in the beginning no vehicles are in demonstration yet
- Several contacts to potential vehicle users are established and discussions are ongoing
- Tests, trials and demo operations are under preparation
- The first hydrogen refuelling station in the framework of the HyLIFT-EUROPE project will start its operation in Q4 2015

FUTURE STEPS

- As one of the first steps test trials for potential customers will be performed
- The consortium will prepare a package comprising vehicles, hydrogen refuelling station and hydrogen supply to be offered to potential customers
- Focus will be on customers with large fleets, three-shift operation and cheap hydrogen available
- As soon as demonstration has started Total Costs of Ownership (TCO) calculations will be performed to identify the real TCO in comparison with conventional technology

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- In USA the number of hydrogen powered fuel cell materials handling vehicles has reached 8,500 units
- The USA success factors are not easily to be transferred to Europe
- Substantial financial support will be required until supply chains are fully established and enable competitive cost structures compared to conventional technologies

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	2015 target: number of industrial and off-highway vehicles	500	> 200	0
AIP 2011	Number of FC-systems	>50 units	> 200 units	0
AIP 2011	FC system life time (h)	>7,500 hours	10,000 hours	No vehicles in demo yet
AIP 2011	FC system efficiency (%)	>45%	45-50%	No vehicles in demo yet
AIP 2011	FC-Systems sales price	<3,000 €/kW	< 2,300 €/kW	No agreements with vehicle-users signed yet
AIP 2011	Refuelling time	3 minutes	~3 minutes	First HRSs under construction
AIP 2011	HRS availability	--	98%	First HRSs under construction
AIP 2011	H2 price at pump	<10 €/kg	8-12 €/kg (average <10€/kg)	No hydrogen prices disclosed yet

High V.LO City

Cities Speeding up the Integration of Hydrogen Buses in Public Fleets

AIP / APPLICATION AREA	AIP 2010 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2010.1.1 Large-scale demonstration of road vehicles and refuelling infrastructure III
START & END DATE	01 Jan. 2012 - 31 Dec. 2018
TOTAL BUDGET	€ 31.586.671
FCH JU CONTRIBUTION	€ 13.491.724
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Van Hool

Partners: Riviera Trasporti, Dantherm, Solvay, De Lijn, Waterstofnet, Hyer, DITEN, Regione Liguria, FIT, Aberdeen City Council, CNG Net.

PROJECT WEBSITE/URL

www.highvlocity.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

High V.LO City aims to present the readiness of hydrogen technology for sustainable public transport in 3 European sites through the demonstration of 14 FC buses and 3 hydrogen refueling infrastructures and subsequently disseminate the results to engage stakeholders. These stakeholders are public transport companies, local authorities and the public.

PROGRESS/RESULTS TO-DATE

- 14 FC Buses are delivered
- 2 HRI's are operational (Aberdeen and Antwerp)
- 9 FC Buses are operational in real life circumstances
- data sets required to calculate the KPI's are calculated
- practical experience up to the start of the operations is documented

FUTURE STEPS

- activate the Sanremo site after the manufacturing and startup of the local HRS
- increase FCBus availability at all sites up to the project objective (85%)
- present bus performances, the evolution since the start and the measures to increase them
- further disseminate the project results

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The legal framework on different plans is only limited ready for FC Buses
- The introduction of HRS and FCB should go combined.
- Local technologic knowledge is a key issue to make FC Buses a success story.
- With the entrance of FC Buses, a complete new technology enters into public transport workshops, depots and drivers. This requires a change of mind of all partners involved.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	FC Buses operational	500 @ 10 new sites	14 @ 3 sites	9 @ 2 sites (4 in Aberdeen, 5 in Antwerp)
MAIP 2008-2013	System cost	<3.500€/kW	2500€/kW	Achieved
MAIP 2008-2013	Durability of the FC System	>5.000h	15.000h guaranteed by supplier	In test
MAIP 2008-2013	Roadmap for the establishment of a commercial HRI	Roadmap for the establishment of commercials HRI	2 new HRI's operational, a third one should come	2/3 achieved
MAIP 2008-2013	Production of hydrogen	Free or carbon lean	2/3 of the hydrogen in High V.LO City is produced lean	In test

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Hycarus

Hydrogen Cells for Airborne Usage

AIP / APPLICATION AREA	AIP 2012 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2012.1.6: Fuel Cell systems for airborne application
START & END DATE	01 May 2013 - 30 Apr. 2016
TOTAL BUDGET	€ 10,515,603.60
FCH JU CONTRIBUTION	€ 5 219 265,00
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Lothar Kerschgens (Zodiac Cabin & Control)

Partners: Commissariat à l'énergie atomique et aux énergies alternatives, DASSAULT Aviation, Air Liquide, Joint Research Centre - Institute for Energy and Transport, Spanish National Institute for Aerospace Technology, ARTTIC, Zodiac Aeroelectric, Zodiac Galleys Europe sro, Zodiac Aerotechnics

PROJECT WEBSITE/URL

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PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

HYCARUS develops 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 (TRL 6) will be achieved through flight tests on-board a Dassault Falcon aircraft.

Moreover, HYCARUS will assess how to valorise the by-products (especially heat and Oxygen Depleted Air - ODA) produced by the fuel cell system to increase its global efficiency.

PROGRESS/RESULTS TO-DATE

- Completion of specifications and sizing of the GFCS
- Design of the different sub-systems and components of the GFCS, (Fuel cell stack, Battery, Hydrogen High Pressure Storage, Hydrogen Low Pressure Supply, Air supply, Electrical Power Management, Monitoring and Control, etc.)
- Preliminary Safety analysis
- Detailed integration of the GFCS for the flight test configuration and for the galley configuration
- Preparation for the "permit to Fly" including Qualification Program Plan and Test Flight conditions

FUTURE STEPS

The next part of the project will be focused on the verification of the whole Generic Fuel Cell System. Two configurations will be tested:

1. "Flight test" configuration: in addition to the development tests, performance tests, environmental tests and flight tests on-board a Falcon aircraft will be performed.
2. "Galley" configuration: In addition to the development tests, only performance tests on ground will be performed with the Generic Fuel Cell system integrated in the Galley.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The Consortium will build on the first results to provide and test the GFCS in a representative aircraft environment, in accordance with the TRL6 level.
- The consortium members are engaged into a challenging development and demonstration project
- HYCARUS will contribute to establishment of certification process for on board Fuel Cell system in a cabin environment
- HYCARUS will accelerate market introduction of Fuel Cell systems on board aircraft.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
AIP 2011	Fuel cell system technology maturity	TRL6	TRL6 Fuel cell system with flight tests on-board an aircraft	Fuel cell system Demonstrator development in progress. Qualification Program Plan and Test Flight conditions defined
AIP 2011	Representativeness of demonstrator against application	Power range 20-100 kW	Fuel cell system rated power 20-25 kW	Fuel Cell system demonstrator development in progress. Simulated performances for both Galley and Secondary power source applications.
AIP 2011	Durability with cycling hours	2,500 hours under flight representative load profiles	2,500 hours durability tests under flight representative load profiles	Fuel Cell system test not performed yet. 2000 hours Fuel Cell stack durability test performed under flight representative load profiles.
AIP 2011	Fuel cell system efficiency (LHV)	55% @ 25% of rated power:	55% @ 25% of rated power:	46% system electric efficiency under airborne operating conditions (simulation results, test to be performed in 2016)
AIP 2011	System Power density	Fuel Cell system power density (EOL): 0,4kW/L	Fuel Cell system density (EOL): 0,4kW/L based on the fuel-cell stack value 1,7kW/L	Not yet achieved as the priority is given to the airborne requirements compliance so as TRL6 maturity objective for the demonstrator with flight tests on-board an aircraft is achieved.
AIP 2011	System Specific Power	Fuel Cell system specific power (EOL): 0.65kW/kg	Fuel Cell system specific power (EOL): 0,65kW/kg based on the fuel-cell stack value 1,2kW/kg	Not yet achieved as the priority is given to the airborne requirements compliance so as TRL6 maturity objective for the demonstrator with flight tests on-board an aircraft is achieved.

