3EMOTION

ENVIRONMENTALLY FRIENDLY, EFFICIENT ELECTRIC MOTION

Project ID:	**633174**
Call topic:	**SP1-JTI-FCH.2013.1.1** - Large-scale demonstration of road vehicles and refuelling infrastructure VI
Project total costs:	**€39 232 162.6**
FCH JU max. Contribution:	**€14 999 983**
Project start - end:	01/01/2015 - 31/12/2022
Coordinator:	**VAN HOOL NV, BE**
Website:	**www.3emotion.eu**

BENEFICIARIES: AALBORG KOMMUNEACETILENE & GASTECNICI DI BAGNOLI MARIA & C. SAS, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE, AIR LIQUIDE ADVANCED BUSINESS, AIR LIQUIDE ADVANCED TECHNOLOGIES SA, AUTOCARS DOMINIQUE, AZIENDA PER LA MOBILITA DEL COMUNE DI ROMA SPA, , CENTRO INTERUNIVERSITARIO DI RICERCA PER LO SVILUPPO SOSTENIBILE, COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, COMMUNAUTE URBAINE DE CHERBOURG, COMMUNE DE CHERBOURG-EN-COTENTIN, COMPAGNIA TRASPORTI LAZIALI, CONNEXXION OPENBAAR VERVOER NV, CONNEXXION VLOOT BV, DANTHERM POWER AS, FIT CONSULTING SRL, LONDON BUS SERVICES LIMITED, PROVINCIE ZUID-HOLLAND, REGIONE LAZIO, REGION NORDJYLLAND (NORTH DENMARK REGION), ROTTERDAMSE ELEKTRISCHE TRAM NV, SERVICES AUTOMOBILES DE LA VALLEE DE CHEVREUSE SAS, SYNDICAT MIXTE DES TRANSPORTS URBAINS DE PAU PORTE DES PYRENEES, UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA, VLAAMSE VERVOERSMAATSCHAPPIJ DE LIJN, WATERSTOFNET VZW

PROJECT AND OBJECTIVES

The 3Emotion project aims to operate 29 FCBs in 5 leading European cities: London, Pau, Versailles (2x), Rotterdam and in the Province of South Holland, and in Aalborg (DK) and to develop 3 new HRS.

Objectives:

- Lower H2 consumption <9 kg/100 km
- Integrate latest drivetrain, FC and battery technology < TCO and > lifetime
- Ensure availability >90 %
- Increase warranties (>15 000 hours and improve delivery times of the key components)
- Reduce bus investment costs to €850 000 for a 13 m bus.

Status:

- 24 operational buses; due to COVID-19, 5 buses are still in production (Safra)
- All HRS are operational.

NON-QUANTITATIVE OBJECTIVES

- Contribution to safety improvements for fuel cell buses
- Solution for the hydrogen sensor problem, which arose earlier in the project, enabled the same issue to be avoided in the new buses.

PROGRESS AND MAIN ACHIEVEMENTS

- 24 fuel cell buses in operation, the remaining 5 buses will follow soon after the coronavirus measures have been eased
- 3 different OEMs, with 2 different fuel cell suppliers, have sold their buses to different EU sites for the 'set' bus price stated in the FCH JU call
- Buses are meeting their targets on hydrogen consumption, and averaging 8 kg/100 km, with increasing availability of >90 %.

FUTURE STEPS AND PLANS

- Catch up on the delays and start operation of all buses at all sites, including the last 5 that are stuck in production due to COVID-19
- Use and full operation, meeting the 3 HRS requirement
- Data monitoring and gathering of operational and performance indicators (KPIs) for the FCBs and HRS.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives and AIP 2013	Lower H_2 consumption for FCBs to less than 9 kg/100 km	kg/100 km	9	Average of 8 kg/100 km	✓	N/A	2020
	Ensure availability >90 %	%	90	< = 80	✗		
	Increase warranties (>15 000 hours)	Hours	15 000	15 000	✓		
	Investment cost of <€850 000 for a 13 m bus	Euro	850 000	850 000	✓		

FLAGSHIPS

CLEAN WATERBORNE TRANSPORT IN EUROPE

Project ID:	**826215**
Call topic:	**FCH-01-2-2018:** Demonstration of Fuel Cell applications for midsize passenger ships or inland freight
Project total costs:	**€6 790 561.43**
FCH JU max. Contribution:	**€4 999 978.75**
Project start - end:	01/01/2019 - 31/12/2022
Coordinator:	**TEKNOLOGIAN TUTKIMUSKESKUS VTT OY, FI**
Website:	**flagships.eu/**

BENEFICIARIES: LMG MARIN FRANCE, LMG MARIN AS, NORLED AS, WESTCON POWER AND AUTOMATION AS, MARITIME CLEANTECH, PERSEE, COMPAGNIE FLUVIALE DE TRANSPORT, BALLARD POWER SYSTEMS EUROPE AS, ABB OY, KONGSBERG MARITIME AS

PROJECT AND OBJECTIVES

The project aims to deploy two hydrogen fuel cell vessels. The Paris (FR) demo vessel is a self-propelled barge operating as a utility vessel on the River Seine , while the Stavanger (NO) demo vessel is a passenger and car ferry. The design of both vessels is almost ready, pending a few details. In addition, a design case study for a push-boat in Lyon has been conducted. The Stavanger demo vessel is currently suspended and will resume once the issues with the hydrogen supply and bunkering have been solved.

NON-QUANTITATIVE OBJECTIVES

- Strengthen the European supply chain and competence network for hydrogen fuel and PEMFC system technologies for maritime applications
- Contribute to highlight gaps in the rules and regulations for the use of hydrogen in maritime applications
- Contribute to make politicians and lawmakers aware of the practical challenges related to the lack of hydrogen production plants in Norway.

