

PROJECT FINAL REPORT

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Project acronym: SWARM

Project title: Demonstration of Small 4-Wheel fuel cell passenger vehicle Applications in Regional and Municipal transport

Funding Scheme: Collaborative Project

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¹ Usually the contact person of the coordinator as specified in Art. 8.1. of the Grant Agreement.

4.1 Final publishable summary report

Public Executive summary

The SWARM project set out to establish demonstration fleets of small passenger vehicles supporting and expanding upon existing hydrogen refuelling infrastructure across three clusters: British Midlands, Brussels and Wallonia, and the Weser-Ems region in NW Germany. The location of the infrastructure was planned to close gaps in a continuous 'hydrogen network' stretching from Scotland to London, Belgium and Cologne, via Bremen to Hamburg, Scandinavia or Berlin. Three SME OEMs, Riversimple (UK), Microcab (UK) and H2O e-mobile (Germany) were to deploy up to 90 vehicles, demonstrating them for three years of the project, accruing significant data on vehicle performance.

In 2015, following delays in the delivery of vehicles, in part due to difficulties in finding suitable fuel cell stacks from suppliers, the project was revised to focus on vehicle development, with a shorter demonstration phase and fewer demonstrated vehicles. By the end of the project, the proposed fleet size was for up to 34 vehicles deployed in the demonstration clusters in the British Midlands and Wales (UK), Brussels/Wallonia (Belgium) and North Rhine Westphalia (Germany): 20 from Riversimple, 2 JHS prototype elano vehicles (H2O terminated) and 12 Microcabs (including 5 re-designed vehicles and 2 new left-hand drive vehicles). The German Air Liquide 200kg/day station was built in Frechen (Cologne), while a number of smaller HRSs were upgraded and recommissioned in the UK: a new 20kg/day station in Abergavenny, Wales, which the Riversimple trial vehicles will use and two recommissioned HRS in Coventry and Birmingham.

The entire fleets were not deployed in the fifth and final reporting period, ending in October 2018. However, important progress was made towards securing the commencement, continuation and reporting of fleet activities beyond the end of the project. Of particular note, Riversimple will start their 20-vehicle demonstration after the project, Microcab have developed plans for their post-demonstration phase, the Air Liquide Frechen station is a vital contribution to the development of an exciting hydrogen hub in Cologne and will refuel RVK's fuel cell bus fleet for a time, and the ZEFER project will ensure fleet vehicles are refuelled at the Air Liquide Zaventem station. Furthermore, meaningful contributions have been made by the SWARM research activities, including a number of conference papers published by JADE University on powertrains in hybrid battery and fuel cell electric vehicles and the use of DC/DC converters in fuel cell electric vehicles. The work by universities as part of the project will further build up enthusiasm and experience with hydrogen fuel cells in academia.

The achievements of SWARM were communicated at the SWARM Final Event, held in October 2018 at Coventry University. Presentations on SWARM by the project partners were followed by its situation within the wider hydrogen and hydrogen mobility sectors.

While the ambitious objectives of the project were not fully achieved during the active project period, the contribution of this spearhead project to the development of the European hydrogen mobility sector and the enthusiasm surrounding it is significant. Crucially, lessons learnt in SWARM were applied to the HyFIVE, H2ME 1+2 and ZEFER projects, further cementing its successful legacy.

Project description and objectives

Project Overview

The SWARM project set its focus on seven essential issues that make it special and unique:

- the demonstration of a significant number of vehicles to form a critical mass of employment and user-exposure to the new technology of hydrogen fuel cell vehicles
- the reduction of costs of vehicles and hydrogen supply to a level to allow a commercialisation phase immediately following the demonstration programme
- the creation of refuelling station clusters in three European regions:
 - UK: Midlands & Abergavenny, Wales,
 - Belgium: Brussels/Wallonia,
 - North Rhine Westphalia (NRW).

this refuelling network offers an extension of the ‘European hydrogen highway network’ from Scotland via Brussels to Scandinavia, Eastern Europe and South Germany

- the creation of focal points for future hydrogen fuel cell vehicle rollout, through the dedicated industry reach-out programme
- the addition of 3 high-capacity hydrogen refuelling stations to existing and new refilling sites
- the supply of vehicles on a ‘lease’ basis, avoiding the problem of investment risk with the end users
- the integration of a large number of universities to support the development work of the OEMs

The project sought to establish a fleet of 34 (as well as an additional 4 upgraded vehicles from Microcab for the 2018 demonstration phase) small passenger vehicles within a mixture of existing infrastructure and newly built hydrogen supply stations. After the termination in 2016 of H2O as a partner in the project, it was no longer possible to deploy all 50 vehicles foreseen in the original plan. In place of the originally planned 20 elano vehicles and by integrating learnings gained throughout the project, Microcab deployed 5 redesigned vehicles and 2 new left-hand drive vehicles and JHS built 2 prototype elano vehicles to coincide with the Riversimple deployment in 2018.

Three European regions participated in this effort: the British Midlands and Wales, the Brussels area and Wallonia, and North West Germany. Considering the developments going on in Scotland, the existing hydrogen refuelling stations in London, Cologne, Hamburg, Berlin, Frankfurt/M., Copenhagen and in Norway and Sweden, these sites close the gaps in a continuous ‘hydrogen highway’ that could lead from Scotland via the Midlands to London, connecting to Brussels and from there proceeding to Cologne and on to Hamburg/Scandinavia/Berlin. The map in Fig. 1 shows such a prospective route.



Figure 1 - Using the existing hydrogen infrastructure in London and Cologne, a hydrogen vehicle with approx. 300 km range could drive from the Midlands to Hamburg.



Figure 2 - Lightweight vehicles employed in the project. Left to right: Microcab, elano and Riversimple Rasa passenger car.

The cars employed (Fig. 2) are three different types of low-cost, high fuel-efficiency, light-weight passenger and small transport vehicles specifically designed for city and regional transport. The organisations Riversimple (Llandrindod Wells, Wales, UK), Microcab (Coventry, UK) and JHS (Wilhelmshaven, Germany) were to contribute 20, 12 (and 4 redesigned RHD vehicles for 2018) and 2 vehicles, respectively, to the project. These were to be built during the project alongside the implementation of the hydrogen supply infrastructure. Europe-wide certification was sought for the first two vehicles and hydrogen installations in order to allow their use throughout Europe, thus increasing the commercial possibilities of continuing the project without further funding. The equipment was continuously monitored and improved throughout the demonstration phase.

Regions	Sites	Vehicles	Users	HRSS
UK	Coventry / Birmingham	10 + 4 Microcab (8 right hand drive, 2 left hand drive, 4 redesigned)	Coventry University, Birmingham University, City Council, Marks & Spencers, Warwickshire County Council plus use in Belgium and Frechen	Coventry & Birmingham University stations to be reinstated Up to 20 kg/day, 35 MPa
	Abergavenny, Monmouthshire/ South Wales	20 Riversimple Rasas	Private users & council fleet	20 kg/d, 35 Mpa
Belgium	Brussels	1 Microcab (loan from Coventry)	ULB, Brussels city & region, small technology companies, private users	200 kg/d, 70 Mpa

	Spa Francorchamps	1 Microcab (loan from Coventry)	Research vehicle	Temporary refuelling solution for testing at race track
Germany	Frechen, NRW	1 Microcab (loan from Coventry for opening event) Vehicles outside of the project.	Private users	200 kg/d, 35 MPa and 70 Mpa
	Wilhelmshaven	2 elanoFC vehicles	University & private users	Temporary refuelling solution for research testing

In two of the locations (Frechen and Brussels/Zaventem), fully 200kg/day 350 and 700 bar compatible stations were installed by Air Liquide. In both locations, it is expected that vehicles outside of the SWARM project from large passenger car OEMs will be deployed after the period of the SWARM project, thereby justifying the investment in these large stations and ensuring continued operation.

In the UK the decision has been taken to prioritise the refuelling of the developmental vehicles which will be deployed in the SWARM project, as opposed to installing capacity for as yet not fully existent demand. As a result, the UK partners have installed refuelling station equipment which meets the refuelling requirements of the vehicles which will be deployed on this project rather than installing excess capacity to cope with future expansion of the vehicle park. This decision is based on analysis of the likely behaviour of large passenger car OEMs in the UK (completed under the UK H2Mobility initiative) which suggests that there will be very limited demand for OEM vehicle refuelling in the preferred demonstration locations for the duration of the project. Hence any investment in larger station capacity would be wasted, leading to stranded assets and deterring future investments in the HRS sector.

As a result, the UK HRS deployment involves a new 20kg/day station in Abergavenny, Wales and the recommissioning of two smaller fuelling stations in Coventry and Birmingham, to allow respectively the testing of the Riversimple and Microcab vehicles.

In addition, a temporary refuelling solution was established in Spa Francorchamps.

7 universities and university institutes are integrated into the project as both end-users and research partners. The university involvement in several research projects on the vehicles and hydrogen provision directly supports the OEM's in improving their equipment and contributes towards providing improved vehicles to the project.

In addition, this will expose university staff, R&D personnel and students to modern technology with a very much hands-on approach. This is an important feature in developing the future European Hi-Tech human resource necessary for a full market roll-out of fuel cell and hydrogen technology.

The vehicles have and will be made available to the end users under a leasing agreement. This allows users to enjoy a hassle-free use of the vehicles, as they would a normal petrol vehicle and reduces the financing pressure and risk on the end users. In the case of Riversimple, a full package offering is envisaged leasing the vehicle in a concept of a mobility as a service (Maas) rather than selling the vehicle to the end-users. The service includes all 4 points below for a single monthly payment:

- The car
- Insurance
- Service and Maintenance
- All fuel

Main results and foreground

Project information and achievements

Project Context	
Date started	01/10/2012
Date finished	31/10/2018
Number of partners	Start 17 End 12
Total project spend	€ 15,294,319.66
FCH JU contribution	€ 6,712,985.60
Results	
No. of cars built	Revised plan (after project end) 34 Current completed 14 – 34 as direct continuation of the project
No. of HRSs built or refurbished	6
Installed refuelling capacity	700kg/day, 400kg/day public

Vehicle supply

Microcab

The Microcab vehicles have undergone significant development over the course of the project.

<i>Generation</i>	<i>Fuel cell and DC/DC system</i>	<i>Lithium Battery Pack</i>	<i>Vehicle Control Unit (VCU)</i>	<i>Number of vehicles of Gen.</i>
Gen 1	Horizon 3kW Air cooled stack	Single pack 72v Headway cell – LifeBatt design	Potenza V1 – (third party company)	4
Gen 2	Ballard 70 cell 3kW, Air cooled stack	Single pack 72v Headway cell – LifeBatt design	Potenza V2 – (third party company)	2
Gen 3	Ballard 80 cell 3.5kW, Air cooled stack (integration development by CU including processor	3 x 24v pack (in series gives 72v) Headway cell (pack design by CU including battery management system)	Motohawk processor overall vehicle control (in house development by CU including circuit board design)	8

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Throughout SWARM, Microcab’s policy has been to take its early stage prototype vehicle designs and, by a process of on road testing with real users, gain user-centric knowledge across all aspects of vehicle engineering and design. From this information further generations of vehicle have been developed, rolled out and tested. Virtually all elements of the powertrain have been improved or re-designed in the process as well as re-working vehicle interior and displays, exterior styling and comfort features.