HyFIVE

Hydrogen for Innovative Vehicles

hyFIVE HYDROGEN FOR INNOVATIVE VEHICLES

AIP / APPLICATION AREA	AIP 2013 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2013.1.1 Large-scale demonstration of road vehicles and refuelling infrastructure VI
START & END DATE	01 Apr. 2014 - 30 Sept. 2017
TOTAL BUDGET	€ 38,445,634.82
FCH JU CONTRIBUTION	€ 17,970,566.00
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Greater London Authority

Partners: BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT (BMW), Daimler AG, Honda Europe, Hyundai Motor Europe, Toyota Europe, Air Products, Danish Hydrogen Fuel, ITM Power, Linde, Danish Partnership for Hydrogen and Fuel Cells, ISTITUTO PER INNOVAZIONI TECNOLOGICHE BOLZANO SCRL, Element Energy, Thinkstep, OMV

PROJECT WEBSITE/URL

www.hyfive.eu

PROJECT CONTACT INFORMATION

Simona Webb
Simona.Webb@london.gov.uk

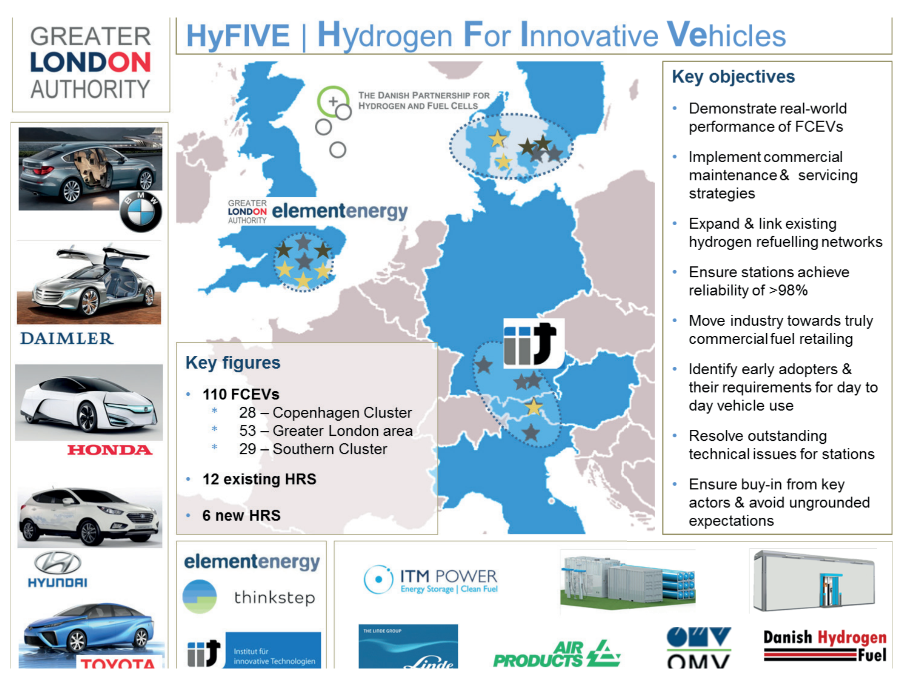
MAIN OBJECTIVES OF THE PROJECT

To deploy and monitor 110 next generation FCEVs from leading global OEMs (BMW, Daimler, Honda, Hyundai and Toyota) from summer 2014.

To place vehicles with end users representative of the likely earliest commercial adopters, study their behaviour and attitudes towards hydrogen transport to inform subsequent roll-out strategies for the technology.

To create viable hydrogen refuelling station (HRS) networks in 3 regions by deploying 6 new 700 bar HRS and incorporating 12 existing HRS in the project.

To spread a positive and accurate message about the status of FCEV and HRS technology and industry plans for commercialisation via a well-targeted dissemination strategy.



PROGRESS/RESULTS TO-DATE

- Orders placed for 69 vehicles with 38 vehicles operational in the three clusters.
- Sites identified for the Copenhagen Cluster: Aarhus and Korsor.
- Work on one of the sites ongoing over summer 2015 and work done on site identification for other 2 stations in London.
- Station deployed in the Southern Cluster (Innsbruck) in May 2015.
- Ongoing activities linking the HyFIVE project with other existing FCHJU projects as well as National Projects and Initiatives like the CEP.

FUTURE STEPS

- Organising test drives across the three clusters to identify end users and place more FCEVs orders.
- Finalising discussions on the sites for London and Copenhagen and beginning the build of stations.
- Using milestones in the project to disseminate information about it to local and national government, decision makers, potential early adopters and members of the public.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- More work needs to be done to ensure acceptance and understanding of the technology from early responders (fire brigade, etc) as well as insurers and local planning teams.
- More work needs to be done to prepare and inform potential end users about the positives and benefits of the technology.
- More work needs to be done to improve regulations around the use of the technology in vehicles and refuelling as well as to ensure this technology becomes mainstream.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Durability in car propulsion systems 5,000 hours	Durability in car propulsion systems 5,000 hours	Vehicle Operation lifetime (>2,000 hrs initially, min. 3,000 hrs as programme target)	On track: vehicles have operated on avg. ~180 hours /~ 72 hours / ~ 23 hours for Southern / Copenhagen / Greater London Clusters. (as of March 31st 2015). 2.000 hrs will not be reached but utilisation and availability of the FCEV are high.
MAIP 2008-2013	Roadmap for the establishment of a commercial European hydrogen refueling infrastructure	Roadmap for the establishment of a commercial European hydrogen refueling infrastructure	Deployment of six new HRS, linking with 12 existing stations and task forces to resolve all remaining pre-commercial hydrogen retailing issues	We expect to reach this target. These HRS are tracking data within HyFIVE: Southern Cl.: OMV Stuttgart Apt, OMV Innsbruck and IIT Bolzano; Copenhagen Cl.: Sydhavnen and Gladsaxe; London Cluster: no data available yet
AIP2013	Vehicle Operation lifetime	(>2,000 hrs initially, min. 3,000 hrs as programme target)	> 2,000 hours initially and minimum 3,000 hours as project target	On track, current operating hours/vehicle: Copenhagen Cl. 71,5 / 22,8 / 180 h for Copenhagen/ London / Southern Cl.
AIP2013	Minimum vehicle operation during the project	12 months or 10,000 km	12 months or 10,000 km	Avg distance/vehicle (as of March 31st 2015): 2.578/ 714 / 4.903 km for Copenhagen / London / Southern Cluster
AIP2013	Mean time between failures (>1,000km)	>1,000km	>1,000km	On track, currently Southern and Copenhagen Cluster achieved an MDBF of 8683 km.
AIP2013	Vehicle availability	>95%	>95%	On track: Achieved availability on the first 6 month of the project: 99,8%
AIP2013	HRS refuelling capacity	min. 50kg/day at start of project, extended to 200kg/day (50 FCEVs/day), with concept for modular upgrade to 100 FCEVs/day	All HRS will have a capacity of >80kg/day initially and the network in each cluster will exceed the 200kg/day target	We expect to reach this target • Swindon: 61kg/d (upgrade possible) • Temple Mills 320kg/d • Hatton Cross 50 kg/d (upgrade: tbc) • Central London 80kg/d upgrade: tbc) • IIT Bolzano: 150 kg/d (upgrade poss.) • OMV Stuttgart Airport 356 kg/d (upgrade: tbc) • OMV Innsbruck no data available yet • Sydhavnen, Koge, Gladsaxe, Aarhus, Konsor: 100 kg/d (upgrade: tbc)
AIP2013	Hydrogen purity and vehicle refuelling process	according to SAE J2601 and 2719 and ISO specifications. IR Communication according to SAE TIR J 2799	H2 purity and refuelling time according to SAE J2601 & J2719 spec. IR communication to SAE TIR J2799 included on all stations	Achieved. Current average refueling time of 2 min 48 sec.