PROGRESS AND MAIN ACHIEVEMENTS

- Design of H2 & FC systems and powertrains for all three vessels is almost ready. Some minor details are still pending
- Design of the marine-based 200 kW FCwave fuel cell module is ready. DNV GL type approval is ongoing
- Tools for logging, tracking and analysing voyage energy consumption and performance have been developed.

FUTURE STEPS AND PLANS

- Solve the issues with the Stavanger case. A solution for feasible hydrogen supply/bunkering will be sought. If no solution is found, we will look for an alternative demo case for the project
- The Zulu ship is to start operation. Main tasks to be completed are: finalise the design, get the derogation, integrate the H2 system, commission the H2 system
- Finalise FCwave testing following the test plan
- Manufacture 5x FCwave for the 2 demonstrations.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objectives and MAWP Addendum (2018-2020)	PEMFC system availability	%	95	✓
	A complete FC & H2 system cost	€/kW	4 000	✓
	PEMFC system lifetime	Hours	25 000	

H2HAUL

HYDROGEN FUEL CELL TRUCKS FOR HEAVY-DUTY, ZERO EMISSION LOGISTICS

Project ID:	**826236**
Call topic:	**FCH-01-1-2018:** Large Scale Demonstration of H2 fuelled HD Trucks with High Capacity Hydrogen Refuelling Stations (HRS)
Project total costs:	**€28 033 073.41**
FCH JU max. Contribution:	**€12 000 000**
Project start - end:	01/02/2019 - 31/01/2024
Coordinator:	**ELEMENT ENERGY LIMITED, UK**
Website:	**www.h2haul.eu**

BENEFICIARIES: ELRINGKLINGER FUELCELL SYSTEMS AUSTRIA GMBH, ELEMENT ENERGY, H2 ENERGY AG, AIR LIQUIDE FRANCE INDUSTRIE, VDL ENABLING TRANSPORT SOLUTIONS BV, VDL BUS CHASSIS BV, EOLY, FPT MOTORENFORSCHUNG AG, HYDROGENICS GMBH, IRU PROJECTS ASBL, FPT INDUSTRIAL SPA, AIR LIQUIDE ADVANCED TECHNOLOGIES SA, SPHERA SOLUTIONS GMBH, IVECO SPA, ELRINGKLINGER AG, ETABLISSEMENTEN FRANZ COLRUYT NV, WATERSTOFNET VZW

PROJECT AND OBJECTIVES

H2Haul brings together two major European truck OEMs (IVECO/FPT and VDL) and three fuel cell stack/system suppliers (ElringKlinger, Bosch and PowerCell) to develop and demonstrate fleets of heavy-duty trucks (26-44 t) in day-to-day commercial operations at four sites across four countries. The overall objective of H2Haul is to prove that hydrogen trucks can be a practical zero-emission and zero-carbon solution for much of Europe's trucking needs and so pave the way for the commercialisation of fuel cell trucks in Europe. The project is currently in the planning and pre-deployment phase.

NON-QUANTITATIVE OBJECTIVES

- Develop long-haul heavy-duty (26 and 44 t) fuel cell trucks that meet customers' requirements in a range of operating environments. Truck design is ongoing and specifications are being designed as per specific customer requirements and mission profiles. Objectives are expected to be met
- Homologate three fuel cell truck types to certify that they are safe to use on Europe's roads. Truck OEMs are working closely with hydrogen safety experts and the relevant certification bodies to secure all necessary safety approvals for using the trucks on public roads in Europe
- Develop the business case for the further roll-out of heavy-duty fuel cell trucks. H2Haul will provide a valuable database of real-world performance information and insights into the next steps required for the commercialisation of this sector. Business case to be developed as a result of FC truck design to meet customers' needs. Operation of FC trucks and subsequent data collection will highlight the costs involved in the technology. Analysis will be carried out to highlight the economics of more ambitious deployments of many tens of vehicles or more
- Prepare the European market for further roll-out of fuel cell trucks through: (i) the development of innovative commercial models; and (ii) disseminating information from the project to a wide audience of relevant stakeholders. H2Haul's dissemination activities will share key findings with relevant audiences to prepare the market for wider roll-out of fuel cell trucks on a commercial basis. The project's dissemination strategy and communication activities, created in the first year, have stimulated significant interest from relevant audiences.

PROGRESS AND MAIN ACHIEVEMENTS

- Data on the technical specifications of the fuel cell trucks and hydrogen refuelling stations
- Commissioning of the first hydrogen refuelling station in Rothenburg, Switzerland, in January 2021
- The first Observer Group meeting took place on 2 July 2020.

FUTURE STEPS AND PLANS

- Finalise design phase for FPT/IVECO and VDL trucks and continue preparation for full construction. Design phase is near completion
- Development of first prototype of fuel cell systems and fuel cell trucks, and commencement of internal testing. Construction of H2Haul trucks for end-users. Testing of prototypes to commence in 2021, in preparation for full deployment from 2022
- Preparatory activities for HRS deployment; all sites selected, permits requested, and the commencement of civil works. Currently one HRS is in operation. Remaining HRS are in pre-deployment phase, with civil works to commence
- Continued high-profile dissemination and lobbying work through attendance and presentation at key conferences and events. Continue work on Observer Group and other stakeholder engagement. Communication and dissemination activities have been strong in the first phase of the project. As equipment and trucks are deployed, key milestones, achievements and results will be disseminated extensively.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
Project's own objectives and MAWP Addendum (2018-2020)	Truck operational period	Months	Start of operation incl. ramp-up phase: minimum of 24 months	N/A	N/A
	Truck distance travelled	km	Min. 30 000 km per truck per year, on average, per site		
	Truck availability	%	>90 % on a fleet basis after an initial ramp-up phase of max. 6 months		
	Truck specific fuel consumption	kg/100 km	<7.5 kg/100 km (rigid, @30-50 % load, inner city delivery (<25 km/h on average) <8.5 kg/100 km (tractor with semi-trailer @30-50 % load, long haul delivery (>65 km/h on average)		
	Availability of station (by project end)	%	99	98	2017
	Mean distance between failures	km	Fuel cell MDBF >2 500 km	N/A	N/A
	WtW CO_2 emissions <50 % compared to diesel truck	kg CO_2/km	kg CO_2/ vehicle km (per vehicle type, average across fleet) <50 % compared to diesel truck		
	Speed of hydrogen dispensing	kg/min	>2.5 kg/min		
	Cost of hydrogen dispensed to HRS	€/kg	≤7.5 €/kg dispensed (excl. taxes) at end of project – in practice, lower values are expected	12	2017
	Amount of hydrogen dispensed to project trucks	kg/year	>2 500 kg per truck per year	N/A	N/A