To celebrate SWARM, expressing a successful conclusion to the project and to begin to develop the market for Microcab vehicles, a new model of the Gen 3 has been launched with the latest styling and interior. This is called the Vianova and features all the key developments of the last few years, both in SWARM and in parallel projects. The vehicle was first seen at the SWARM Coventry hydrogen event (on 17 Oct 2018) and is built as a Left-Hand Drive vehicle and thus able to address the market in Germany where extensive hydrogen infrastructure exists but few cars are operating.



Figure 3 - Microcab Vianova on display at the SWARM Coventry Hydrogen Event (October 2018)

Model	Microcab Gen.3
Chassis	Lotus bonded aluminium
Vehicle type	M1 class vehicle
Gross vehicle weight	Approx. 750kg
Length	3.5m
Width	1.6m
Height	1.7m
Crash protection	Front offset impact; side impact; roof crush
No of seats	4 (car format) 2 (van format)
Baggage capacity	0.3 m ³ (car format) 0.96 m ³ (van format)

Energy demand	120-150Wh/km
CO2 emissions	Down to 0g/km (depending on source of hydrogen)
Hydrogen tank	350bar or 700bar option
Fuel cell	3kW or 10kW option
Range	180miles
Max speed	55mph
Drive	AC brushless motor & gearbox 50kWp, 72V
Battery	4.3kWh

Riversimple

During the SWARM project, Riversimple have developed 2 generations of vehicle, the Alpha and the Beta car. The Alpha car was launched in 2016 after 3 years of development. The Alpha car has been used extensively for technological testing and development, for a large range of dissemination purposes and to support the training and development of Riversimple's initial customer base, the Beta trialists.

As a direct result of the SWARM project and the extensive testing of the Alpha car, Riversimple have successfully begun the build of their first production vehicles, the Beta Rasa. The Beta demonstrates significant technological and mechanical improvements which will enable it to be released to the general public. The first of these vehicles has been used in extensive dissemination activities and will be deployed as part of the Clean Mobility Trial operating from Abergavenny, Wales. Monmouthshire County Council have secured the first car in the trial and will include it in their vehicle fleet for 12 months.



Figure 4 - Riversimple Mk1 (left) and Riversimple Rasa Alpha car (right)



Figure 5 - Riversimple Rasa Beta car

Model	Riversimple Rasa
Chassis	Carbon composite
Vehicle type	Lightweight vehicle
Gross vehicle weight	630kg
Length	3.67m
Width	1.63m
Height	1.33m
Crash protection	Front and side impact
No of seats	2
Baggage capacity	130l
Energy demand	250mpg or 1.15l/100km equivalent
CO2 emissions	Down to 0g/km (depending on source of hydrogen)
Hydrogen tank	350bar
Fuel cell	8.5kW

Range	300miles
Max speed	60mph
Torque	680Nm

Elano FC

Two fuel cell vehicles (elanoFC) were built in the project. The vehicles were delivered to JHS as fully equipped battery electric version elano 1st Go from the stock of former project partner H²O e-mobile GmbH.

The previously installed lithium iron phosphate batteries (LiFePO) with a rated energy of 10 kWh and voltage 50 V continue to be fully integrated in the powertrain. The fuel cell system Hydrogenics HyPM HD 8-200 PN with a rated output power of 8.5 kW and an open circuit voltage of 80 V was coupled with the battery. The main features that distinguish the elano concept from other fuel cell vehicles are the passive connection of fuel cell system and battery, the switching of the fuel cell according to power demand, the plug-in character of the vehicle concept, and the light-weight/low energy consumption vehicle frame.



Figure 6 – Hydrogenics fuel cell system integrated into elano former motor compartment.



Figure 7 - elano vehicle next to Gen. 3 Microcabs at the SWARM Coventry Hydrogen Event, October 2018.

Model	elano 1st FC by H ² O e-mobile GmbH / Jade Hochschule
Chassis	Microcar (Ligier group)
Vehicle type	Lightweight vehicle, L7E class
Gross vehicle weight	Approx. 780 kg
Length	3.3m
Width	1.67m
Height	1.55m
Crash protection	Front offset impact; air bag
No of seats	2
Baggage capacity	0.8 m ³
Energy demand	90-100 Wh/km
CO ₂ emissions	Down to 0 g/km (depending on source of hydrogen)
Hydrogen tank	70 MPa
Fuel cell	8.5 kW
Range	350 km

Max speed	100 km/h
Drive	Single asynchronous motor, 8 kW (max. short-term load 12 kW)
Battery	10 kWh LiFePO

Hydrogen infrastructure

A total of 6 HRS units have been installed as follows:

Site	Refueling capacity (kg/day)	Pressure (bar)
Zaventem (Brussels)	200	350 and 700
Frechen (Cologne region)	200	350 and 700
Birmingham University (Midlands region)	20	350 only
Coventry University (Midlands region)	20	350 only
Abergavenny (Monmouthshire, Wales)	20	350 only
Spa-Francorchamp (Liege Region)	<50	350 only

Zaventem station, Brussels, Belgium

The Air Liquide HRS for Brussels built in Zaventem has been in operation since April 2016.



Figure 8 - Air Liquide Zaventem HRS

The station provides hydrogen at both 350 and 700 bar.

Main characteristics	
Operational since	April 2016
Location	Leuvensesteenweg 546, 1930 Zaventem, Belgium
Operating refuelling pressures	350 bar and 700 bar
Refueling time per car at 700 bar	3min (based on 5-6kg/refill)
Back to back performance	5 cars (with 9min between consecutive refills)
Size	20 x 10m
Hydrogen supply	Trucked in hydrogen
Private/public	Public, authorised customers with accreditation card

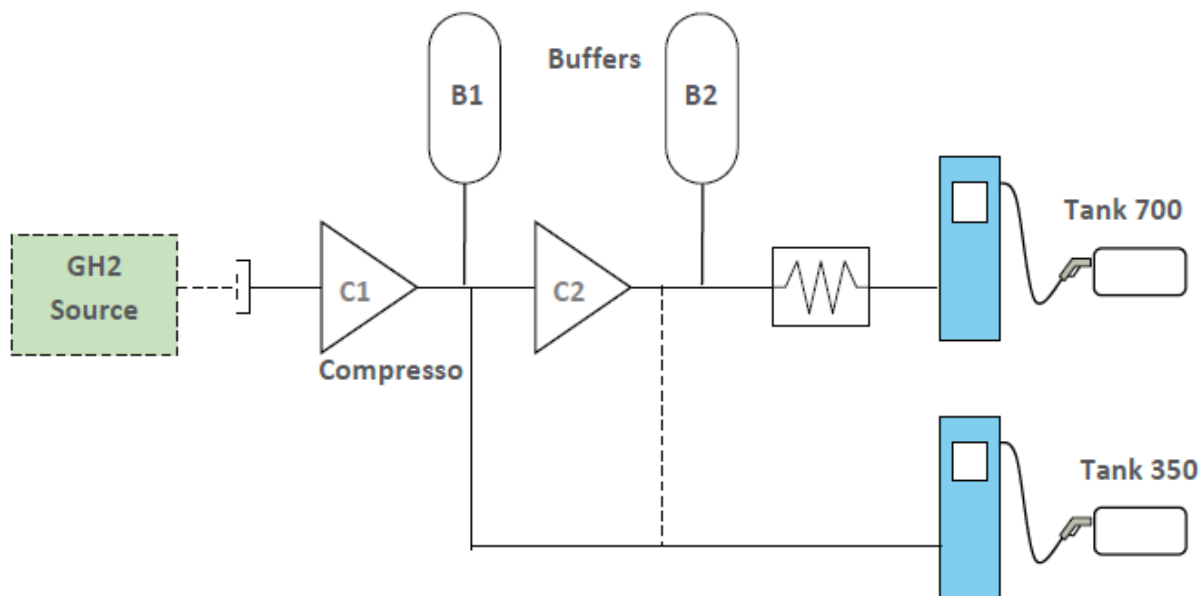


Figure 9 - HRS specifications

Frechen station, Cologne region, Germany

The site proposed in Period 1 by Air Liquide was Bremen (Bremen Airport, on the Hermann-Köhl-Straße close to two car parks of Bremen City Airport; parking 1 and 2), but negotiations with the airport of Bremen could not be completed. Air Liquide instead relocated the site from Bremen to Frechen in the Cologne region. The Air Liquide HRS in Frechen has been in operation since the end of August 2018.



Figure 10 - Finalised Frechen HRS

Main characteristics	
Operational since	August 2018
Location	Kölner Straße 209-211, D-50226, Frechen, Germany
Operating refuelling pressures	350 bar and 700 bar
Size	16 x 10m
Hydrogen supply	Trucked in hydrogen
Private/public	Public, authorised customers with accreditation card

The station has been erected in Frechen next to:

- Highway A1
- Highway A4
- Toyota Headquarter Germany

Abergavenny

The HRS was delivered from France on Friday 21st September and was installed on site. The HRS will be used for the Riversimple trial. As part of Riversimple's ongoing dissemination activities, a local artist has been engaged to provide support with the publicly facing compound of the HRS. A local school has also been

involved in support of the design work. The HRS will provide information to the public on hydrogen fuel cell vehicles and refuelling and will become a focal point for local / regional hydrogen activity.



Figure 11 - Installed McPhy refueler in Abergavenny with Riversimple Rasa Beta vehicle



Figure 12 - Compound structure surrounding HRS with local artwork

Main characteristics	
Operational since	October 2018
Location	Abergavenny, Monmouthshire, Wales, NP7 5HF
Operating refuelling pressures	350 bar
Unit	McFilling 20-350
Hydrogen supply	Trucked in hydrogen
Private/public	Riversimple trial participants

Birmingham University

This Air Products station has been utilised for earlier demonstration efforts from Microcabs and needs maintenance & recertification every three years. This was completed and the station recertified and recommissioned for use in January 2016. It dispenses at 350 bar and can refuel 20kg/day if a high-pressure hydrogen source is used.

Main characteristics	
Operational since	January 2016 (recommissioning date in SWARM project)
Location	University of Birmingham, Birmingham
Operating refuelling pressures	350 bar
Unit	Air Products Series 100
Hydrogen supply	Trucked in hydrogen
Private/public	Private/public – outside use on request and arranged filling

Coventry University

This station was fully re-commissioned a first time in November 2015. It was the first station delivered to the SWARM project. It was re-certified in January 2019 in order to continue to support of Microcab vehicles, an essential for the vehicle roll-out and operations. The refueler is the same model as the one at Birmingham University.