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

HYPER

Integrated Hydrogen Power Packs for Portable and Other Autonomous Applications

AIP / APPLICATION AREA	AIP 2011 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2011.4.4: Research, development and demonstration of new portable fuel cell systems
START & END DATE	03 Sept. 2012 - 02 Sept. 2015
TOTAL BUDGET	€ 3,9 million
FCH JU CONTRIBUTION	€ 2,2 million
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Orion Innovations (UK) Ltd

Partners: PaxiTech SAS, University of Glasgow, Airbus Group Innovations (AGI), Institute of Power Engineering, McPhy Energy SA, Joint Research Centre.

PROJECT WEBSITE/URL

www.hyperportablepower.com

PROJECT CONTACT INFORMATION

Dr Juliet Kauffmann
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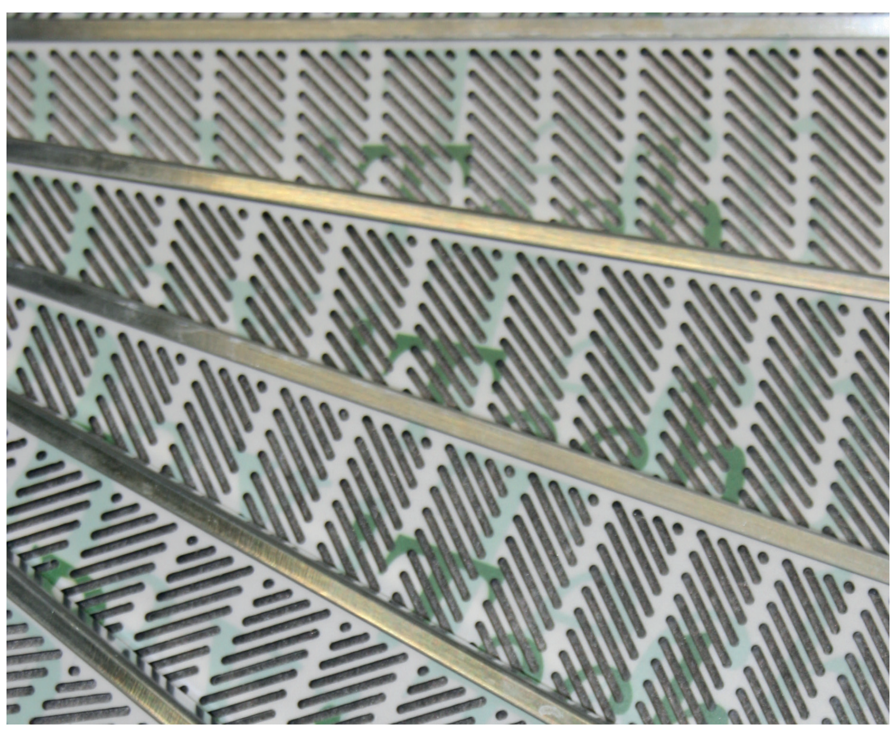
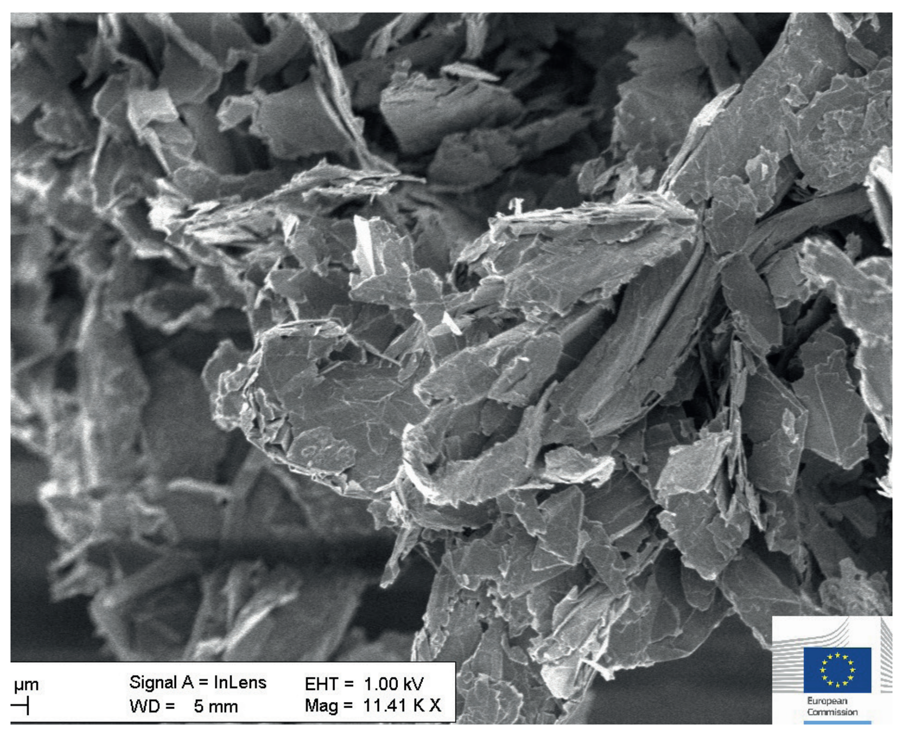
MAIN OBJECTIVES OF THE PROJECT

Development and demonstration of a market ready, portable power pack comprising an integrated modular FC and hydrogen storage system that is flexible in design, cost effective and readily customised for application across multiple low power markets.





PROGRESS/RESULTS TO-DATE

- Developed nanostructured ammonia borane composite H_2 storage material with >5 wt% and no release of toxic gases
- Developed low temperature hydride tank to demonstrate interoperability of HYPER system
- Integrated 20 W_e FC modules into complete 100 W_e FC system (including controls and cooling) incorporating results from thermodynamic modelling
- Initiated field testing of application specific 100 W_e alpha prototypes with both solid and gaseous storage modules
- First beta prototype design with full safety features, in preparation for CE marking and end user trials.