H2ME
HYDROGEN MOBILITY EUROPE

Project ID:	**671438**
Call topic:	**FCH-01.7-2014** - Large scale demonstration of refuelling infrastructure for road vehicles
Project total costs:	**€69 044 206.16**
FCH JU max. Contribution:	**€32 000 000**
Project start - end:	01/06/2015 - 30/11/2020
Coordinator:	**ELEMENT ENERGY LIMITED, UK**
Website:	**www.h2me.eu**

BENEFICIARIES: LINDE GMBH, MERCEDES-BENZ AG, LINDE HYDROGEN FUELTECH GMBH, MCPHY ENERGY ITALIA SOCIETA A RESPONSABILITA LIMITATA, ELEMENT ENERGY, LINDE GAS GMBH, H2 MOBILITY DEUTSCHLAND GMBH & CO KG, COMMUNAUTE D'AGGLOMERATION SARREGUEMINES CONFLUENCES, FALKENBERG ENERGI AB, HYOP AS,DANISH HYDROGEN FUEL AS, OMV DOWNSTREAM GMBH, BOC LIMITED, HONDA R&D EUROPE (DEUTSCHLAND) GMBH, AGA AB, HYUNDAI MOTOR EUROPE GMBH, SYMBIO, AIR LIQUIDE ADVANCED TECHNOLOGIES SA, AREVA H2GEN, INTELLIGENT ENERGY LIMITED, ITM POWER (TRADING) LIMITED, CENEX - CENTRE OF EXCELLENCE FOR LOW CARBON AND FUEL CELL TECHNOLOGIES, MCPHY ENERGY, MERCEDES-BENZ FUEL CELL GMBH, WATERSTOFNET VZW, NISSAN MOTOR MANUFACTURING (UK) LIMITED, AIR LIQUIDE ADVANCED BUSINESS, NEL HYDROGEN AS, TOYOTA MOTOR EUROPE NV, ICELANDIC NEW ENERGY LTD, EIFER EUROPAISCHES INSTITUT FUR ENERGIEFORSCHUNG EDF KIT EWIV, LINDE AG, RENAULT SAS, BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT, DAIMLER AG

PROJECT AND OBJECTIVES

Hydrogen Mobility Europe (H2ME) brought together Europe's four most ambitious national initiatives on hydrogen mobility (in Germany, Scandinavia, France and the UK). The project expanded their developing networks of HRS – 29 new stations will be deployed in total – and the fleets of FCEV operating on Europe's roads – 339 vehicles – creating both a physical and strategic link between these four regions and three 'observer countries', namely Austria, Belgium and the Netherlands, which are using what has been learnt by this project to develop their own strategies.

NON-QUANTITATIVE OBJECTIVES

- Minimum of 100 FCEV and 23 HRS
- 339 vehicles and 29 HRS have been delivered to customers
- Further activities for deployment of HRS
- Further FCH JU and CEF projects have been developed and new projects are in the making
- HRS to be accessible to private users
- All of the 700 bar HRS are accessible to private drivers
- Ensure cross-fertilisation of knowledge acquired in the project
- The project summarised all findings in a final report that is publicly available. The lessons learnt and best practices will continue to be exploited through H2ME 2.

PROGRESS AND MAIN ACHIEVEMENTS

- Successful deployment of all foreseen activities, with 29 HRS and 339 vehicles delivered to customers
- Building a rich dataset valuable for Europe: jointly with H2ME 2. Since 2016, 14 340 000 km have been driven and 134 t of H2 distributed at 61 850 events
- The H2ME project has shown that FCEV and HRS are ready for commercial roll-out and can meet customers' expectations.

FUTURE STEPS AND PLANS

The project has finished.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?	SOA RESULT ACHIEVED TO DATE (BY OTHERS)	YEAR FOR SOA TARGET
FC Vehicles							
Project's own objectives, MAWP Addendum (2018-2020) and AWP 2014	Min. vehicle operation during the project	Months	12	50	✓	12	2017
	Vehicle availability	%	>95	>99	✓	98	
HRS							
Project's own objectives, MAWP Addendum (2018-2020) and AWP 2014	HRS availability	%	97	>95	✗	98	2017
	Min. HRS operation	Months	24	50	✓	32	2017
	Hydrogen purity	%	99.99	99.99	✓	99.99	2015

H2ME 2
HYDROGEN MOBILITY EUROPE 2

Project ID:	**700350**
Call topic:	**FCH-03.1-2015:** Large scale demonstration of Hydrogen Refuelling Stations and FCEV road vehicles - including buses and on site electrolysis
Project total costs:	**€101 449 352.03**
FCH JU max. Contribution:	**€34 999 548.50**
Project start - end:	01/05/2016 - 30/06/2022
Coordinator:	**ELEMENT ENERGY LIMITED, UK**
Website:	**www.h2me.eu**