Figure 13 - Microcab refuelling at Coventry HRS in February 2019

Main characteristics	
Operational since	November 2015, January 2019
Location	Coventry University, Coventry
Operating refuelling pressures	350 bar
Unit	Air Products Series 100
Hydrogen supply	Trucked in hydrogen
Private/public	Private – University use only

Spa-Francorchamps

A temporary Linde HRS has also been installed with success on the Spa-Francorchamps track, Belgium, in November 2016 for the ULB tests using the Microcab.



Figure 14 - Temporary HRS with Microcab at Spa-Francorchamps, 2016

Demonstration and post-demonstration activities

Riversimple

Riversimple will deploy 20 vehicles in their demonstration phase, which started in October 2018 and will run for 2.5 years after the end of the project.

Applicants for the trial cover a broad age range and diverse occupational status, though the biggest group is 45-54 and from professional or management occupations.

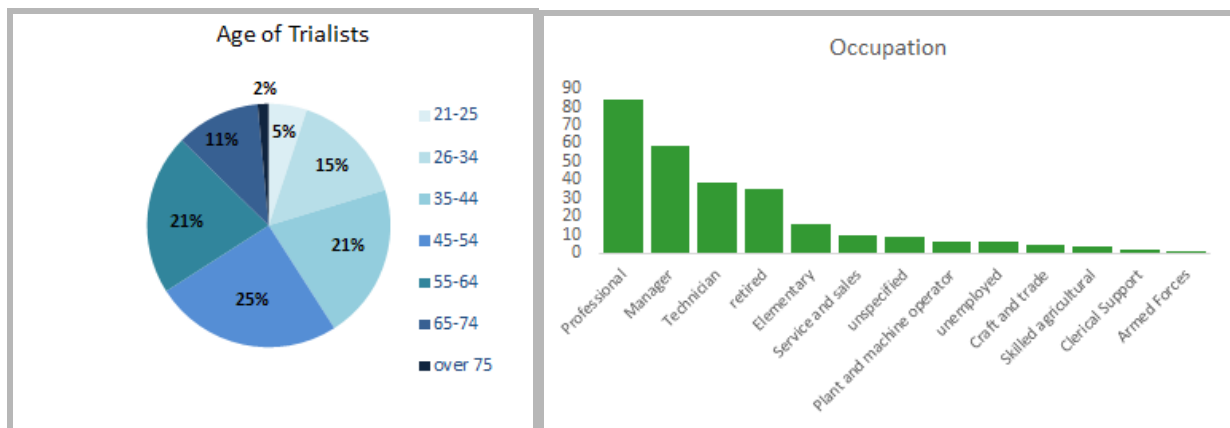


Figure 15 - applicants within a 30-mile radius of the HRS in Abergavenny

All those within the catchment, a 30-mile radius of Abergavenny, were invited to two open evenings in the town for potential trialists. Both events were very well attended - details about the vehicle, the trial and the

service were given, including logistical information, anticipated range of the Rasa and the cost of participation.

The Riversimple service team now has 60 households who have formally registered as participants, agreeing to pay a deposit and full commercial price for their participation. Between them they drive a total of 11,522 miles per week. As well as private customers, various corporate customers have expressed interest in participating in the trial.

Training has begun for the first of the Riversimple Beta Trialists.

All the trial participants, along with the original 1,000 people who expressed an interest in participating, were also sent an invite to the Riversimple Design Forum, which went live in September 2018. This is an online platform where Riversimple will engage with future customers who want to have input into the service and vehicle design but may not be in a position to participate directly in the trial.

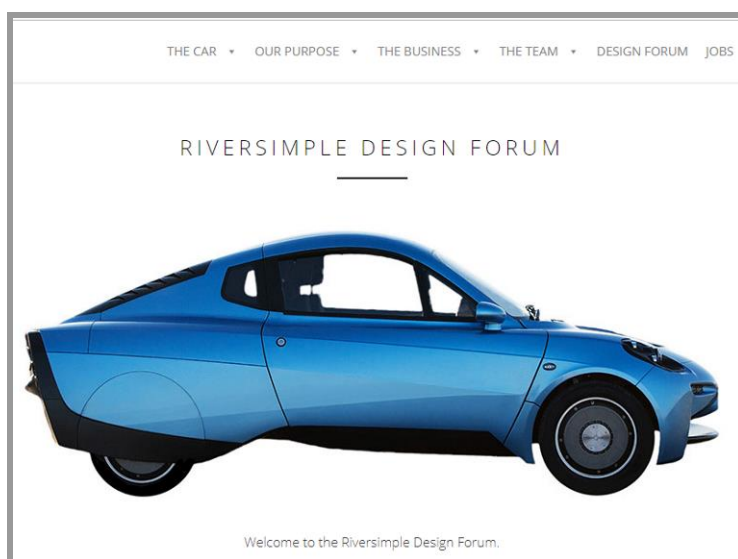


Figure 16 – Riversimple’s online Design Forum

The Riversimple Design Forum is an active online platform that Riversimple are using to gather market intelligence. The first question Riversimple asked the initial 300 participants who signed up was about refuelling habits. This was to ensure they were aware of any peak refuelling times and ensure the Riversimple HRS is properly resourced.

Microcab

Generation 1 and 2 vehicles have been operational since 2015 and have accumulated data in actual road usage. This includes usage as commuter vehicles and for general use by a group of SWARM soft users (as recommended during the Technical review by external evaluators), mostly from Coventry University and Microcab. Vehicles have been used for journeys to and from work, for shopping and other domestic duties and for leisure purposes. Vehicles have been used throughout the year, across the seasons and in day and night use.

They have also operated in a range of locations including in the UK in the Midlands, Sheffield, Isle of Wight and London as well as in Belgium (Brussels and Liege).

Brussels/Zaventem

The universities ULB and VUB were engaged to host the Microcab demo car. Fruitful contacts had also been established with administrations of some of the 19 cities forming Brussels and located in the Eastern part of Brussels (namely Woluwé-Saint-Pierre, Woluwé-Saint-Lambert, Watermael-Boitsfort, Schaerbeek and Ixelles) because they are close to the HRS of the SWARM project (just nearby Woluwé-Saint-Lambert and Schaerbeek even if just outside the Brussels-Capital Region). Other fruitful contacts have been made with some industrial partners (also located in the Eastern part of Brussels) to host some SWARM cars at their facilities and to be used by their employees (as Solvay NOH, Engie/Electrabel, ELIA, Sibelga and Zennit, a Brussels SME). Even some delivery companies working in Brussels to deliver food in the evening have shown a real interest in renting the car in the evening for their delivery activities.

A solution for the leasing of all or some of the cars used in the Brussels-Capital Region and Wallonia Region through one single organization, called H2-Life Foundation, has also been examined by ULB, ULiège and DGO4 Wallonia. Discussions with H2O e-mobile and Microcab about the leasing procedure and the leasing contracts had been initiated. This resulted in using one Microcab H2EV car at ULB during 6 months after the end of the SWARM project (from November 2018 until May 2019) with a contract between ULB and Microcab company.

The option to have the Microcab cars in leasing instead or in addition to the Elano cars has been based on the current know-how build-up of ULB-ATM using this Microcab H2EV car for the WP7 research activities of SWARM.

High-level targets for vehicle development and delivery to the Brussels Capital-Region have been:

- Alpha car (pre-production prototype) completed in May 2016 by Microcab
- First Belgium prototype used in Brussels in the Spring and Summer of 2016
- First Belgium prototype goes to Spa-Francorchamps in the Fall of 2016
- First prototype available at ULB in May 2018
- Road tests in Brussels start with one car in June 2018
- Track tests on Beauvechain Air Base in Spring and Summer 2018
- Short tests in Spa-Francorchamps in early Autumn 2018 (not realised)
- Close of road tests at the end of October 2018
- Test report available in November 2018.



Figure 17 – Air Liquide Brussels HRS and Microcab car refilling in 2016

A first demo phase has been performed with real road testing in urban environment in Brussels in the period from May 2016 until October 2016 with a Microcab car. Some 300 km were driven on the campuses of ULB, on the roads of the Brussels-Capital Region, on the runway track of the Beauvechain Air Base and even outside of the Brussels-Capital Region when going to refill the Microcab car at the Colruyt Energy Division in Halle. This first demo phase was continued and ended with some extra road testing on the Spa-Francorchamps race track during 2 weeks in November 2016.

On 27th of June 2018, ULB-ATM received its 2nd demo Microcab from Microcab and University of Coventry for an extended test period of 4 full months. For more precise and consistent tests, the Beauvechain Airbase was used for testing the Microcab. The car was also stored there during about 2 months.



Figure 18 - Beauvechain Airbase closed circuit

The airbase has a closed circuit (Figure 14) where driving at different and constant velocities was easy to perform. Two kinds of runs were done on the track: doing laps at a constant speed or doing the 1.8 km straight

line of the runaway. By doing so, the power and H2 consumption at different speeds were more precisely evaluated.

The main objective of the project was to review the methods used to derive the power consumption of the Microcab. Many types of driving cycle can be simulated depending on the character of speed and engine load changes thus divided into ‘steady-state’ cycle and ‘transient’ cycle². The steady-state driving cycle represents the reality of trying to maintain a steady speed, where the transient cycle is a test that is performed in a real-world situation where there are responses to road bumps, traffic and road junctions. These two kinds of cycle were then made with the Microcab to cover all the possibilities of how the car would be used by the average user.

In total 725 km have been run in Belgium during the summer and autumn of 2018 by ULB. These tests are in fact still running until March 2019 in order to have additional driving test data during the cold months in Brussels. After this the vehicle may be replaced with one of the new Microcab Vianova models.

Air Liquide Zaventem HRS

The Air Liquide HRS in Zaventem, Brussels, will be used after SWARM in the FCH JU-funded ZEFER Project, which started in September 2017. The ZEFER Project is deploying 180 FCEVs into fleet service across three major European cities (London, Paris, Brussels). 60 of these will be deployed as taxis in Brussels and will refuel at the Air Liquide station in Zaventem. ZEFER will aim to demonstrate viable business cases for captive fleets of Fuel Cell Electric Vehicles (FCEVs).