FUTURE STEPS

- Complete field testing of alpha prototypes and incorporate results into future design development.
- Complete beta design with focus on cost-efficient manufacturing optimised for different power outputs
- Build beta prototypes and complete CE marking process
- Trial with independent end users
- Follow through with the project's commercialisation strategy to reach early sales of FC system

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Ammonia borane composite could provide step change in terms of gravimetric density, but requires more research before integration into storage tank
- Two working 100 W_e HYPER prototype systems with alternative fuelling are being tested within specific applications.
- Detailed market analysis and validation exercise showed remote monitoring and control particularly attractive for HYPER System, which can offer a reliable low power (<20 W), grid-independent power source
- Independent end users have expressed interest in trialling the complete system as soon as possible

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Demonstrate technology readiness of specific applications	12,000 - 13,000 portable & micro FC's in the market by 2015	Field demonstration as 100 W_e portable power pack and 500 W_e UAV range extender	Field testing of 100 W_e systems for specific applications are underway, using interchangeable H_2 storage.
AIP 2011	Develop application specific prototypes ready to be used by specified end users	Demonstration of complete systems	Field demonstration as 100 W_e portable power pack and 500 W_e UAV range extender	Field testing of 500 W_e UAV range will not be achieved during the lifetime of the project due to technical difficulties with scale up.
AIP 2011	Weight and volume	<35 kg/kW and 50 l/kW	100 W_e system: 65 kg/kW and 60 l/kW 500 W_e system: 20 kg/kW and 20 l/kW	100 W_e system, 85 kg/kW and 250 l/kW. High weight and volume due to BoP requirements, use of off-the-shelf casing, incorporation of fans to meet safety regulations and spacing of FC modules to ensure cooling by natural convection. Call targets will readily be met at lower powers where BoP and need for cooling reduced (<40 W).
AIP 2011	Final system cost	<5,000 €/kW	<5,000 €/kW	Current high volume costs anticipated at > 5000 €/kW. However, cost per kW rises significantly for small FC systems. Composed of compact 20 W modules with limited BoP, the HYPER system is expected to be very competitive at small scales (<40 W).
AIP 2011	System efficiency	>30%	FC efficiency >50%	FC efficiency of 50% achieved.
AIP 2011	Lifetime:	1000h, 100 start stop cycles	1000h, 100 start stop cycles	Targets for lifetime and start stop cycles will be exceeded by the end of the project for the 20 W_e FC module.
AIP 2011	Operating temperature	-20°C to 60°C	-20°C to 60°C	FC demonstrated from -20°C to 40°C. 40°C is a maximum operating temperature, but cooling triggered at 41°C.

HyTEC

Hydrogen Transport in European Cities

AIP / APPLICATION AREA	AIP 2010 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2010.1.1: Large-scale demonstration of road vehicles and refuelling infrastructure III
START & END DATE	01 Sept. 2011 - 31 Aug. 2015
TOTAL BUDGET	€ 29,2 million
FCH JU CONTRIBUTION	€ 11,95 million
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Air Products

Partners: Element Energy, HyER, LTI Ltd (Note that LTI is no longer part of the HyTEC project. However, the organisation contributed greatly to the first half of the project), Cenex, Greater London Authority, hySOLUTIONS, Matgas, LBST, Copenhagen Hydrogen Network, Kobenhaven Kommune, Foreningen Hydrogen Link, Intelligent Energy, Heathrow Airport Ltd, London Bus Services Ltd, Fraunhofer Gesellschaft, Hyundai Motor Europr

PROJECT WEBSITE/URL

http://hy-tec.eu/

PROJECT CONTACT INFORMATION

Emma Guthrie
guthriej@airproducts.com

MAIN OBJECTIVES OF THE PROJECT

The HyTEC project was tasked with creating new hydrogen vehicle deployment centers in London, Copenhagen and Oslo. Each city adopted trialled different vehicle types and approaches to refuelling infrastructure rollout, allowing diverse concepts to be tested:

- In Copenhagen passenger were trialled alongside a refuelling station dispensing green hydrogen.
- In London passenger cars and taxis were deployed alongside a state-of-the-art refuelling station using innovative delivered hydrogen technology.
- In Oslo passenger cars were deployed, utilising existing infrastructure

The experience acquired by the cities is being shared with other cities and communities.

PROGRESS/RESULTS TO-DATE

London:

- Installation and operation of the UK's first publicly accessible hydrogen fuelling station.
- Vehicle test and shakedown, driver training and certification of five fuel cell taxis and creation of their operations base in London.

London and Oslo:

- Deployment and operation of fuel cell passenger cars in both cities.

Copenhagen:

- Completion of the tendering process for the procurement of FCEVs, resulting in the delivery and operation of 15 Hyundai ix35 FCEVs (9 of these vehicles are supported by HyTEC, with 6 coming via another project).
- Installation and operation of three hydrogen fuelling stations based on green hydrogen.

FUTURE STEPS

- Continued operation and data collection from hydrogen vehicle fleets and the associated fuelling infrastructure in Copenhagen and London, through the HyFIVE project.
- Disseminating the results of the project, considering the full well to wheels life cycle impact of the vehicles and associated fuelling networks, demonstrating the technical performance of the vehicles and uncovering non-technical barriers to wider implementation.
- Dissemination of analysis on future commercialisation of the vehicles, as well as providing an approach for the rollout of vehicles and infrastructure, building on the demonstration projects.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- The HyTEC project implemented stakeholder inclusive vehicle demonstration programmes that specifically address the challenge of transitioning hydrogen vehicles from running exemplars to fully certified vehicles and moving along the pathway to providing competitive future products.
- HyTEC's work led to the creation of networks in each country for the ongoing co-ordination of the process leading to hydrogen vehicle rollout in the UK and Denmark.
- These networks will be used beyond the end of the project, providing a lasting legacy and supporting continued commercialisation efforts in the hydrogen transport sector.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Light Duty Vehicles deployment	~500	~20	27
MAIP 2008-2013	Additional sites and stations	2 additional sites with 3 new stations	2 additional sites with 4 new stations	2 additional sites with 4 new stations
MAIP 2008-2013	Vehicle lifetime	> 5,000 hours	> 2,000 hours	This has already been achieved for the passenger cars. For the taxis and scooter, this has been demonstrated in test stands in the laboratory and taxis will achieve this target during the project.
MAIP 2008-2013	Establishment of a commercial European hydrogen refuelling Infrastructure	Roadmap for the establishment of a commercial European hydrogen refuelling Infrastructure	Rollout strategies / partnerships developed in the UK and Denmark. Creation of links between demonstration sites	Rollout strategies reports for Copenhagen and London Development of partnerships with key stakeholders
AIP 2010	Vehicle reliability	Mean Time Between Failure (MTBF) >1,000 km	Vehicle reliability - MTBF >1,000 km	Achieved
AIP 2010	Vehicle availability	>95%	>95%	95% - 99% (average - depending on vehicle type and location)
AIP 2010	Vehicle efficiency	Efficiency >40% (NEDC)	Efficiency >40% (NEDC)	Real-world (non-NEDC) consumption of 70 km/kg H2 - 74 km/ kgH2 (average - depending on vehicle type and location)
AIP 2010	Refuelling capacity	Stations refuelling at 35 and 70 MPa, with refuelling capacity of 50 kg and potential for extension to 200 kg	Stations refuelling at 35 and 70 MPa, with refuelling capacity of 50 kg and potential for extension to 200 kg	35 and 70 MPa, with potential for extension to 200 kg
AIP 2010	Station availability	98%	98%	95% - > 99% (average - depending on site)
AIP 2010	Station hydrogen production efficiency	Efficiency of 50-70%	Will be achieved at each station (>55% for onsite), the overall efficiency of the logistics based energy chains can exceed 70% (well to tank)	N/A (Not tested as yet)
AIP 2010	H2 price at pump (€/kg)	10 €/kg or price that matches cost per driven km on gasoline	10 €/kg or price that matches cost per driven km on gasoline	10 €/kg or price that matches cost per driven km on gasoline

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

HyTransit

European Hydrogen Transit Buses in Scotland

AIP / APPLICATION AREA	AIP 2011 / AA 1: Transportation and Refuelling Infrastructure
CALL TOPIC	SP1-JTI-FCH.2011.1.1 - Large-scale demonstration of road vehicles and refuelling infrastructure IV
START & END DATE	01 Jan. 2013 - 30 Jun. 2017
TOTAL BUDGET	€ 16,3 million
FCH JU CONTRIBUTION	€ 7 million
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: BOC Ltd

Partners: Van Hool N.V., Aberdeen City Council, Stagecoach Bus Holdings Ltd., Hydrogen, Fuel Cells and Electro-mobility in European Regions, Planet Planumgsgruppe Energie und Technik GBR, Dantherm Power A.S., Element Energy Ltd.