BENEFICIARIES: TOYOTA NORGE AS, TOYOTA DANMARK AS, ELEMENT ENERGY, B. KERKHOF & ZN BV, TECH TRANSPORTS COMPAGNIE, ALPHABET FUHRPARKMANAGEMENT GMBH, LINDE GAS GMBH, ISLENSKA VETNISFELAGID EHF, COMMUNAUTE URBAINE DU GRAND NANCY, STEDIN DIENSTEN BV, SOCIETE DU TAXI ELECTRIQUE PARISIEN, H2 MOBILITY DEUTSCHLAND GMBH & CO KG, HYOP AS, BRINTBRANCHEN, NEW NEL HYDROGEN AS, COMPAGNIE NATIONALE DU RHONE SA, HYDROGENE DE FRANCE, HONDA R&D EUROPE (DEUTSCHLAND) GMBH, GNVERT SAS, AGA AB, SYMBIO, AIR LIQUIDE ADVANCED TECHNOLOGIES SA, AREVA H2GEN, SOCIETE D'ECONOMIE MIXTE DES TRANSPORTS EN COMMUN DE L'AGGLOMERATION NANTAISE (SEMITAN), MINISTERIE VAN INFRASTRUCTUUR EN WATERSTAAT, INTELLIGENT ENERGY LIMITED, MANUFACTURE FRANCAISE DES PNEUMATIQUES MICHELIN, ITM POWER (TRADING) LIMITED, CENEX - CENTRE OF EXCELLENCE FOR LOW CARBON AND FUEL CELL TECHNOLOGIES, KOBENHAVNS KOMMUNE, HYSOLUTIONS GMBH, MCPHY ENERGY, MERCEDES-BENZ FUEL CELL GMBH, NISSAN MOTOR MANUFACTURING (UK) LIMITED, AIR LIQUIDE ADVANCED BUSINESS, RENAULT TRUCKS SAS, NEL HYDROGEN AS, ICELANDIC NEW ENERGY LTD, EIFER EUROPAISCHES INSTITUT FUR ENERGIEFORSCHUNG EDF KIT EWIV, STEDIN NETBEHEER BV, RENAULT SAS, BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT, AUDI AKTIENGESELLSCHAFT, OPEN ENERGI LIMITED, DAIMLER AG, THE UNIVERSITY OF MANCHESTER

PROJECT AND OBJECTIVES

H2ME 2 brings together actions in 8 countries in a 6-year collaboration to deploy 20 HRS and over 1 000 vehicles. The project will perform a large-scale market test of a large fleet of fuel cell electric vehicles operated in real-world customer applications across multiple European regions. In parallel, it will demonstrate that the hydrogen mobility sector can support the wider European energy system via electrolytic hydrogen production.

NON-QUANTITATIVE OBJECTIVES

- Min. of 1 200 fuel cell vehicles and 20 HRS
- >1 200 fuel cell vehicles and 20 HRS foreseen by the end of the project
- Demonstration of electrolyser integrated HRS operating in grid balancing
- H2ME 2 has a dedicated WP to assess how electrolytic hydrogen production in the mobility sector can link to the wider energy system
- Vehicles supplied by multiple OEMs, including cars and utility vehicles
- H2ME 2 will deploy cars, light-duty vans and trucks from OEMs, including Daimler, Honda, Symbio, Hyundai and Toyota
- Ensure cross-fertilisation of knowledge acquired in the project
- Dedicated WP and dissemination and exploitation plan to achieve this. Three observer countries are included in the coalition.

PROGRESS AND MAIN ACHIEVEMENTS

- Demonstration under way for 296 vehicles from 5 OEMs (Daimler, Honda, Hyundai, Symbio and Toyota) and 9 HRS from 5 suppliers across 5 countries
- Demonstration of positive business cases under H2ME 2 has led to further commitments from partners to expand fleets in France, Denmark and Germany
- Building a rich dataset for Europe – jointly with H2ME. Since 2016, 14.5 million kilometres have been driven and 147 t of H2 distributed at 68 000 events.

FUTURE STEPS AND PLANS

- Most of the 20 HRS planned for the project are expected to have been commissioned and to be in operation in the next 16 months. Commissioning of new HRS has been impacted by the COVID-19 pandemic
- Most of the vehicles planned for the project are expected to be deployed in the next 16 months. Deployment of vehicles has been impacted by the COVID-19 pandemic
- Solid and growing basis of operational data from vehicles and stations and further fact-based analysis of vehicles and HRS performances. The H2ME initiative is the largest European deployment to date for hydrogen mobility, with 632 vehicles and 37 HRS deployed
- Further exploitation of results. Across H2ME and H2ME 2, c. 50 reports have been prepared to date. The projects have prepared a summary report for the end of phase 1 of the initiative.

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
HRS							
Project's own objective aligned with AWP 2015/MAWP Addendum (2018-2020)	HRS availability	%	98	>95	✗	98	2017
	Min. HRS operation	Months	36	48	✓	32	
	Hydrogen purity	%	99.99	99.999	✓	99.99	
FC Vehicles							
Project's own objectives, MAWP Addendum (2018-2020) and AWP 2015	Min. vehicle operation during project	Months	36	50	✓	12	2017
	Vehicle availability	%	98	>99	✓	98	

H2PORTS

IMPLEMENTING FUEL CELLS AND HYDROGEN TECHNOLOGIES IN PORTS

Project ID:	**826339**
Call topic:	**FCH-03-1-2018:** Developing Fuel Cell applications for port/harbour ecosystems
Project total costs:	**€4 117 197.50**
FCH JU max. Contribution:	**€3 999 947.50**
Project start - end:	01/01/2019 - 31/12/2022
Coordinator:	**FUNDACION DE LA COMUNIDAD VALENCIANA PARA LA INVESTIGACION, PROMOCION Y ESTUDIOS COMERCIALES DE VALENCIAPORT, ES**
Website:	**h2ports.eu/**