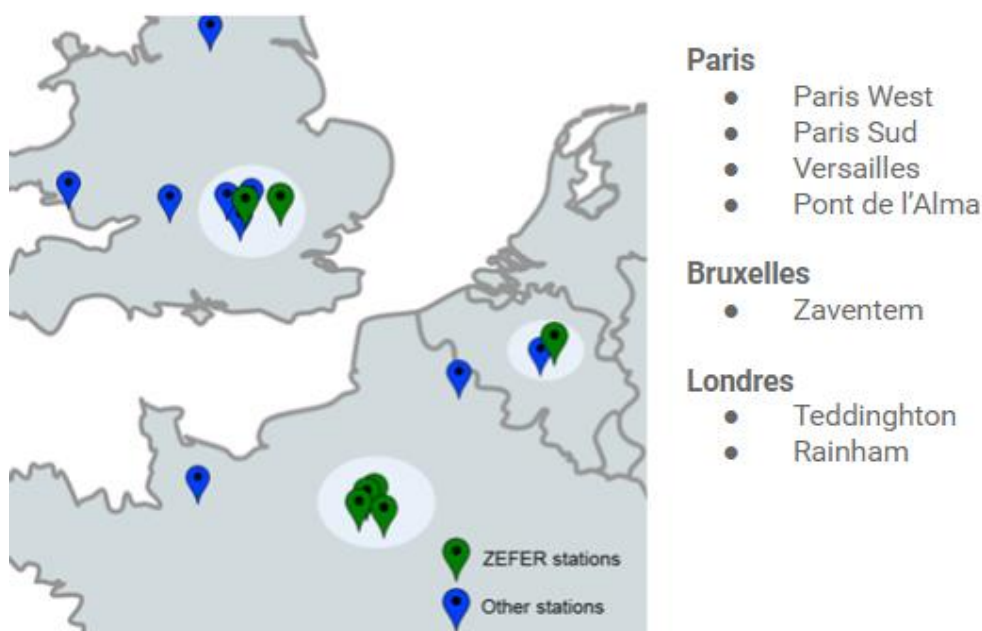


Figure 19 - ZEFER HRS deployment locations

Air Liquide Frechen HRS

² A reference book of driving cycles for use in the measurement of road vehicle emissions, *TJ Barlow, S Latham, Published project report PPR354*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/4247/ppr-354.pdf

A trial with 1 to 3 Microcab vehicles should have been organised from beginning of September 2018 until the end of the project. The objective was to deliver the cars to identified end users (HyCologne) found to support operation of this station. Microcab did not get the license to drive the vehicle in Germany, so that the trial could not happen. Nevertheless, other vehicles from major OEMs (such as Toyota) are regularly refueling at the station in Frechen, vehicles in the Cologne area as the vehicles by travelling from France or Belgian to Germany.

A Microcab car was in Frechen to support the opening ceremony. It allows Microcab to access a new European public and promote its technology. Air Liquide will continue to operate the station after project end. The station is operated as a public station. Anyone can refuel either 350bar or 700bar cars at the station.

The Frechen station will also be used as a back-up location to refuel the fuel cell buses being deployed by RVK, a local bus operator, as part of the FCH JU JIVE and JIVE 2 projects. The Frechen station will be transferred to H2 Mobility GmbH, who own and operate most of the public hydrogen refuelling stations in Germany. Through this, the Frechen station will deeply contribute to the development and deployment of the hydrogen infrastructure in the Cologne area. This transfer will promote the hydrogen refuelling of cars outside SWARM project and now predominantly commercial cars refuel at the Frechen station.

Accompanying Research

Accompanying research was crafted to tie in R&D expertise and laboratory capabilities of the university partners and offer the SWARM OEMs direct access to their technical resources, as they developed final designs for first and second-generation vehicle deployments during the project.

The objective of Jade University was the design and optimisation of the powertrain, initially for the elano fuel cell vehicle, but in principle applicable to any hybrid fuel cell vehicle platform. For this reason, a test-bench was constructed at JHS with which the power train of an electric vehicle could be simulated (hardware in the loop). Further, two battery-electric elano vehicles were converted into fuel cell vehicles.

Test bench

With the test bench, the powertrain, i.e. the combination of fuel cell system and battery, can be loaded with a real driving cycles. In the current state, the powertrain can be loaded with load currents of up to 420A and with charging currents of up to 260A. To simulate a drive cycle, the electronic loads and power supplies are controlled using a LabVIEW program.

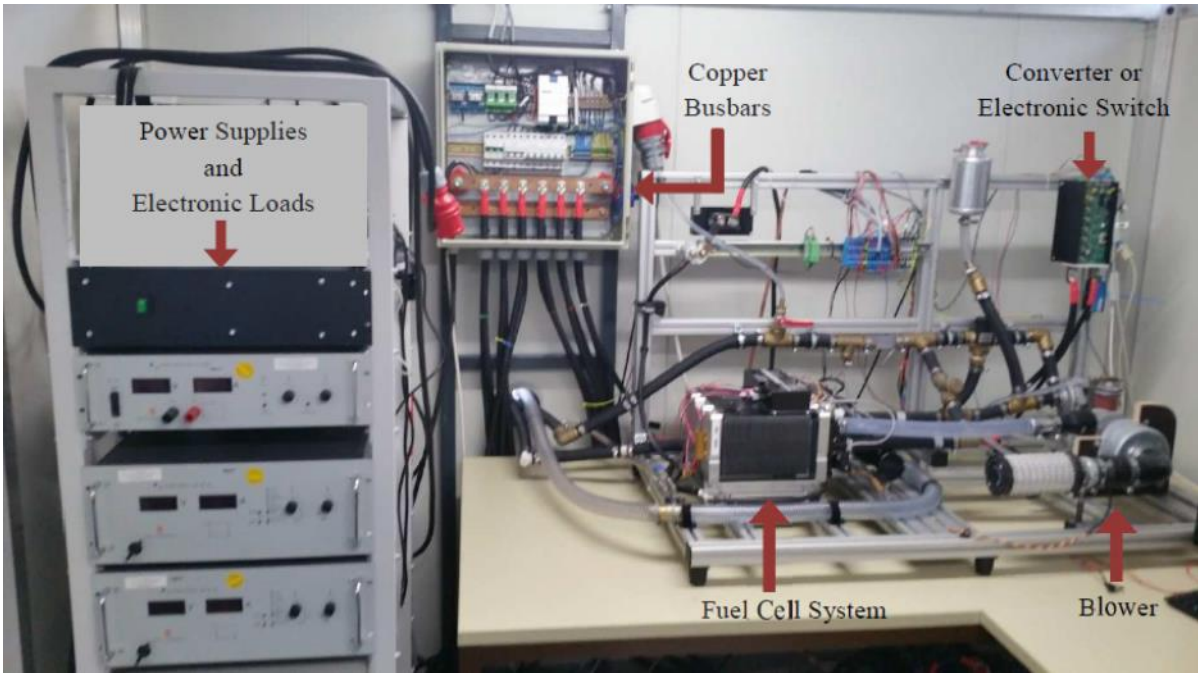


Figure 20 - Test bench realisation to simulate and test the drive train of battery-fuel cell hybrid vehicles.

Passive Hybrid System

In a passive hybrid system (Fig.19), the fuel cell is connected with the battery via an electronic switch over a defined period of time. Thus, during the ‘slow’ switching process the hydrogen supply can be coordinated with the electrical power change of the fuel cell system. During the extended switching process, the power switch/semiconductors operate with large losses in linear operation. The originally envisaged mechanical switch was never implemented, since the electronic switch solid state losses proved to be very low.

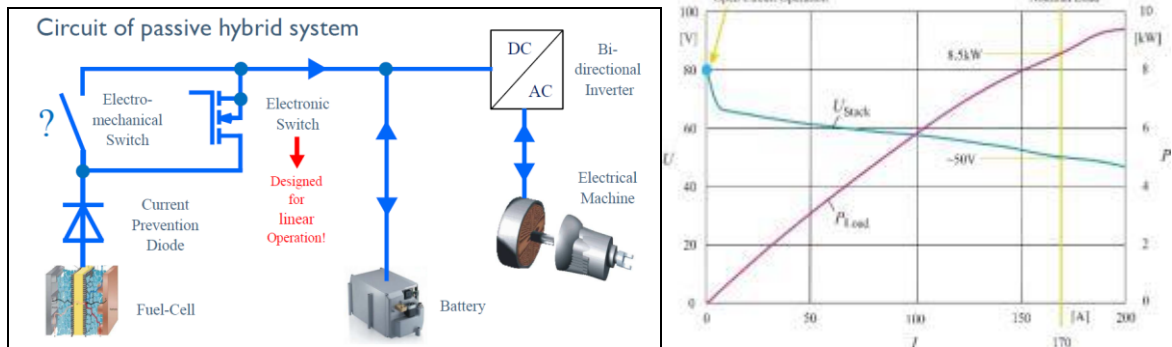


Figure 21 - Power train of a passive hybrid circuit (left) and the behaviour of the fuel cell system (right).

In the selected concept with the power electronic switch, the voltages of fuel cell system and battery must be matched. Fig. 20 shows the principal fuel cell voltage waveform. The fuel cell system Hydrogenics HYDM HD8-200 has a nominal power of $P_N = 8.5kW$ and an open circuit voltage of $U_0 = 80V$. At the nominal power which corresponds to a current of approx. $I_N = 170A$, the fuel cell system voltage output is only $U_N = 50V$. The battery voltage must be selected such that this voltage is reached when the battery is completely discharged.

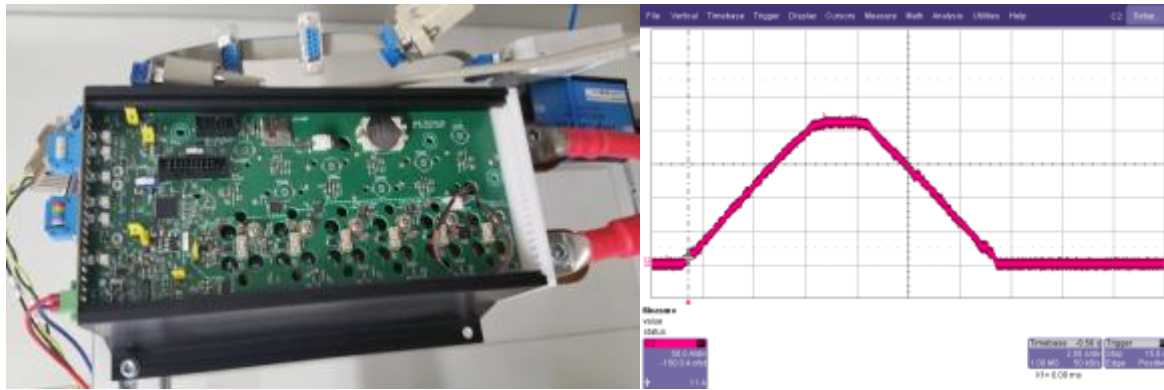


Figure 22 - Power electronic switch redesign (left) and current during switching operation (right)

From these power electronic switches in total, three units were constructed and tested, one for the test bench, and two for vehicle integration. Initial tests with the operation of the electronic switch were very positive and the concept works as designed. The power can be varied gradually by CAN communication up to the rated power of 8.5kW. In this way the switch can be fully integrated into the vehicle control unit (VCU) that manages all system components on the vehicle platform.

Development of the DC/DC Converter

As an alternative to the direct (passive) coupling of fuel cell system and battery as explained above – which is considered the most energy efficient alternative – the possibility of a boost/buck converter was investigated. For the rated fuel cell system power of $P_N = 8.5\text{kW}$ a six-phase buck converter was finally chosen. The input voltage of the converter can vary between $U_{In} = 55$ to 80V , depending on the required fuel cell power. The voltage at the converter output varies between $U_{Out} = 45$ to 55V depending on the state of charge of the battery.