PROJECT WEBSITE/URL

http://aberdeeninvestlivevisit.co.uk/Invest/Aberdeens-Economy/City-Projects/H2-Aberdeen/Hydrogen-Bus/Hydrogen-Bus-Project.aspx

PROJECT CONTACT INFORMATION

Dr Hamish Nichol
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+44(0)7554437269

MAIN OBJECTIVES OF THE PROJECT

The overall project objective is to prove that a hybrid fuel cell bus is capable of meeting the operational performance of an equivalent diesel bus on demanding UK routes (including urban and inter-urban driving), whilst considerably exceeding its environmental performance.

This will be achieved by bringing together a primarily industrial consortium from five member states to develop, deploy a state of the art refuelling station and bus fleet and then monitor the buses in day to day service, with an overarching aim to demonstrate an operational availability for the buses equivalent to diesel (over 90%).

PROGRESS/RESULTS TO-DATE

- All six hydrogen buses operational on a commercial route.
- State of the art hydrogen production and refuelling station commissioned and operational.
- Hydrogen safe maintenance facility built and operational.

FUTURE STEPS

- Continue operation of buses and collect data on usage
- Continue operation of hydrogen production plant and refuelling station and collect data
- Analyse usage data
- Disseminate data and knowledge to wider community
- Techno-economic feasibility study based on real data.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

Too early to conclude on findings.

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Fuel cell life: > 4,000h initially, with a min. of 6,000h lifetime as target	System with > 12,000h warranty.	Lifetime not yet reached
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Availability of over 85%, with maintenance as for conventional buses	Availability > 90%(Availability is defined as in the CHIC and HyFLEET:CUTE project: "the ratio of time that the unit is operational (i.e. operating or on stand-by) to the total time of the project". www.global-hydrogen-bus-platform.com), maintenance regime based on that for a conventional bus.	*Still in 'teething' period of bus operation.*
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Fuel consumption < 11–13 kg H2/100 km	< 10 kg of hydrogen /100 km.	*Data yet to be analysed*
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Refuelling capacity > 50kg/day (at the beginning of the project) to be extended to min. 200kg/day	System peak fuelling capacity : 300kg/day, compatible with modular expansion to > 1,000kg/day with minimal modification to the on-site H2 storage system.	Peak fuelling is currently 360kg/day. We are regularly refuelling ~200kg/day
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Ensure that 1–2 buses can be refuelled per hour	Station design incorporates ionic compressors in a booster configuration allowing continuous dispensing at 120g/s (> AIP targets).	Each bus fuelling takes <10 minutes and the system can manage all six buses back to back.
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	The refuelling station concept must include a modular expansion to 100/vehicles per day	Refuelling station modular design - can dispense up to 1,000 kg/day, (50 buses or 250 cars).	Design is modular - compliant and exceeding AIP targets
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	The refuelling station must prove an availability of ≥98% (usable operation time of the whole station)	Target achievable by the refuelling technology proposed.	So far, 7 months of running the station at 100% availability.
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Hydrogen purity and refuelling time according to SAE and ISO specifications	SAE and ISO specs as contractual requirements for H2 supplied by the fuelling station.	Compliant
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	Hydrogen Opex cost < 10 €/kg (excluding tax), and individuation of a suitable strategy to achieve 5 €/kg	Opex + H2 production costs basis (200 Kg/day): 6 €/kg. For 1,000kg/day, the price could fall to < 5 €/kg.	*Data yet to be analysed (but €/GBP exchange rate changed considerably since 2011)*
AIP 2011	Large-scale demonstration of road vehicles and refuelling infrastructure IV	H2 production efficiency 50% to 70%	Initially: H2 sourced within BOC's merchant network (> 60% SMR). To be replaced by on-site water electrolysers linked to the grid (expected efficiency > 60%)	All H2 currently used is produced on site by electrolysis. Efficiency data not analysed yet.

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

MobyPost

Mobility with Hydrogen for Postal Delivery

AIP / APPLICATION AREA	AIP 2009 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2009.4.1 Demonstration of fuel cell powered materials handling vehicles and infrastructure
START & END DATE	01 Feb. 2011 - 30 Nov. 2015
TOTAL BUDGET	€ 8,257,272.60
FCH JU CONTRIBUTION	€ 4,251,064.21
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Université de Technologie de Belfort Montbéliard

Partners: Steinbeis Europa Zentrum der Steinbeis Innovation GmbH, EUROPAISCHES INSTITUT ENERGIEFORSCHUNG ELECTRICITE DE FRANCE/ UNIVERSITAT KARLSRUHE (EIFER), Mahytec SARL, La Poste SA, MES SA, Institut Pierre Vernier, H2Nitidor SRL, Ducati energia SPA

PROJECT WEBSITE/URL

www.mobypost-project.eu.com

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

MobyPost aims at testing a unique autonomous and sustainable mobility concept based on solar to wheel solution for postal delivery: 2 fleets of 5 FCEV specifically designed for improving ergonomics of postal delivery and 2 related solar hydrogen production and refuelling stations.

PROGRESS/RESULTS TO-DATE

- Metal hydride tanks used to store and deliver H_2 on board to a 1kW low temperature FC
- 10 vehicles built and homologated despite of missing regulations
- One infrastructure built and producing 1,5 kg H_2 per day
- Demonstration under real conditions running with 5 vehicles and one infrastructure since May 2015

FUTURE STEPS

- Finish the second infrastructure
- Analyse the demonstration data
- Exploitation and business plan under work

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- niche market on which FCEV could have a high impact
- solar-to-wheel concept as well as the metal-hydride technology used could improve the general public acceptance of the fuel cell technologies. Technology already well accepted by the postmen using it
- legal frame as well as standards are at the moment inexistent for such technologies (hydrides), which could delay the general entry on the market

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
AIP 2009	Number of vehicles	10	10	10
AIP 2009	Refueling time	< 5 min	~ 3 hours	~ 3hours according to technology chosen
AIP 2009	FC system efficiency (%)	>40	>40	32 (measure on test bench)
AIP 2009	H_2 price at pump (€/kg)	<13	<13	Not already measured
AIP 2009	FC price	<4000€/kW	<5000€/kW	<5000€/kW

pure auxiliary power unit for recreational yachts

PURE

Development of Auxiliary Power Unit for Recreational Yachts

AIP / APPLICATION AREA	AIP 2011 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2011.4.4 Research, development and demonstration of new portable Fuel Cell systems
START & END DATE	01 Jan. 2013 - 31 Dec. 2015
TOTAL BUDGET	€ 2,884,875.00
FCH JU CONTRIBUTION	€ 1,641,194.00
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: HyGear Fuel Cell Systems

Partners: Danmarks Tekniske Universitet, Centre for Research and Technology Hellas, Joint Research Centre, Scheepswerf Damen Gorinchem bv.