BENEFICIARIES: VALENCIA TERMINAL EUROPA SA, CANTIERI DEL MEDITERRANEO SPA, HYSTER-YALE NEDERLAND BV, ATENA SCARL - DISTRETTO ALTA TECNOLOGIA ENERGIA AMBIENTE, MEDITERRANEAN SHIPPING COMPANY TERMINAL VALENCIA SA, CENTRO NACIONAL DE EXPERIMENTACIONDE TECNOLOGIAS DE HIDROGENO Y PILASDE COMBUSTIBLE CONSORCIO, GRIMALDI EUROMED SPA, BALLARD POWER SYSTEMS EUROPE AS, AUTORIDAD PORTUARIA DE VALENCIA, ENAGAS SA, UNIVERSITA DEGLI STUDI DI NAPOLI PARTHENOPE, UNIVERSITA DEGLI STUDI DI SALERNO, AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE, L'ENERGIA E LO SVILUPPO ECONOMICO SOSTENIBILE

PROJECT AND OBJECTIVES

The H2Ports project will demonstrate and validate, through real port operations at the port of Valencia, two innovative solutions based on FC technologies and a mobile HRS specifically designed for the project. A Reach Stacker to be tested at a container terminal (MSCTV) and a Terminal Tractor to be tested at Valencia Terminal Europa (part of the Grimaldi Group) have been selected as being especially suited to fuel cell use in port facilities. The project will run the equipment on a daily basis for two years. All three pilots are currently being built and the pilot period is expected to start in November 2021.

PROGRESS AND MAIN ACHIEVEMENTS

- Design and start of construction of a mobile HRS
- Design and component selection for an FC Reach Stacker
- Design and component selection for a Terminal Tractor.

FUTURE STEPS AND PLANS

- Finalisation of the HRS, expected in August 2021
- Construction of the Reach Stacker, expected in November 2021
- Retrofit of the Terminal Tractor, expected in November 2021.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objectives, MAWP Addendum (2018-2020) and AWP 2018	Lifetime	Hours	20 000	
	Tank-to-wheel efficiency	%	50	
	HRS availability	%	>98	

JIVE
JOINT INITIATIVE FOR HYDROGEN VEHICLES ACROSS EUROPE

Project ID:	**735582**
Call topic:	**FCH-01-9-2016:** Large Scale Validation of fuel cell bus fleets
Project total costs:	**€110 375 045.24**
FCH JU max. Contribution:	**€32 000 000**
Project start - end:	01/01/2017 - 31/12/2022
Coordinator:	**ELEMENT ENERGY LIMITED, UK**
Website:	**www.fuelcellbuses.eu/projects/jive**

BENEFICIARIES: REBELGROUP ADVISORY BV, IN-DER-CITY-BUS GMBH, ESWE VERKEHRSGESELLSCHAFT MBH, MAINZER VERKEHRSGESELLSCHAFT MBH, VERKEHRS-VERBUND MAINZ-WIESBADEN GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, REGIONALVERKEHR KOLN GMBH, EUE APS, DUNDEE CITY COUNCIL, WEST MIDLANDS TRAVEL LIMITED, SASA SPA AG SOCIETA AUTOBUS SERVIZIDAREA SPA, HERNING KOMMUNE, WSW MOBIL GMBH, RIGAS SATIKSME SIA, TRENTINO TRASPORTI SPA, EE ENERGY ENGINEERS GMBH, SPHERA SOLUTIONS GMBH, HYSOLUTIONS GMBH, ABERDEEN CITY COUNCIL, SUEDTIROLER TRANSPORTSTRUKTUREN AG, HYCOLOGNE - WASSERSTOFF REGION RHEINLAND EV, LONDON BUS SERVICES LIMITED, PLANET PLANUNGSGRUPPE ENERGIE UND TECHNIK GBR, BIRMINGHAM CITY COUNCIL, FONDAZIONE BRUNO KESSLER, UNION INTERNATIONALE DES TRANSPORTS PUBLICS, HYDROGEN EUROPE

PROJECT AND OBJECTIVES

The JIVE project aims to assist the commercialisation of fuel cell buses (FCBs) as a zero-emissions public transport option across Europe. The project's goal is to address the current high ownership cost of FCBs relative to conventionally powered buses and the lack of hydrogen refuelling infrastructure across Europe by supporting the deployment of 142 FCBs in 9 locations. This will more than double the number of FCBs currently operating in Europe.

NON-QUANTITATIVE OBJECTIVES

- Providing experience of the suitability of FCBs for wider roll-out. Through the publication of project deliverables, such as the Best Practice and Commercialisation Report 2, information flows have been established to interested observer parties
- Raise awareness of the readiness of fuel cell technology for wider roll-out – with a focus on bus purchasers and regulators. As before, a strong observer group within the JIVE consortium has been established which monitors discussions and best practice emerging from the project. This will ensure that the momentum for fuel cell bus uptake in Europe continues beyond the project
- Deliver positive environmental impacts by operating FC buses for extended periods. As per JIVE's objectives, all buses deployed thus far are replacing diesel technology, which means that they will lead to CO_2 abatement and not simply operate as a 'visible extra'.

PROGRESS AND MAIN ACHIEVEMENTS

- All the original 142 buses have been ordered from 3 different bus manufacturers
- In addition, 59 buses have entered into commercial operation.