University of Birmingham (UBHAM) supported this work by developing the algorithms to manage the fuel cell system in the context of the vehicle operation. Since the energy efficiency of the battery electric part of the FCEV is highest, whereas the fuel cell/hydrogen system warrant for long distance travel, a balance between using plug-in battery electricity and hydrogen fuel has to be struck. This is also reflected in the fuel cost. Therefore it would be advisable to only switch the fuel cell system on when it is actually needed. Most current FCEV will operate the fuel cell system throughout their travel and thus use more hydrogen fuel than actually required.

Work at UBHAM therefore concentrated on gathering driving and route information in order to feed the VCU so that it can make educated decisions on the necessity to switch on the fuel cell power.

Work conducted by JHS on powertrains in fuel cell vehicles was published in three conference papers:

IEEE-PEMC 2018 Multiphase DC/DC Converter and its Use in the Powertrain of Fuel Cell Vehicles. 18th International Power Electronics and Motion Control Conference, IEEE-PEMC 2018 Budapest, Hungary 26. – 30. August 2018, IEEE catalog number: CFP1834A-USB, ISBN: 978-1-5386-4197.

EPE 2018 A Novel Concept to Control the Powertrain in Battery Fuel Cell Hybrid Vehicles. 20th Conference on Power Electronics and Applications, EPE'18-ECCE Europe, Riga, Latvia 17.–20. September 2018, IEEE catalog number: CFP18850-USB, ISBN: 9789075815290.

IEEE-ISETC 2018 Test bench to optimize the Powertrain in Battery-Electric and Fuel-Cell Vehicles
International Symposium on Electronics and Telecommunications, Timisoara, Romania 08.-09. November
2018.

Open Access publications on the JHS and UBHAM developments are in preparation.

Potential Impact, Major Dissemination Activities and Exploitation of Results

Hydrogen fuel cell technology has a crucial role to play in decarbonising transport and the economy more widely. The development of fuel cell passenger cars is thus clearly an important step on the road towards decarbonisation.

One of the main dissemination events of the project was *The Coventry Hydrogen Event: Final SWARM Forum*, which took place on the afternoon of the 17th October 2018 at Coventry University. The event focused on three key topics: an overview the SWARM project and its achievements, applications of hydrogen mobility in local contexts, and the wider UK and international hydrogen context. The audience of 100 people came from a range of backgrounds, including project partners, university, industry and public sector.

Project partners from Element Energy, Coventry University, Microcab, Riversimple, Air Liquide, University of Brussels (ULB), JADE University, PLANET and the University of Birmingham were present. In addition to project partners Element Energy, Microcab, Riversimple, Air Liquide, ULB and JADE, presentations were made by Monmouthshire County Council, Oakdene Hollins (a specialist circular economy consultancy), Toyota and the FCH JU.



Figure 23 - (left to right) Toyota Mirai, Riversimple Rasa and Microcab Vianova on display outside the Engineering and Computing Building of Coventry University.



COVENTRY HYDROGEN EVENT

FINAL EVENT SWARM PROJECT

The Coventry Hydrogen Event will take place on 17th October 2018.
The event is hosted by Coventry University.

This event will celebrate the achievements of the FCH JU-funded SWARM Project, which finishes this year, putting them in the context of the wider hydrogen transport landscape in the UK and Europe and reflecting on the benefits of implementing the technology as a local solution

Conference opening | 12:00 – 13:15

12:00 - 13:00	45'	Arrival and light lunch, registration Visit of vehicles exhibition
13:00 –13:15	15'	Honorary speaker, Coventry University Prof Richard Dashwood Deputy Vice Chancellor for Research

SWARM Project | 13:15 – 14:30

13:15-13:30	15'	Overview Project and State of Play for H2 Mobility – SWARM coordinator Element Energy (Ben Madden)
13:30-13:45	15'	Interlinking project demonstration and research activities – JADE (Folker Renker) / University of Brussels (Patrick Hendrick)
13:45-14:00	15'	Experience of deployment in Coventry - Microcab (John Jostins)
14:00-14:15	15'	Experience of deployment in Brussels (Belgium) and Frechen (Germany) – Air Liquide (Caroline Le Mer)
14:15-14:30	15'	Experience of deployment in Wales – Riversimple (Hugo Spowers)
14:30-15:15	45'	Coffee break



Applications and local projects | 15:15 – 15:45

15:15-15:30	15'	Perspectives from Local Authority – Monmouthshire County Council (Paul Matthews)
15:30-15:45	15'	Opportunities for innovative approaches for Hydrogen and Fuel Cell in the circular economy – Oakdene Hollins (Olivia Bertham)

International and UK context | 15:45 – 16:15

15:45-16:00	15'	Perspectives and trends at the UK level on hydrogen and fuel cell technologies – Toyota GB (Jon Hunt)
16:00-16:15	15'	Perspectives and trends at the European level on hydrogen and fuel cell technologies – FCH JU (Enrique Giron)

16:15-17:00 Networking Reception

These activities have received funding from the European Union's Seventh Framework Programme (FP7-2007-2013) through the Fuel Cells and Hydrogen Joint Undertaking under grant agreement number 303485

This event is organised with the support and as a collaboration between :



Figure 24 - Coventry Hydrogen Event Agenda.

Individual partners contributed to various conferences throughout the project, and opening ceremonies were held for the Air Liquide HRS in Brussels and Frechen in 2016 and 2018 respectively. Below are some examples of project dissemination activities.

Dissemination activities

Air Liquide HRS public opening Brussels, Belgium 22 April 2016

The Official Opening of the commissioned HRS took place on April 22, 2016 also under the auspices of Minister Annemie Turtelboom with more than 150 invitees attending and was organised in partnership with (in addition to the project partners) the FCH JU, Hydrogen Europe and Toyota Motor Europe.



Figure 25 - Official Opening of the commissioned HRS on 22nd April 2016

A Microcab and a Elano vehicle also supported the event and were on display on the day alongside a number of other FC vehicles as well as dissemination material about the project. A FC bus was made available as a shuttle to pick up EU Parliamentary representatives from Brussels European quarters. This event was also widely reported in the local and international medias.

Air Liquide HRS public opening Frechen, Germany 21 September 2018

The Official Opening of the commissioned HRS took place on September 21, 2018 under the auspices of the Minister for Economic Affairs, Innovation, Digitalisation and Energy of the State of North Rhine Westphalia Stefan Leuchten, with more than 150 attendees. It was organised in partnership with the FCH JU, the mayor of the city of Frechen, Mundorf Mineralölhandels GmbH und Co KG and Toyota Motor Europe.

Statements were given during the opening ceremony by:

Stefan Leuchten, Ministry for Economic Affairs, Innovation, Digitalisation and Energy of the State of North Rhine-Westphalia:

"Particularly in the transport sector, considerable efforts are still needed to achieve the objectives of the Paris Agreement. We consider hydrogen-powered fuel cell vehicles as an important building block for future climate-friendly mobility. A decisive factor for the market ramp-up of this technology will be the development of a nationwide refuelling infrastructure. We therefore welcome the opening of the hydrogen refuelling station here in Frechen."

Susanne Stupp, Mayor of the City of Frechen:

"We all know the climate and environmental challenges of our time. Pollutant load is increasing, even in Frechen. Climate change is perceptible, and we have recently been experiencing an accumulation of weather extremes. A long time ago already, we in Frechen started addressing the climate change issue. For example, we regularly take part in the European Mobility Week and, over the past few months, we have implemented all kinds of measures that are good for our climate and people's health: For instance, we have put into operation charging stations for electric cars and pedelecs. Also here in Frechen, e-bikes experienced a

veritable boom in recent years. The opening of the hydrogen station perfectly fits into a whole package of measures to protect our climate.”

Fabio Mundorf, Managing Director, Mundorf Mineralölhandels GmbH und Co. KG:

"I am delighted to be here today for the inauguration and I congratulate Air Liquide on the opening of the hydrogen refuelling station at our site here in Frechen. We are honoured to be involved in the roll-out of this new refuelling technology. We are happy about the cooperation and look forward to the next projects.”



Figure 26 - Official Opening of the commissioned HRS on 21st September 2018

A Microcab also supported the event and was on display on the day alongside a number of other FC vehicles as well as dissemination material about the project.



Figure 27 - Microcab at the HRS opening

This event was widely reported in the local and international media.

Riversimple Rasa Alpha car dissemination activities

Since being commissioned for road use in 2016, the Alpha car has been deployed for a significant number of events and road tests, principally to publicise Riversimple's achievements and assist with raising additional funds for the demonstration. Stand out events include Goodwood Festival of Speed, a visit to the Houses of Parliament and the London Motor Show (Figure 40).



Figure 28 - Riversimple Alpha car (a) Houses of Parliament with Rt. Hon Sajid Javid, at that time Secretary of State for Business, Innovation and Skills, (b) Goodwood Festival of Speed, (c) London Motor Show with Richard Noble and (d) Carfest with Chris Evans.

Riversimple Rasa Beta car dissemination activities



Figure 29 - Riversimple Beta car Bristol City Council event (left), with Monmouthshire council at HRS site (centre), and Hydrogen hub event Swindon (right)

All three of the events referenced above were attended by a variety of stakeholders, including local authorities, members of the public, fleet vehicle managers from a range of organisations, representatives of the community, vehicle OEM's and supply chain manufacturers.

Riversimple's dissemination activities have also engaged a number of high-profile public figures such as Chris Evans, Kate Humble and Hugh Fearnley-Whittingstall. While Chris Evans commented in a magazine article that "Britain needs more companies like RS", Kate Humble tweeted about her visit to the workshop to her 101k followers.

"The future of motoring? This unique #sustainable #innovation by #riversimple & the business model behind it are game changing and give cause for optimism in not very optimistic times."

FEV open new centre at Coventry University – 21st March 2019

C-ALPS, the Centre for Alternative Low Carbon Propulsion Systems, opened on 21 March 2019. This new building on Coventry University's techno park is a joint development between the Aachen-based engineering company FEV and Coventry University. Included in the exhibits was Microcab's Vianova fuel cell plug hybrid vehicle (Fig.30). FEV have expressed interest in fuel cell systems having developed the Breeze project (2015), a compact car with fuel cell range extender, based on the Fiat Cinquecento platform.



Figure 30 - Microcab Vianova on display at C-ALPS opening, March 2019

26 Feb. 2018 Jeremy Corbyn, Leader of UK Labour Party, delivers Brexit speech at the National Transport Design Centre (NTDC), Coventry

The NTDC building (funded and operated by Coventry University) is adjacent to Microcab HQ. “Labour party descends on Coventry for Jeremy Corbyn speech about the need for A Customs Union after Brexit. Microcab asked to provide SWARM hydrogen vehicles for backdrop. Speech delivered in the heart of UK automotive sector in which frictionless, pan EU supply chain is essential.”