PROJECT WEBSITE/URL

www.pure-projcet.eu

PROJECT CONTACT INFORMATION

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MAIN OBJECTIVES OF THE PROJECT

The main objective in the PURE project is the development, construction and testing of a fuel cell system for maritime applications. The LPG based fuel processor produces reformate which is used to produced 500 W DC electricity in a high temperature PEM fuel cell.

Other objectives are:

- Weight target: 35kg/kW
- System volume target: 50l/kW
- Sulphur tolerant hydrogen production catalysts
- Improved sulphur adsorption materials
- Optimised MEA production methods for HT PEM stack
- System designed for maritime applications

Two prototypes are built for environmental testing at JRC and on board of a ship.

PROGRESS/RESULTS TO-DATE

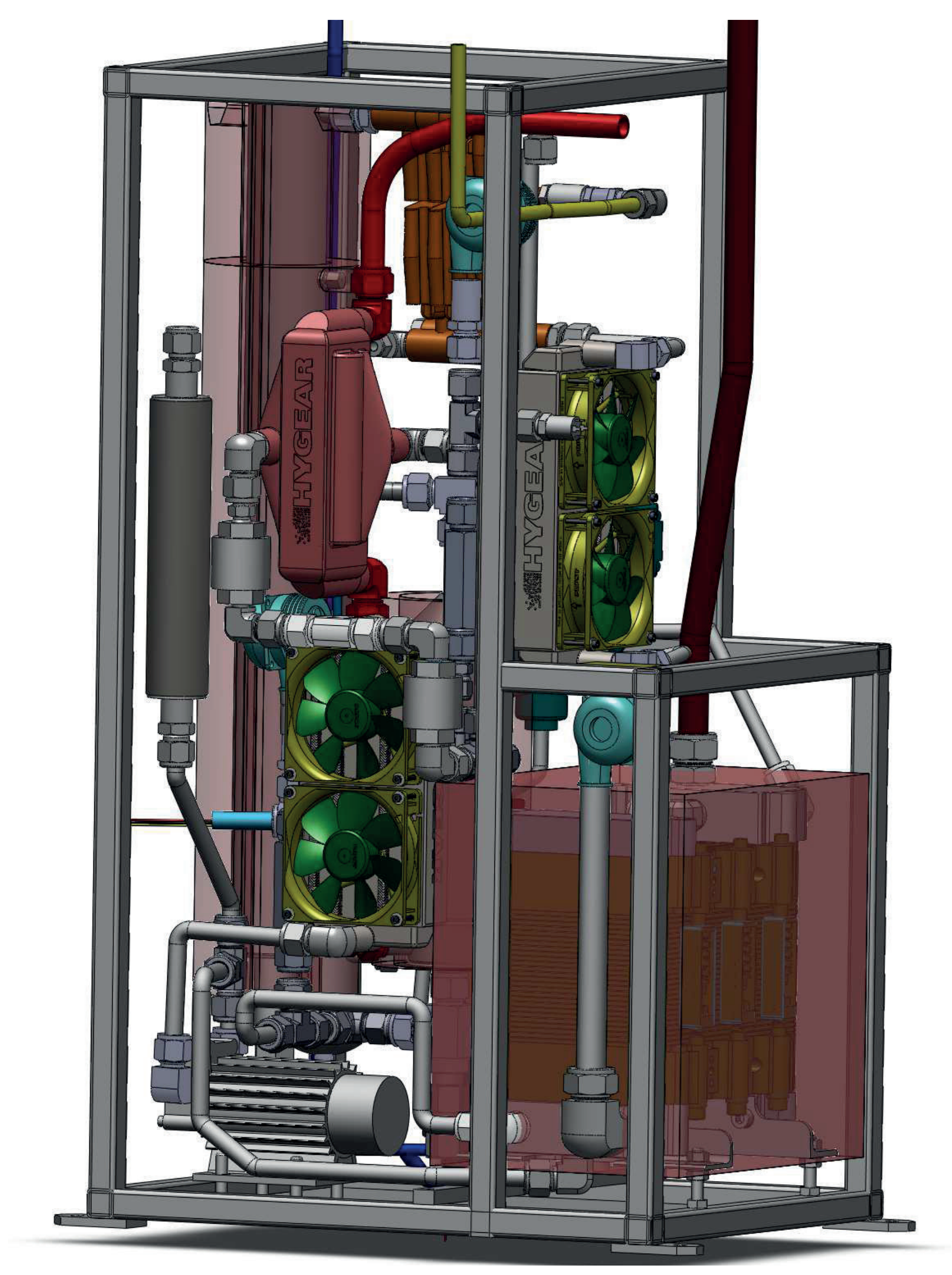
- System design and construction ready
- Optimised MEA's built into stacks
- Improved ATR catalysts delivered for integration in system
- System Modules (ATR, Stack, ATO) successfully tested
- 3D printed metal heat exchangers successfully tested

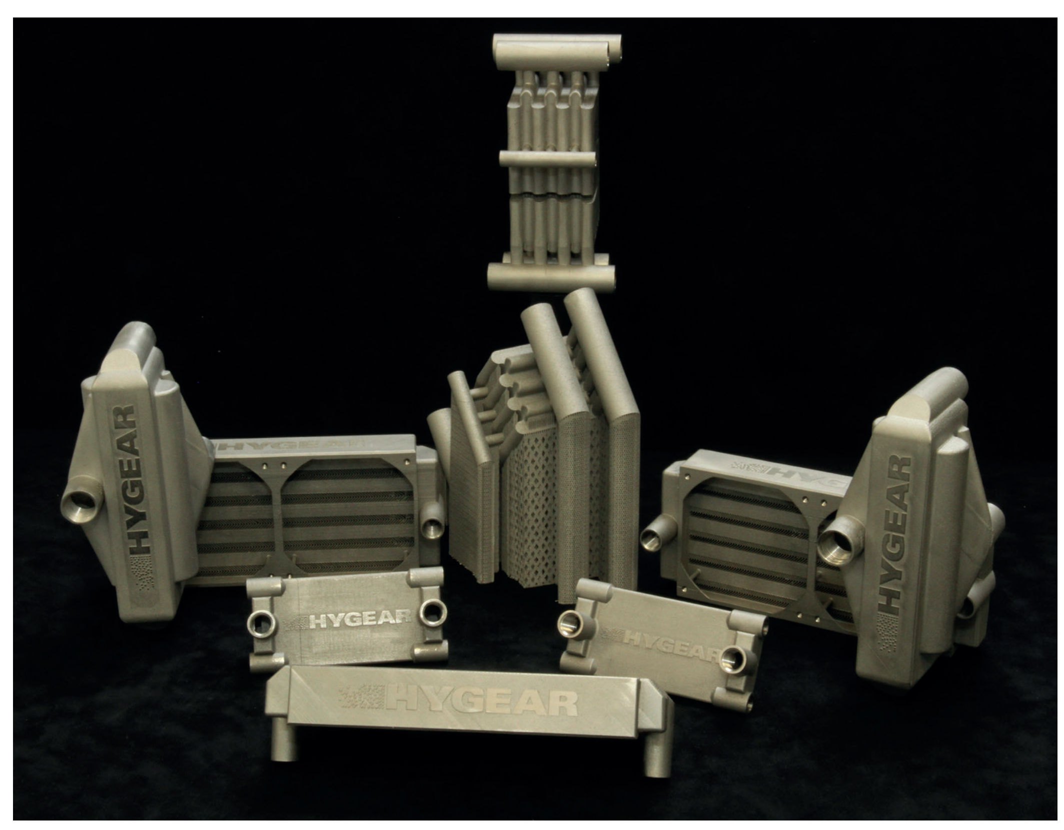
FUTURE STEPS

- Shock and vibration tests on Modules and system
- Environmental tests on system
- System testing in lab
- System testing on board of a ship.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Improved sulphur tolerance ATR catalysts shown
- 3D metal printing is a useful new manufacturing technology for small systems
- MEA production by environmental friendly processes and materials proven
- Small size system compared to SoA designed and constructed





CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Development of miniaturized BoP for specific devices	50l/kWe, 35kg/kWe	50l/kWe, 35kg/kWe	75 l/kWe, 52kg/kWe
MAIP 2008-2013	Assessment of fueling supply options	Logistics fuel	LPG based system	LPG fuel processing proven
AIP 2011	Stack power max. 50-500We net	Max 500 We	Max 500 We	Max power reached.
AIP 2011	On board fuel processing	Max conversion in LPG fuel processing	100% conversion vs chemical equilibrium reached & proven	Ready for implementation

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

SAPIENS

Solid Oxide Fuel Cell Auxiliary Power in Energy/Noise Solutions

AIP / APPLICATION AREA	AIP 2011 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2011.4.4: Research, development and demonstration of new portable Fuel Cell systems
START & END DATE	01 Nov. 2012 - 31 Oct. 2015
TOTAL BUDGET	€ 2,369,507.20
FCH JU CONTRIBUTION	€ 1,591,590.00
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: Adelan Ltd

Partners: Auto-Sleepers Group Ltd, Center for Abrasives and Refractories Research and Development, Clausthaler Umweelttechnik Institut GMBH, Joint Research Centre –European Commission, Fundacio Institut de recerca de L'Energia de Catalunya, Zachodniopomorski Uniwesytet Technologiczny w Szczecinie.

PROJECT WEBSITE/URL

http://sapiens-project.eu

PROJECT CONTACT INFORMATION

Jill Newton
jill.newton@adelan.co.uk

MAIN OBJECTIVES OF THE PROJECT

SAPIENS aims to design, optimize and build 100W micro-tubular solid oxide fuel cell (mSOFC) stacks, and to integrate them into hybrid power systems. These will form auxiliary power units to provide power for appliances found in recreational vehicles (RVs).

- Test the liquid petroleum gas (LPG) fuel
- Improve the mSOFC in terms of materials, lifetime, performance, noise reduction, emissions and costs
- To disseminate by getting users to apply the new device and report results across Europe. Also three special conferences will be organised to disseminate information, ten refereed publications will be submitted and patents will be published.

PROGRESS/RESULTS TO-DATE

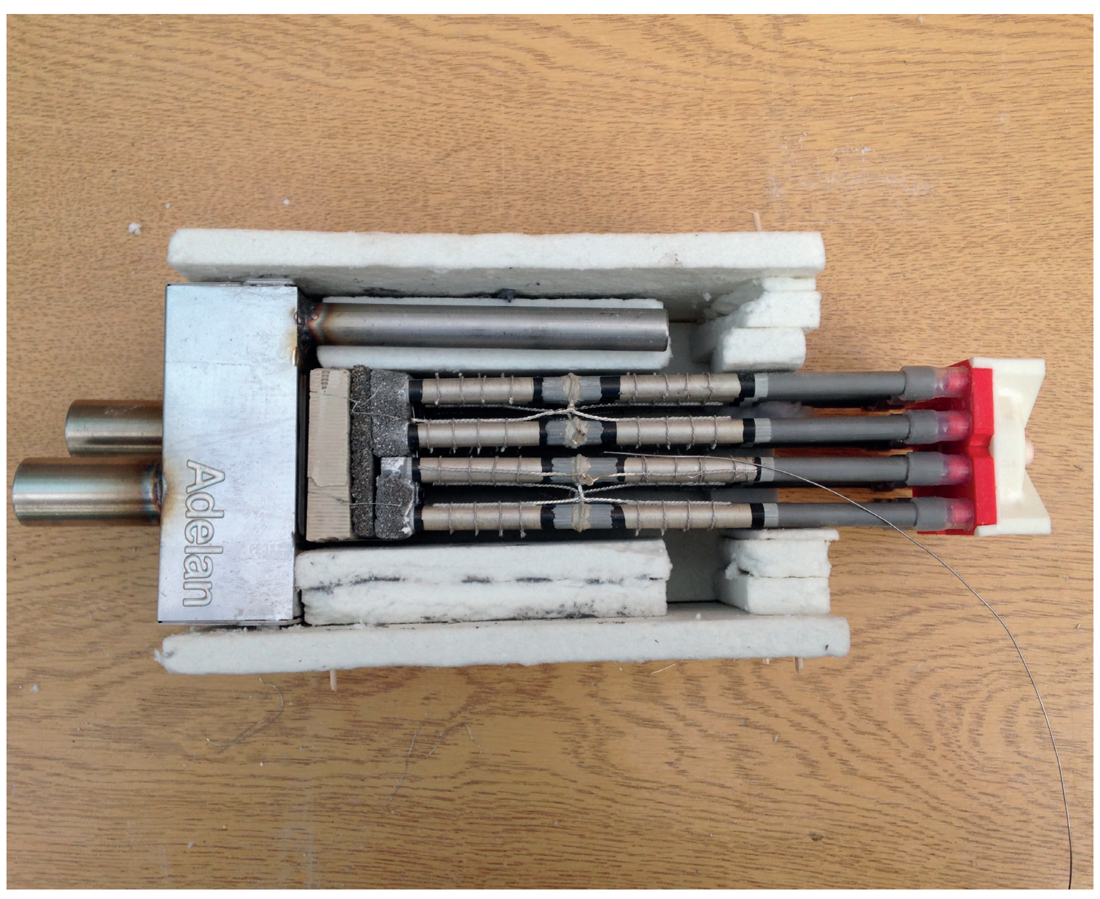
- Cells tested
- Stack built
- Balance of plant complete
- CPOX experiments with LPG were successful
- Prototype installed in RV

FUTURE STEPS

- Complete field trials
- Demonstration of consumer/environmental performance and acceptability.

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- Good cell and substack performance has been achieved
- CPOX experiments with LPG were successful
- Prototype installed in RV



CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	Development of miniaturized BoP for specific devices ...		As the fuel cell generator including fueling has to fit into a confined RV space, the BoP components have to be miniaturized	The fuel cell generator has been fitted in cofined space in RV
MAIP 2008-2013	Assessment of fueling supply options		On-board fueling with LPG for mission extension	The fuel cell generator runs on LPG
MAIP 2008-2013	Supportive actions for SME		Auto-Sleepers is customer and contributor in SAPIENS SME, producer of RV products, Adelan Ltd is developer of the core modules	Successful partnership

SUAV

Microtubular Solid Oxide Fuel Cell Power System Development and Integration into a Mini-UAV

AIP / APPLICATION AREA	AIP 2010 / AA 4: Early Markets
CALL TOPIC	SP1-JTI-FCH.2010.4.5: RTD on new portable and micro Fuel Cell solutions
START & END-DATE	01 Dec. 2011 - 30 Nov. 2015
TOTAL BUDGET	€ 3,873,401.02
FCH JU CONTRIBUTION	€ 2,109,514.00
PANEL	Panel 1- Transport Demonstration

PARTNERSHIP/CONSORTIUM LIST

Coordinator: HyGear Fuel Cell Systems B.V.