FUTURE STEPS AND PLANS

- Nearly all the buses are expected to be operational by the end of 2021. The buses are currently being delivered to cities in batch and should enter into operation shortly after arrival
- By the end of 2021, enough operational data will have been analysed and key project findings communicated to demonstrate technological readiness. Even with the current data collection issues, it should be possible to present valid data at the next GA in September 2021.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objectives and AWP 2016	Vehicle operational lifetime	Years	8	✗
	Distance travelled	km/year	Min. 44 000	
	Operating hours per fuel cell system	Hours	> 20 000	
	Availability	%	>90	
	Mean Distance Between Failures (MDBF)	km	>2 500	
	Specific fuel consumption	kg/100 km	< 9	
	Efficiency	%	Over 42	
	Vehicle OPEX	Euro	Max. 100 % more than diesel bus OPEX	
	Vehicle CAPEX	Euro	<650 000	✓

JIVE 2

JOINT INITIATIVE FOR HYDROGEN VEHICLES ACROSS EUROPE 2

Project ID:	**779563**
Call topic:	**FCH-01-5-2017** - Large scale demonstration in preparation for a wider roll-out of fuel cell bus fleets (FCB) including new cities – Phase two
Project total costs:	**€106 578 605.62**
FCH JU max. Contribution:	**€25 000000**
Project start - end:	01/01/2018 - 31/12/2023
Coordinator:	**ELEMENT ENERGY LIMITED, UK**
Website:	**www.fuelcellbuses.eu/projects/jive-2**

BENEFICIARIES: OBCINA SOSTANJ, ELEMENT ENERGY, ENGIE ENERGIE SERVICES, CA DE L'AUXERROIS, RHEINSCHE BAHNGESELLSCHAFT AKTIENGESELLSCHAFT, SOCIETE PUBLIQUE LOCALE D'EXPLOITATION DES TRANSPORTS PUBLICS ET DES SERVICES A LA MOBILITE DE L'AGGLOMERATION PALOISE, STRAETO BS, OPENBAAR LICHAAM OV-BUREAU GRONINGEN EN DRENTHE, PAU BEARN PYRENEES MOBILITES, LANDSTINGET GAVLEBORG, REBELGROUP ADVISORY BV, REGIONALVERKEHR KOLN GMBH, DUNDEE CITY COUNCIL, WSW MOBIL GMBH, RIGAS SATIKSME SIA, MESTNA OBCINA VELENJE, KOLDING KOMMUNE, SPHERA SOLUTIONS GMBH, BRIGHTON & HOVE BUS AND COACH COMPANY LIMITED, RUTER AS, PROVINCIE ZUID-HOLLAND, PETROLEOS DE PORTUGAL - PETROGAL SA, VATGAS SVERIGE IDEELL FORENING, NOORD-BRABANT PROVINCIE, UNION INTERNATIONALE DES TRANSPORTS PUBLICS, HYDROGEN EUROPE

PROJECT AND OBJECTIVES

The JIVE 2 project started in January 2018. The two JIVE projects combined will deploy nearly 300 fuel cell buses in 22 cities across Europe by the early 2020s – the largest deployment in Europe to date.

NON-QUANTITATIVE OBJECTIVES

- Providing experience of suitability of FCBs for wider roll-out. Through the publication of project deliverables, such as the Best Practice and Commercialisation Report 2, information flows have been established to interested observer parties
- Raise awareness of the readiness of fuel cell technology for wider roll-out – with a focus on bus purchasers and regulators. As before, a strong observer group within the JIVE consortium has been established which monitors discussions and best practices emerging from the project. This will ensure that the momentum for fuel cell bus uptake in Europe continues beyond the project
- Deliver positive environmental impacts by operating FC buses for extended periods. As per the project objectives, all buses deployed thus far are replacing diesel technology, which means that they will lead to CO_2 abatement and not simply operate as a 'visible extra'.

PROGRESS AND MAIN ACHIEVEMENTS

- To date, 110 of the 152 buses originally envisaged have been ordered from 4 different bus manufacturers
- In addition, 5 buses have been delivered.

FUTURE STEPS AND PLANS

- Half of the buses are expected to be delivered by the end of 2021
- By the end of 2021, enough operational data will have been analysed and key project findings communicated to demonstrate technological readiness. Even with the current data collection issues, it should be possible to present valid data at the next GA in September 2021.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	SOA RESULT ACHIEVED TO DATE (BY OTHERS)
Project's own objectives and AWP 2017	Vehicle operational lifetime	Years	8	
	Distance travelled	km/bus	> 44 000	
	Operating hours per fuel cell system	Hours	>20 000	
	Availability	%	> 90	
	Mean Distance Between Failures (MDBF)	km	>2 500	
	Fuel consumption	kg/100 km	< 9	
	Efficiency	%	>42	
	Vehicle OPEX	%	Max. 100 more than diesel bus OPEX	
	Vehicle CAPEX	Euro	<625 000	✓

REVIVE

REFUSE VEHICLE INNOVATION AND VALIDATION IN EUROPE

Project ID:	**779589**
Call topic:	**FCH-01-7-2017** - Validation of Fuel Cell Trucks for the Collect of Urban Wastes
Project total costs:	**€9 247 149.59**
FCH JU max. Contribution:	**€4 993 851**
Project start - end:	01/01/2018 - 31/12/2021
Coordinator:	**TRACTEBEL ENGINEERING, BE**
Website:	**h2revive.eu**

BENEFICIARIES: GEMEENTE GRONINGEN, SAVER NV, SUEZ NEDERLAND HOLDING BV, AZIENDA SERVIZI MUNICIPALIZZATI DI MERANO SPA, SEAB SERVIZI ENERGIA AMBIENTE BOLZANO SPA, SWISS HYDROGEN SA, RENOVA AKTIEBOLAG, E-TRUCKS EUROPE, GEMEENTE GRONINGEN, GEMEENTE BREDA, SYMBIO, STAD ANTWERPEN, WATERSTOFNET VZW, POWERCELL SWEDEN AB, ELEMENT ENERGY LIMITED, PROTON MOTOR FUEL CELL GMBH, GEMEENTE AMSTERDAM, COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES

PROJECT AND OBJECTIVES

The REVIVE project will significantly advance the state of development of fuel cell refuse trucks by integrating fuel cell powertrains into 14 vehicles and deploying them at 8 sites across Europe. The first truck was deployed in Breda (NL) and is being tested in the field. The other 13 trucks will all be deployed in 2021.