Figure 31 - Jeremy Corbyn delivers Brexit speech

University of Birmingham (UB) Hydrogen and Fuel Cell Showcase May 31st 2018

Hydrogen and fuel cell industry, academics and students were present at this event. UB is a long-standing partner of Microcab having worked in collaborative projects together from 2006. UB is a user of the Gen 3 Microcab vehicle and the pictures below show the vehicle being handed over to Ahmad El-Kharouf during UB’s hydrogen conference in May/June 2018.

LCV 2018 12-13 September 2018

The UK's premiere low carbon vehicle event, 3 days of conference and many global automotive companies represented. A Gen 3 Microcab operated on the ride and drive on the city circuit with about 12 rides given. Audience included local authorities, policy makers, hydrogen and general vehicle industry (OEM and niche companies), fleet managers and general public. Microcab shared a stand with Aachen-based FEV. The Mahle stand also featured the Microcab MEET, (Mahle Energy Efficient Transport).

Microcab Isle of Wight Challenge, 20th April 2016

As part of the Eco Island project with ITM Power and Arcola Energy, Microcab toured the Isle of Wight on 20th April 2016, stopping at famous landmarks and six primary schools where the kids get their first sight of a hydrogen fuel cell vehicle. The event was filmed and made into a video, found here:

<https://www.youtube.com/watch?v=0ykWf3R8xZ4&t=42s>



Other Communication activities

Partners featured in a number of articles and made a number of videos to educate the public about the project, vehicles and FC transport technologies more widely. Key examples include:

- <http://reactif.wallonie.be/?p=199>
- <http://www.telegraph.co.uk/cars/features/riversimple-rasa-review-welsh-hydrogen-fuel-cell-runabout-could/>
- <https://www.theguardian.com/technology/2018/jan/20/hydrogen-cars-hugo-spowers-future>

Project website

<https://www.swarm-project.eu/>

The following statistics of website access were recorded up until May 2018. Unfortunately, the web host was not able to provide further statistics up until the end of the project in Oct 2018. Therefore, the interest generated by the final project events is not captured here.

2013				
Month	Unique visitors	Number of visits	Pages	Hits
01.10.2013	456	1055	7249	28074
01.11.2013	214	512	3517	104
01.12.2013	483	1117	6533	18221
Total	1153	2684	17299	46399
2014				
Month	Unique visitors	Number of visits	Pages	Hits
01.01.2014	140	401	2634	10454
01.02.2014	325	762	4644	15062
01.03.2014	459	992	11031	21904
01.04.2014	421	1233	5898	1667
01.05.2014	437	1293	6271	16694
01.06.2014	453	1117	6481	18195
01.07.2014	424	1123	5436	16281
01.08.2014	501	1133	5465	16506
01.09.2014	432	1088	6358	21395
01.10.2014	606	1055	7213	27007
01.11.2014	401	1133	5465	16506
01.12.2014	453	1107	6381	18062
Total	5052	12437	73277	199733
2015				
Month	Unique visitors	Number of visits	Pages	Hits
01.01.2015	405	799	4042	16026
01.02.2015	445	902	4465	15196
01.03.2015	580	1407	5126	22209
01.04.2015	531	1233	5923	16962
01.05.2015	547	1293	6283	17311
01.06.2015	483	1117	6533	18221
01.07.2015	534	1123	5436	16435
01.08.2015	501	1133	5465	16676
01.09.2015	542	1088	6358	21868
01.10.2015	606	1055	7249	28074
01.11.2015	n/a	n/a	n/a	n/a

01.12.2015	n/a	n/a	n/a	n/a
Total	5174	11150	56880	188978
2016				
Month	Unique visitors	Number of visits	Pages	Hits
01.01.2016	345	602	2442	14146
01.02.2016	349	771	2365	14146
01.03.2016	560	1201	2926	22209
01.04.2016	561	1213	5123	16962
01.05.2016	247	843	3383	10311
01.06.2016	477	1007	4433	15232
01.07.2016	334	993	3936	14456
01.08.2016	341	899	4065	14875
01.09.2016	452	901	4358	15898
01.10.2016	306	703	3998	28074
01.11.2016	234	532	3301	9987
01.12.2016	266	611	3522	10006
Total	4472	10276	43852	186302
2017				
Month	Unique visitors	Number of visits	Pages	Hits
Pages	Hits			
01.01.2017	199	352	1082	7991
01.02.2017	201	405	1465	7018
01.03.2017	266	433	1226	6781
01.04.2017	335	597	2073	15964
01.05.2017	347	615	1883	13561
01.06.2017	401	759	1931	14516
01.07.2017	356	651	1936	15570
01.08.2017	312	645	2065	16090
01.09.2017	201	378	1258	9868
01.10.2017	234	432	1565	8014
01.11.2017	188	291	1009	8006
01.12.2017	156	242	998	8145
Total	3196	5800	18491	131524
2018				
Month	Unique visitors	Number of visits	Pages	Hits
01.01.2018	133	331	882	5899
01.02.2018	161	455	1269	6115
01.03.2018	146	418	1231	6751
01.04.2018	95	297	981	8521
01.05.2018	245	674	1971	13561
Total	780	2175	6334	40847

4.2 Use and dissemination of foreground

Section A (public)

This section includes two templates

- Template A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- Template A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

These tables are cumulative, which means that they should always show all publications and activities from the beginning until after the end of the project. Updates are possible at any time.

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers ³ (if available)	Is/Will open access ⁴ provided to this publication?
1	<i>Fuel Cell Vehicles Book Chapter (Under contract)</i>	<i>Prof. Robert Steinberger-Wilckens, Prof. J. Jostins</i>	TBC		<i>Elsevier</i>	<i>NL</i>	<i>2019</i>	<i>TBC</i>		<i>TBC</i>
2	<i>Proposed paper State of the Art review of Fuel Cell Hybrid Vehicle technology with consideration of power and energy split between different energy sources in real driving conditions.</i>	<i>Jostins, J. Blundell, M. Quillivic, C. Jostins, P.</i>	TBC		<i>Elsevier TBC</i>	<i>TBC</i>	<i>2019-2020 TBC</i>	<i>TBC</i>		<i>TBC</i>

³ A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

⁴ Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

3	<i>Proposed paper Small fuel cell vehicle fleet support by green hydrogen</i>	<i>Jostins, J. Quillivic, C. Jostins, P. Blundell, M.</i>	<i>TBC</i>		<i>TBC</i>	<i>TBC</i>	<i>2019-2020 TBC</i>	<i>TBC</i>		<i>TBC</i>
4	<i>Proposed paper Vibration Analysis of Fuel Cell Stack Mounting in Automotive Applications</i>	<i>Shang, J. Apicella, M. Jostins, J. Jostins P.</i>	<i>Journal of Vibration and Control, TBC</i>		<i>Sage TBC</i>	<i>TBC</i>	<i>2019-2020 TBC</i>	<i>TBC</i>		<i>TBC</i>
5	<i>Proposed paper Power Shifting and Series Topology DC/DC Converter for Fuel Cell applications.</i>	<i>Jostins, P. Jostins ,J. Apicella,M. et al</i>	<i>Vehicle Power Electronics TBC</i>		<i>IEEE TBC</i>	<i>TBC</i>	<i>2019-2020 TBC</i>	<i>TBC</i>		<i>TBC</i>
6	<i>A Design Methodology for Hydrogen Fuel Powered City Vehicles in Rear Impact Collisions</i>	<i>Ravenhall, N. , Bastien, C. , Orlowski, M. , Porter, B. and Jostins, J.</i>	<i>'Light Electric Vehicle Summit - LEVS</i>		<i>'Light Electric Vehicle Summit - LEVS</i>	<i>Barcelona, Spain</i>	<i>2016</i>	<i>Not known</i>		<i>Yes</i>
7	<i>Performance and energy efficiency testing of a lightweight FCEV Hybrid Vehicle</i>	<i>Dylan Ryan1, Jinlei Shang1*, Christophe Quillivic, Bernard Porter</i>	<i>European Electric Vehicle Congress</i>		<i>European Electric Vehicle Congress</i>	<i>Brussels, Belgium</i>	<i>2014</i>	<i>Not known</i>		<i>Yes</i>
8	<i>IEEE-PEMC 2018 Multiphase DC/DC Converter and its Use in the Powertrain of Fuel Cell Vehicles. 18th International Power Electronics and Motion Control Conference, IEEE-PEMC 2018 Budapest, Hungary 26. – 30. August 2018, IEEE catalog number: CFP1834A-USB, ISBN: 978-1-5386-4197.</i>	<i>Folker Renken, Wensong Shen, Udo Schürmann, Ioana-Monica Pop- Calimanu</i>	<i>IEEE</i>		<i>IEEE catalog</i>	<i>Budapest, Hungary</i>	<i>2018</i>	<i>Not known</i>		<i>conference proceedings</i>
9	<i>EPE 2018 A Novel Concept to Control the Powertrain in Battery Fuel Cell Hybrid Vehicles. 20th Conference on Power Electronics and Applications, EPE'18-ECCE Europe, Riga, Latvia 17.–20. September 2018, IEEE catalog number: CFP18850-USB, ISBN: 9789075815290.</i>	<i>Folker Renken, Ioana-Monica Pop- Calimanu, Robert Steinberger- Wilckens</i>	<i>EPE'18- ECCE Europe</i>		<i>IEEE catalog</i>	<i>Riga, Latvia</i>	<i>2018</i>	<i>Not known</i>		<i>conference proceedings</i>

10	<i>IEEE-ISETC 2018 Test bench to optimize the Powertrain in Battery-Electric and Fuel-Cell Vehicles International Symposium on Electronics and Telecommunications, Timisoara, Romania 08.-09. November 2018.</i>	<i>International Symposium on Electronics and Telecommunications</i>	<i>Not know</i>		<i>Not know</i>	<i>Timisoara, Romania</i>	<i>2018</i>	<i>Not known</i>		<i>TBC</i>
11	<i>Proposed paper: A High-Level Energy Management System based on Model Predictive Control using Navigation Data for a Fuel Cell Hybrid Electric Vehicle</i>	<i>Matthew Holden, Stefan Radic Webster, Yousif Al-Sagheer, Robert Steinberger-Wilckens</i>	<i>World Electric Vehicle Journal (MDPI) or IJHE</i>	<i>2019</i>	<i>MDPI or Elsevier</i>	<i>Basel or Rotterdam</i>	<i>2019</i>	<i>n/a</i>		<i>yes</i>
12	<i>Proposed paper: A Technology comparison of lightweight FCEV</i>	<i>Katharina Buss, Naseruddin Khan, Yousif Al-Sagheer, Ahmad El-kharouf, Robert Steinberger-Wilckens</i>	<i>World Electric Vehicle Journal (MDPI) or IJHE or Applied Energy</i>	<i>2019</i>	<i>MDPI or Elsevier</i>	<i>Basel or Rotterdam</i>	<i>2019</i>	<i>n/a</i>		<i>yes</i>
13	<i>Proposed paper: Methodologies of cost comparison of FCEV with incumbent technologies</i>	<i>Beatrice Sampson, Jan Bebbington, Ahmad El-kharouf, Robert Steinberger-Wilckens</i>	<i>IJHE or Applied Energy</i>	<i>2019</i>	<i>Elsevier</i>	<i>Rotterdam</i>	<i>2019</i>	<i>n/a</i>		<i>yes</i>
14	<i>Proposed paper: Life Cycle Analysis of lightweight FCEV</i>	<i>Sophie Archer, Robert Steinberger-Wilckens</i>	<i>IJHE or Applied Energy</i>	<i>2019</i>	<i>Elsevier</i>	<i>Rotterdam</i>	<i>2019</i>	<i>n/a</i>		<i>yes</i>