Partners: Adelan Ltd., Catator AB, CNR-ITAE, Airbus Group Innovations UK and Germany, efceco, University of Birmingham, West Pomeranian University of Technology Szczecin, SURVEY Copter SAS

PROJECT WEBSITE/URL

www.suav-project.eu

PROJECT CONTACT INFORMATION

Dr. Ellart de Wit - ellart.de.wit@hygear.nl (coordinator contact)
Dr. Erich Erdle – efceco@efceco.com (technical contact)

MAIN OBJECTIVES OF THE PROJECT

The objective of the project is to design, optimise and build a fuel cell power generator for small Unmanned Aerial Vehicles (mini-UAV). The stack to be developed will be integrated together with the required fuel processor and mechanical as well as electrical balance of plant components. The fuel cell generator will be packaged and placed into a mini-UAV. The advanced mini-UAV will be tested in a flight mission with the goal to achieve three-times longer flight endurance compared to batteries.

PROGRESS/RESULTS TO-DATE

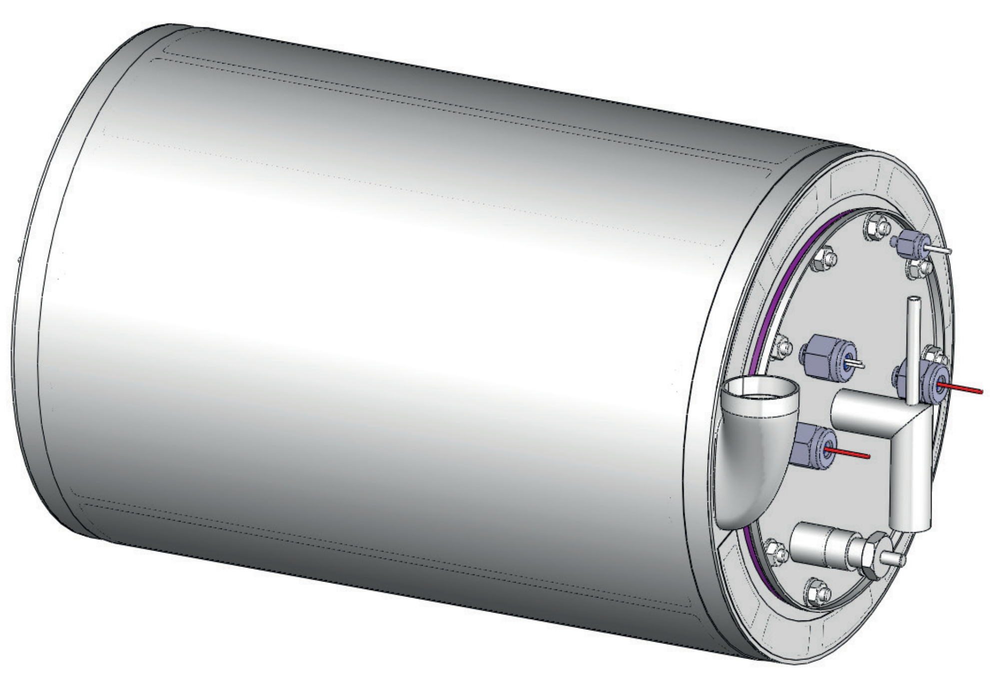
- Top level requirements for fuel cell system into UAV defined including battery sizing
- improvement of tubular cell power from 1 W to 7 W (hydrogen flow)
- design of tubular SOFC stack (micro-SOFC) and stress calculation and modelling of micro-SOFC-stack
- development of highly integrated fuel cell power system design and design to implement fuel cell power system into UAV
- Lab testing commercial micro-SOFC system

FUTURE STEPS

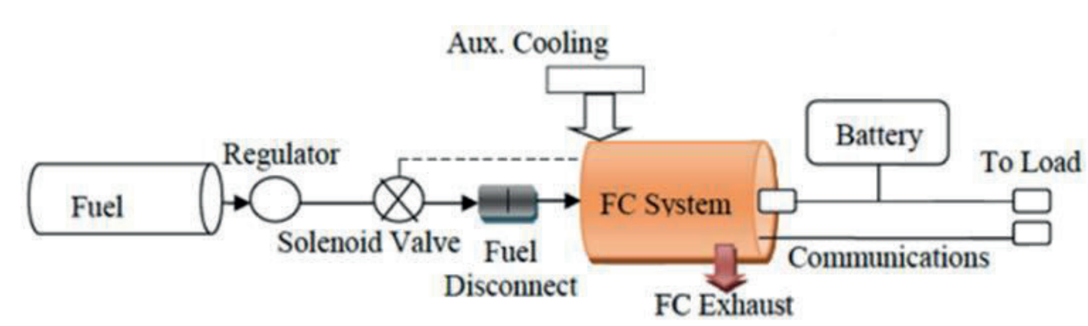
- Assembly fuel cell power system after successful stack manufacture
- Test of hybrid fuel cell power system(s)

CONCLUSIONS, MAJOR FINDINGS AND PERSPECTIVES

- sealing big challenge for tubular SOFC
- weight/volume constraints hard to tackle
- perspective to achieve European technology with higher energy densities compared to other technologies (e.g. batteries alone)



Exterior SOFC system



Schematic SUAV system

CONTRIBUTION TO THE PROGRAMME OBJECTIVES

SOURCE OF OBJECTIVE/ TARGET (MAIP, AIP)	ASPECT ADDRESSED	PROGRAMME OBJECTIVE/ QUANTITATIVE TARGET	PROJECT OBJECTIVES/ QUANTITATIVE TARGETS	CURRENT STATUS/ ACHIEVEMENTS TO-DATE
MAIP 2008-2013	portable & micro FCs on EU market in 2012	400	Project started in 2011, targeted to mini-UAV	
MAIP 2008-2013	portable & micro FCs on the EU market in 2015	12,000 – 13,000		Not on market, SUAV will end in November 2015, targeted to a mini-UAV prototype
MAIP 2008-2013	Development of miniaturized BoP for specific devices	-	As the fuel cell generator including fueling has to fit into a mini-UAV the BoP components have to be miniaturized	stack and BoP miniaturized, development of special lightweight air valve (50 g in total)
MAIP 2008-2013	Assessment of fueling supply options	-	On-board fueling with Propane for long range missions	propane is the fuel to fly with
MAIP 2008-2013	Supportive actions for SME	-	SURVEY Copter is customer and contributor in SUAV SME, producer of mini-UAV and part of Airbus HyGear Fuel Cell Systems B.V., ADELAN Ltd. and CATATOR SA as developer and manufacturer of the core modules efceco as technical manager and advisor in all WPs	
MAIP 2008-2013	Pre-normative research on safety, emissions etc.	-	Is part of the Top Level Requirements task related to civil aviation	
AIP 2010	Stack power	200 W_e net	250 W_e	potentially 300 W_e
AIP 2010	On-board fuel storage		Propane on-board storage	
AIP 2010	Fuel Processing	-	Pre-reformer development	highly integrated CPOX-Fuel Cell system, manufactured
AIP 2010	Stack	-	stack development	Design ready; first stack assembled according to design, however it was broken during the FAT due to experimental circumstances
AIP 2010	Balance of Plant	-	Mechanical and Electrical Balance of Plant	highly integrated fuel cell power system manufactured
AIP 2010	Power electronics and controls	-	Controls development	development on-going with delay
AIP 2010	Proof-of-Concept unit		assembly of lab test and UAV unit	Delayed due to stack failure
AIP 2010	System validation through testing		lab testing and flight mission of UAV version	Delayed; commercial FC system tested in lab and combined with battery pack. Lab testing of the original SUAV system to be performed at later stage of the project