NON-QUANTITATIVE OBJECTIVES

- Today we have 2 EU FC suppliers for the project: Proton Motor and PowerCell Sweden
- Demonstrate a route to high utilisation of HRS to support the roll-out of H2 mobility for light vehicles. Due to lack of deployment, this objective has not yet been achieved.

PROGRESS AND MAIN ACHIEVEMENTS

- In total, 14 trucks have been ordered and are being built
- First Proton Motor FC system has been delivered and successfully integrated
- First truck certification process has been completed and first REVIVE truck deployed.

FUTURE STEPS AND PLANS

- The consortium will ask for a project extension in order for most of the trucks to reach the 24-month period of operation. It will launch an amendment in Q2 2021
- Implementation of the data collection framework: finalise the data collection plan, roll out diesel data loggers to do a relevant comparison (TCO, LCA analysis), provide monthly reports
- Increase dissemination activities. In order to catch up with the delays in 2020, a plan for dissemination in 2021 will be developed.

QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	ACHIEVED TO DATE BY THE PROJECT	TARGET ACHIEVED?
AWP 2017	Number of FCs deployed in the project	-	15	14	
	Tank-to-wheel efficiency	%	50	N/A	
	Lifetime	Hours	25 000		
	Availability	%	90		
	Mean Distance Between Failures (MDBF)	km	3 500		
	FC power	kW	>40	45	✓

SHIPFC

PILOTING MULTI MW AMMONIA SHIP FUEL CELLS

Project ID:	**875156**
Call topic:	**FCH-01-2-2019:** Scaling up and demonstration of a multi-MW Fuel Cell system for shipping
Project total costs:	**€13 179 056.25**
FCH JU max. Contribution:	**€9 975 477.50**
Project start - end:	01/01/2020 - 31/12/2025
Coordinator:	**MARITIME CLEANTECH, NO**
Website:	**shipfc.eu/**

BENEFICIARIES: EIDESVIK SHIPPING AS, WÄRTSILÄ GAS SOLUTIONS NORWAY AS, SUSTAINABLE ENERGY AS, NORTH SEA SHIPPING AS, STAR BULK SHIPMANAGEMENT CO. (CYPRUS) LTD, WARTSILA NORWAY AS, CAPITAL-EXECUTIVE SHIP MANAGEMENT CORP, PERSEE, PROTOTECH AS, EQUINOR ENERGY AS, YARA INTERNATIONAL ASA, UNIVERSITY OF STRATHCLYDE, NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS", FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG EV

PROJECT AND OBJECTIVES

The ShipFC project's main mission is to prove and show the case for large-scale zero-emission shipping through developing, piloting and replicating a modular 2 MW fuel cell technology using ammonia as fuel. We also aim to prove the case for large-scale zero-emission fuel infrastructure through a realistic business model. Currently, the fuel cells are being scaled up and undergoing lab testing. The on-board fuel system design is in progress, as is the integration design for the FC power system. We are building our knowledge base for the development of a global green ammonia fuel infrastructure.

NON-QUANTITATIVE OBJECTIVES

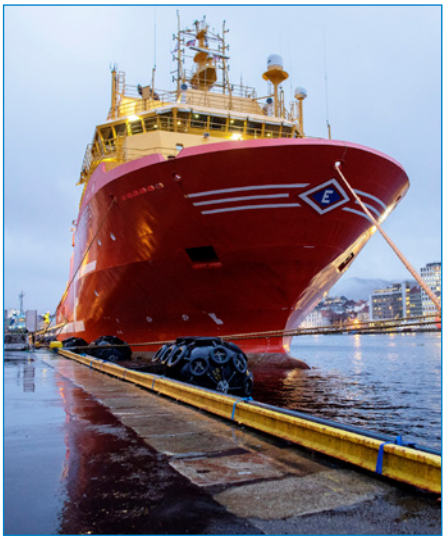
- Prove viability of green ammonia fuel system by covering ship systems, bunkering and infrastructure. Development of ammonia fuel system is in the development phase, with several potential concepts having been identified and being further developed. Initial HAZID is being performed for the ammonia fuel system, which is subject to further iterations as the concepts are being further developed for a concept selection
- Integration of ammonia fuel cell and fuel systems in ship power systems. Integration activities have started, with single line diagrams being developed and calculations being performed for the required battery pack. Power electronics are being designed to integrate the SOFC powertrain with the existing powertrain on board the vessel
- Show wider use and scale-up of the system to 20+ MW. Data collection and analysis of selected replicator vessels is being performed to identify the requirements of the larger vessels.

PROGRESS AND MAIN ACHIEVEMENTS

- The project has signed an agreement for the delivery of green ammonia fuel for the duration of the project
- Conceptual designs for the fuel system have been developed
- Requirement specifications for SOFC have been developed.

FUTURE STEPS AND PLANS

- Scale-up and testing of SOFC. SOFC is currently undergoing lab-scale testing in preparation for large-scale tests. The full size 2 MW SOFC will be tested by November 2023.