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES

NO.	Type of activities ⁵	Main leader	Title	Date/Period	Place	Type of audience ⁶	Size of audience	Countries addressed
1	Conferences	SWARM	SWARM final conference	17/10/2018	Coventry	scientific community, industry, policy makers	100	UK
2	Workshops	Riversimple	Bristol City Council	06/03/2019	Bristol	policy makers	100-150	UK
3	Oral presentation to a wider public	Riversimple	Monmouthshire County Council @ HRS	22/02/2019	Abergavenny	civil society	25-50	UK
4	Presentations	Riversimple / Exeter University	Exeter University CE event	05/02/19	Exeter	scientific community	50	UK
5	Articles published	Riversimple / Hacking Finance	Hacking Finance article	29/01/2019	N/A	industry	Not known	UK
6	Workshop	Riversimple	Training MCC	24/01/2019	Llandrindod	other	12	UK
7	Presentations	Riversimple / HW Wood Ltd	Lloyds of London motor club	05/11/2018	London	civil society	300 – 500	UK
8	Presentations	Riversimple / Future Economy Network	Future Economy Network presentation (Green GB week)	16/10/2018	Bristol	policy makers	30	UK
9	Oral presentation to a wider public	Riversimple / Cabinet office for Wales	Claire Perry - Green GB week	16/10/2018	Cardiff	policy makers	50	UK
10	Articles published	Riversimple	Guardian	01/08/18	N/A	civil society	Not known	UK
11	Exhibitions	Riversimple	Carfest	27/07/18	Cheshire	civil society	50,000	UK
12	Interviews	Riversimple / Speakers office	Andrea Leadsome - Office visit	25/07/2018	Llandrindod	policy makers	4	UK
13	Exhibitions	Riversimple / Goodwood	Goodwood Festival of Speed	22/06/16	Goodwood	civil society	300,000	UK
14	Exhibitions	Riversimple / Chateau Impney	Chateau Impney hill climb	07/07/18	Droitwich	civil society	16,000	UK

⁵ A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

⁶ A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

15	Exhibitions	Riversimple	Abergavenny Beta tester event	27/06/18	Abergavenny	other	100	UK
16	Exhibitions	Riversimple	Abergavenny Beta tester event	07/06/18	Abergavenny	other	150	UK
17	Articles published	Riversimple	South Wales Argus	14/07/2017	N/A	civil society	Not known	UK
18	Press releases	Riversimple	Press release - Green car maker Riversimple launches recruitment drive for 100 beta testers	05/07/2017	N/A	medias	Not known	UK
19	Articles published	Riversimple	Next Green Car	05/07/17	N/A	civil society	Not known	UK
20	Articles published	Riversimple	inside EV's	05/07/17	N/A	civil society	Not known	UK
21	Exhibitions	Riversimple / Messum's Art Gallery	Messums	12/05/2017	Tisbury	civil society	200	UK
22	Exhibitions	Riversimple / Welsh Government	Royal Welsh Spring Festival	20/05/2017	Builth Wells	civil society	5,000	UK
23	Exhibitions	Riversimple	Hay Festival	25/05/17	Hay-on-Wye	civil society	100	UK
24	Exhibitions	Riversimple / Royal Horticultural Society	Chatsworth Flower Show	05/06/07	Chatsworth	civil society	90,000	UK
25	Exhibitions	Riversimple / Monmouthshire County Council	Abergavenny Clean Air Roadshow	15/06/17	Abergavenny	civil society	100	UK
26	Presentations	Riversimple / AutoCar	Great British women in the auto industry	21/06/2017	London	industry	230	UK
27	Workshops	Riversimple / Monmouth school	Hydrogen Hack	21/08/17	monmouthshire	civil society	30	UK
28	Exhibitions	Riversimple / Hydrogen Hub	H2 hub showcase	23/08/17	Swindon	civil society	70	UK
29	Workshops	Riversimple / Monmouth school	Hydrogen Hack	24/08/17	Monmouthshire	civil society	30	UK
31	Presentations	Riversimple / Barclays and Unreasonable Impact	Impact Summit - Royal Institution and DT journalist drive	28/09/2017	London	civil society	150	UK
32	Conferences	Riversimple / Wired Magazine	Wired Energy conference	12/10/2017	London	civil society	150	UK
33	Exhibitions	Riversimple / IMI	Advanced Engineering Show	01/11/2017	Birmingham	industry	230,000	UK
34	Presentations	Riversimple / I Mech E	I Mech E	04/12/17	London	industry	50	UK

35	Presentations	Riversimple / IET	IET	29/07/17	London	industry	60	UK
36	Exhibitions	Riversimple / Welsh Government	Low Carbon Intelligent Mobility Wales Conference	29/11/18	Cardiff	industry	200	UK
37	Presentations	Riversimple / I Mech /IET/IEEE	Franco-British Engineers' Annual Dinner	25/01/18	Paris	industry	50	France
38	Exhibitions	Riversimple / Fully Charged	Fully Charged Live	6/7/18	Silverstone	civil society	7,000	UK
39	Web	Microcab	Microcab Bulletin	March 2019	n/a	Microcab mailing list	c1500	UK /EU/China / USA / SA/ India
40	Exhibitions	Coventry University /Microcab	Vianova on display at Opening of new FEV building Coventry	21/03/19	Coventry	Industry / Academic / Government	c150	UK / Germany /France / Japan
41	Conferences	Microcab	Vianova on display / Microcab presentation including SWARM at Birmingham Hydrogen Conference NEC	19/03/19	Birmingham	Industry / academic / local government	c300	UK /EU/China / Canada / India /Japan
42	Conferences	Microcab	Microcab H2EV on display Robot day (major science tech event) IET British Science week	9/03/19	Coventry	Toddlers to academics	C1000+	UK/EU
43	Conferences	Microcab / Coventry University	Microcab presentation on SWARM / Microcab nominated for an FCHJU award FCHJU 10th anniversary conference	Nov 18	Brussels	Industry / Academic / Government	C1000	UK /EU/China /
44	Web	Microcab	Microcab Bulletin	Sept 18	n/a	Microcab mailing list	c1500	UK /EU/China / USA / SA/ India
45	Exhibitions	Coventry University /Microcab	Microcab H2EV on display on FEV stand & ride & drive Cenex Low Carbon Vehicle Show 2018	Sept 18	Millbrook, Bedfordshire	Industry / Academic / local & national Government	C4300	UK / EU / World
46	Exhibitions	Coventry University /Microcab	Microcab H2EV on display Frechen opening of 51st HRS	21st Sept 18	Frechen, Koln, Germany	Industry / Academic / local & national Government	C100	UK/ Germany / Spain
47	Presentations	Microcab	Presentation including SWARM project ECOBULK project	June 2018	Koblenz, Germany	Industry / Academic	C60	UK + 11 other EU countries
48	Exhibitions	Coventry University /Microcab	Microcab H2EV on display Jeremy Corbyn / Labour Party speech on Brexit	Feb 18	Coventry National Transport Design Centre building	Industry / Academic / local & national Government	C300	UK/EU
49	Publication	ULG	Le 15e Jour, Projet européen SWARM : Le véhicule à hydrogène en test. Monthly magazine published by ULG	January 2017	Liege, Belgium	University stuff, University students.	> 10,000	Belgium
50	Exhibitions	ALAT	Brussels HRS opening event	April 2016	Brussels	Policy makers	200	Belgium
51	Exhibitions	ALAT	Frechen HRS opening event	September 2018	Frechen	Policy makers	200	Germany
52	Articles published in	ALAT	Wochenende	September	N/A	Civil society		Germany

	<i>the popular press</i>			2018				
53	Articles published in the popular press	ALAT	Ecomento.de	October 2018	N/A	Civil society		Germany
54	Conferences	ULB	3rd UNICA Green Academic Footprint (UGAF) conference on Universities as change agents for the cities' environmental sustainability	07 June 2013	Lisbon (Portugal)	University representatives, city representatives	c 70	Portugal, Belgium, Norway, Croatia, Italy, Estonia, Finland
55	Conferences	ULB	Interlinking project demonstration and research activities in the SWARM H2 EV project. Conference of Green Mind University – 2nd edition	22 May 2018	Brussels (Belgium)	Industry, students, scientific administration, policy makers	c 80	Belgium, Netherlands, Germany, France, Luxemburg, Italy, Romania
56	Conferences	ULB	Hydrogen mobility in Europe – Demo projects. GenComm conference – Future of Hydrogen as energy carrier	12 September 2018	Brussels	Industry, academics, scientific administrations	c 40	Belgium, Germany, UK, Ireland, France
57	Conference	ULB	Hydrogen for mobility in Europe. SAME World project (H2020) – Final international seminar	26 October 2017	Sintra (Portugal)	Schools, educational agents, policy makers, press	C 80	Portugal, Belgium, Italy, Germany, Greece, Tanzania, Kenya, Denmark
58	Presentations	EE	Overview of SWARM project and state of play for H2 mobility, at Coventry Hydrogen Event: Final SWARM Forum – Ben Madden	17 October 2018	Coventry	Scientific community, students, industry,	C 100	UK, EU
59	Exhibition and outdoor event	University of Birmingham	Clean Air Day	June 2018	Birmingham	students, general public	1500	UK

Section B (Confidential⁷ or public: confidential information to be marked clearly)
Part B1

The applications for patents, trademarks, registered designs, etc. shall be listed according to the template B1 provided hereafter.

The list should, specify at least one unique identifier e.g. European Patent application reference. For patent applications, only if applicable, contributions to standards should be specified. This table is cumulative, which means that it should always show all applications from the beginning until after the end of the project.

TEMPLATE B1: LIST OF APPLICATIONS FOR PATENTS, TRADEMARKS, REGISTERED DESIGNS, ETC.					
Type of IP Rights ⁸ :	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Application reference(s) (e.g. EP123456)	Subject or title of application	Applicant (s) (as on the application)
<i>Trade Mark</i>	<i>No</i>	<i>n/a</i>	<i>UK00003343263</i>	<i>Vianova</i>	<i>Microcab</i>
<i>Trade Mark</i>	<i>Yes</i>	<i>Jan 2020</i>	<i>UK00003343336</i>	<i>Hycoco</i>	<i>Microcab group</i>
<i>Company formation</i>	<i>No</i>	<i>n/a</i>	<i>Company number 11144699</i>	<i>Hycoco</i>	<i>Hycoco Ltd</i>
<i>Renewal of Design Registration</i>	<i>No</i>	<i>n/a</i>	<i>6019436</i>	<i>Microcab H2EV</i>	<i>Microcab</i>

⁷ Note to be confused with the "EU CONFIDENTIAL" classification for some security research projects.