QUANTITATIVE TARGETS AND STATUS

TARGET SOURCE	PARAMETER	UNIT	TARGET	TARGET ACHIEVED?
Project's own objectives	GHG reduction by use of ammonia fuel	%	70	
	Ammonia SOFC system power	MW	2	
	MW-scale SOFC operational experience	Hours	3 000	

ZEFER

ZERO EMISSION FLEET VEHICLES FOR EUROPEAN ROLL-OUT

Project ID:	**779538**
Call topic:	**FCH-01-6-2017:** Large scale demonstration of Hydrogen Refuelling Stations and Fuel Cell Electric Vehicle (FCEV) road vehicles operated in fleet(s)
Project total costs:	**€17 556 029.18**
FCH JU max. Contribution:	**€4 998 843**
Project start - end:	01/09/2017 - 31/08/2022
Coordinator:	**ELEMENT ENERGY LIMITED, UK**
Website:	**zefer.eu**

BENEFICIARIES: LINDE GMBH, ELEMENT ENERGY, GREEN TOMATO CARS LIMITED, BREATH, SOCIETE DU TAXI ELECTRIQUE PARISIEN, AIR LIQUIDE ADVANCED TECHNOLOGIES SA, ITM POWER (TRADING) LIMITED, CENEX - CENTRE OF EXCELLENCE FOR LOW CARBON AND FUEL CELL TECHNOLOGIES, AIR LIQUIDE ADVANCED BUSINESS, VILLE DE PARIS, LINDE AG, BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT, MAYOR'S OFFICE FOR POLICING AND CRIME

PROJECT AND OBJECTIVES

ZEFER aims to demonstrate viable business cases for fuel cell electric vehicles (FCEVs) in high-mileage fleet applications. The project will deploy 180 FCEVs as taxis, private hire vehicles and emergency service vehicles in three major European cities where their operational benefits and zero-emission credentials can be monetised. The vehicles will use existing HRS networks to increase local utilisation levels and improve the business case for HRS operators. As of March 2021, 117 vehicles had amassed >5.1 million kilometres and 3 HRS had been upgraded to cater to fleets.

NON-QUANTITATIVE OBJECTIVES

- Develop comprehensive understanding from the deployment project. Public deliverables have been produced, covering topics such as customer acceptance, the business case for FCEVs, and the technical performance of HRS and FCEVs subject to high utilisation
- Develop the confidence of investors and policymakers in FCEV and HRS roll-out. Analysis in ZEFER has proven that FCEVs and HRS are capable of meeting the demands of high-mileage fleet operations. This has led to fleet operators increasing the number of FCEVs in their fleet and attracting investors into joint ventures (HySetCo)
- Maintain and, if possible, increase SME participation in FCH JU projects to or over 25 %. 50 % of partners in ZEFER are SMEs. In fact, 84 % of project funding targets SMEs
- Reduce the production cost of fuel cell systems to be used in transport applications, while increasing their lifetime levels to make them competitive with conventional technologies. The project will demonstrate the lifetime of fuel cells in FCEVs at utilisation levels well beyond those currently deployed. The bulk procurement of FCEVs is also expected to have reduced FCEV costs to their lowest level
- Increase the energy efficiency of hydrogen production, while reducing operating and capital costs so that the combined system is competitive with alternatives in the marketplace. ZEFER aims to reduce the cost of hydrogen at the pump to <€10/kg. This will be achieved by providing a stable demand for hydrogen at an HRS. The project will also trigger further cost reductions by creating a climate of investment in low-cost green production systems required to drive the delivered cost below this level.

PROGRESS AND MAIN ACHIEVEMENTS

- A total of 117 FCEVs have been deployed in everyday operation in Paris (57) and London (60), amassing over 5.1 million kilometres to date
- 75 % of HRS upgrades have been completed, leading to improvements in the technical performance and customer experience of HRS
- All deployment partners in the project have plans to scale up their FCEV fleets as a result of the ZEFER project.

FUTURE STEPS AND PLANS

- Deploy the final 60 FCEVs in high-mileage applications. With the Brussels deployment deemed unfeasible within the timeline of the ZEFER project, the consortium has agreed to reallocate the vehicles to another party/ location. The Project Officer has been kept up-to-date on the reallocation proposals and is awaiting a formal proposal from the consortium
- Reintroduce FCEVs into service once COVID regulations allow. As noted above, the ZEFER partners have been significantly impacted by the COVID pandemic. Many have had to take their vehicles out of operation as government rules prohibit all but essential travel. It is hoped that as cases reduce, the vehicles can re-enter service. However, this is somewhat out of the control of the project partners
- Complete the HRS upgrades required in Paris, which have been delayed due to permit issues at the Paris-Ouest site. This is not expected to be resolved within the period of the project. Alternative upgrades are therefore being discussed with the Project Officer
- Continue data collection on the FCEVs and HRS to better understand how performance is impacted by long-term high utilisation levels. Data collection has been ongoing throughout the project. Some difficulties have been encountered with retrieving data from the Metropolitan Police Service (MPS) but this will soon be resolved as the MPS are fitting telematics to the vehicles
- Production of project reports analysing the business case for FCEVs in high-mileage applications. This will be supported by customer survey analysis. New iterations of the business case and customer acceptance reports are expected in Q2/Q3 2021
- Higher visibility dissemination work to inform policymakers and ensure that the fleet operation use case is expandable across other European regions. Roundtables with policymakers will be hosted by the project to increase awareness of the business case for FCEVs in fleet applications.

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
FC Vehicles							
Project's own objectives	Min. distance for vehicles	km /vehicle	90 000	~45 500 km per year pre-COVID for certain fleets	✗	FCEVs in taxi operation in H2ME drive on average ~45 000 km per year	2020
	Vehicle availability	%	>98	>99	✓	>99	
	Range	km	500	605	✓	756	
HRS							
Project's own objective	HRS availability	%	>98	96	✗	98	2016
	Hydrogen purity	%	99.99	99.99	✓	99.99	2019
	Level of back-to-back vehicle refuelling	refuelling incidents/hour	6	6	✓	6	2020
	Cost of hydrogen	€/kg	≤10	10	✓	10	