⁸ A drop down list allows choosing the type of IP rights: Patents, Trademarks, Registered designs, Utility models, Others.

<i>Renewal of Design Registration</i>	<i>No</i>	<i>n/a</i>	<i>6019438</i>	<i>Microcab H2EV van variant</i>	<i>Microcab</i>
<i>Renewal of Design Registration</i>	<i>No</i>	<i>n/a</i>	<i>6019437</i>	<i>Microcab HyLite</i>	<i>Microcab</i>
<i>Patent application</i>	<i>yes</i>	<i>2020/21</i>	<i>P267820GB</i>	<i>Power balancing in a multi-input/multi-output energy system</i>	<i>UBHAM</i>

Part B2

Please complete the table hereafter:

Type of Exploitable Foreground ⁹	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application ¹⁰	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
Commercial exploitation of R&D results	New traction battery system design	yes	Jan 2020	Product	Automotive	2020 vehicle production	Potential to licence	Microcab (owner)
Commercial exploitation of R&D results	New motor & gearbox integration	yes	Jan 2020	Product	Automotive	2020 vehicle production	Potential to licence	Microcab (owner)
Commercial exploitation of R&D results	New Fuel Cell integration	yes	Jan 2020	Product	Automotive / marine / materials handling	2020 vehicle production / 2019 other applications	Potential to licence	Microcab (owner)
Commercial exploitation of R&D results	New vehicle control unit design	yes	Jan 2020	Product	Automotive	2020 vehicle production	Potential to licence	Microcab
Commercial exploitation of R&D results	Complete Interior design	yes	Jan 2020	Product	Automotive	2020 vehicle production	Potential to licence	Microcab (owner)
Commercial exploitation of R&D results	Digital dashboard design	yes	Jan 2020	Product	Automotive	2020 vehicle production	Potential to licence	Microcab
Technology	Tech Know-How & Trade Secret	YES	1/1/22	Product Profile	Automotive	TBC	Technology Licence is a consideration	Riversimple

⁹ A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

¹⁰ A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

Type of Exploitable Foreground ⁹	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application ¹⁰	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
Technology	Design	YES	1/1/22	Powertrain Reconfiguration	Automotive	TBC	Technology Licence is a consideration	Riversimple
Technology	Design	YES	1/1/22	Test methods & procedures	Automotive	TBC	Technology Licence is a consideration	Riversimple
Technology	Tech Know-How & Trade Secret	YES	1/1/22	Simulation model development	Automotive	TBC	Technology Licence is a consideration	Riversimple
Design	Design	YES	1/1/22	Styling	Automotive	TBC	Technology Licence is a consideration	Riversimple
Design	Design	YES	1/1/22	Monocoque design	Automotive	TBC	Technology Licence is a consideration	Riversimple
Design	Tech Know-How & Trade Secret	YES	1/1/22	Wheel motors & regen braking	Automotive	TBC	Technology Licence is a consideration	Riversimple
Software	Copyright & Design	YES	1/1/22	Axle Guardian	Automotive	TBC	Technology Licence is a consideration	Riversimple
Software	Copyright & Design	YES	1/1/22	HV Controller	Automotive	TBC	Technology Licence is a	Riversimple

Type of Exploitable Foreground ⁹	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application ¹⁰	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
							<i>consideration</i>	
<i>Software</i>	<i>Copyright & Design</i>	<i>YES</i>	<i>1/1/22</i>	<i>Body Controller</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Software</i>	<i>Copyright & Design</i>	<i>YES</i>	<i>1/1/22</i>	<i>Telemetry System (STU)</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Technology</i>	<i>Copyright</i>	<i>YES</i>	<i>1/1/22</i>	<i>Manuals (User)</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Technology</i>	<i>Copyright</i>	<i>YES</i>	<i>1/1/22</i>	<i>Manuals (Emergency Responder)</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Engineering</i>	<i>Trade Secret</i>	<i>YES</i>	<i>1/1/22</i>	<i>Product Manufacture - methods, process, parameters</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Engineering</i>	<i>Trade Secret</i>	<i>YES</i>	<i>1/1/22</i>	<i>Product Manufacture - assembly, maintenance</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Business</i>	<i>Trade Secret</i>	<i>YES</i>	<i>1/1/22</i>	<i>Supplier Relationships & Agreements</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>

Type of Exploitable Foreground ⁹	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application ¹⁰	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
<i>Business</i>	<i>Trade Secret</i>	YES	1/1/22	<i>Supplier Database</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Engineering</i>	<i>Copyright</i>	YES	1/1/22	<i>Quality - RMS Documentation</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Engineering</i>	<i>Design</i>	YES	1/1/22	<i>Configuration files</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Engineering</i>	<i>Design</i>	YES	1/1/22	<i>I/O Box</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Software</i>	<i>Design</i>	YES	1/1/22	<i>Fuel Cell Cooling</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>Engineering</i>	<i>Design</i>	YES	1/1/22	<i>In wheel motors</i>	<i>Automotive</i>	<i>TBC</i>	<i>Technology Licence is a consideration</i>	<i>Riversimple</i>
<i>General advancement of knowledge</i>	<i>climatic controlled test bench for Fuel-cell powertrain tests allows testing under</i>	No		<i>climatic controlled test bench for Fuell-cell powertrains</i>	1. <i>Manu- facturing</i> 2. <i>Professional, scientific and technical activities</i>	2019	no	<i>Owner: DLR institute of networked energy</i>

Type of Exploitable Foreground ⁹	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application ¹⁰	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
	<i>environmental climatic conditions and copes with the risk of a hydrogen enriched atmosphere a closed chamber</i>							
<i>Engineering</i>	<i>Concept for coupling fuel cell system and battery in an FCEV</i>	<i>yes</i>	<i>n/a</i>	<i>concept development and knowhow</i>	<i>automotive</i>	<i>2019/2020</i>	<i>licences</i>	<i>JHS, PLANET, UBHAM</i>
<i>Software</i>	<i>MPC for FCEV control</i>	<i>yes</i>	<i>n/a</i>	<i>licensing</i>	<i>Automotive, energy storage</i>	<i>2019/2021</i>	<i>licenses</i>	<i>UBHAM</i>
<i>Concept</i>	<i>Balancing multi-power source systems</i>	<i>yes</i>	<i>2021</i>	<i>concept of power balancing in a multi-input/multi-output power system</i>	<i>Automotive, energy storage</i>	<i>2019/2021</i>	<i>patent pending</i>	<i>UBHAM</i>

In addition to the table, please provide a text to explain the exploitable foreground, in particular:

- Its purpose
- How the foreground might be exploited, when and by whom
- IPR exploitable measures taken or intended
- Further research necessary, if any
- Potential/expected impact (quantify where possible)

4.3 Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

A General Information <i>(completed automatically when Grant Agreement number is entered.</i>	
Grant Agreement Number:	303485
Title of Project:	SWARM
Name and Title of Coordinator:	Ben Madden
B Ethics	
1. Did your project undergo an Ethics Review (and/or Screening)?	<i>No</i>
<ul style="list-style-type: none"> If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? <p>Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 'Work Progress and Achievements'</p>	
2. Please indicate whether your project involved any of the following issues (tick box) :	<i>No</i>
RESEARCH ON HUMANS	
• Did the project involve children?	NO
• Did the project involve patients?	NO
• Did the project involve persons not able to give consent?	NO
• Did the project involve adult healthy volunteers?	NO
• Did the project involve Human genetic material?	NO
• Did the project involve Human biological samples?	NO
• Did the project involve Human data collection?	NO
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	NO
• Did the project involve Human Foetal Tissue / Cells?	NO
• Did the project involve Human Embryonic Stem Cells (hESCs)?	NO
• Did the project on human Embryonic Stem Cells involve cells in culture?	NO
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	NO
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	NO
• Did the project involve tracking the location or observation of people?	NO
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	NO
• Were those animals transgenic small laboratory animals?	NO
• Were those animals transgenic farm animals?	NO
• Were those animals cloned farm animals?	NO

• Were those animals non-human primates?	NO	
RESEARCH INVOLVING DEVELOPING COUNTRIES		
• Did the project involve the use of local resources (genetic, animal, plant etc)?	NO	
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	NO	
DUAL USE		
• Research having direct military use	No	
• Research having the potential for terrorist abuse	NO	
C Workforce Statistics		
3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).		
Type of Position	Number of Women	Number of Men
Scientific Coordinator	0	6
Work package leaders	3	2
Experienced researchers (i.e. PhD holders)	3	13
PhD Students	0	6
Other	8	18
4. How many additional researchers (in companies and universities) were recruited specifically for this project?	9	
Of which, indicate the number of men:	9	

D Gender Aspects

5.	Did you carry out specific Gender Equality Actions under the project?		No
6.	Which of the following actions did you carry out and how effective were they?		
		Not at all effective	Very effective
<input type="checkbox"/>	Design and implement an equal opportunity policy	<input type="radio"/>	<input type="radio"/>
<input type="checkbox"/>	Set targets to achieve a gender balance in the workforce	<input type="radio"/>	<input type="radio"/>
<input type="checkbox"/>	Organise conferences and workshops on gender	<input type="radio"/>	<input type="radio"/>
<input type="checkbox"/>	Actions to improve work-life balance	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	Other:	Each organisation followed its own policies on this topic.	
7.	Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?		
	<input type="radio"/>		
	<input checked="" type="radio"/> No		

E Synergies with Science Education

8.	Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?		
	<input checked="" type="radio"/> Yes- please specify	Research activities conducted by PhD students, reach-out events organised with schools	
	<input type="radio"/> No		
9.	Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?		
	<input checked="" type="radio"/> Yes- please specify (website, explanatory booklets)		
	<input type="radio"/> No		

F Interdisciplinarity

10.	Which disciplines (see list below) are involved in your project?		
	<input checked="" type="radio"/> Main discipline ¹¹ : Other engineering sciences		
	<input type="radio"/> Associated discipline ¹¹ :	<input type="radio"/>	Associated discipline ¹¹ :

G Engaging with Civil society and policy makers

11a	Did your project engage with societal actors beyond the research community? (if 'No', go to Question 14)	<input checked="" type="radio"/>	<input type="radio"/>	Yes	No
11b	If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?				
	<input type="radio"/> No				
	<input type="radio"/> Yes- in determining what research should be performed				
	<input checked="" type="radio"/> Yes - in implementing the research				
	<input checked="" type="radio"/> Yes, in communicating /disseminating / using the results of the project				

¹¹ Insert number from list below (Frascati Manual).

11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?		<input checked="" type="radio"/>	Yes
		<input type="radio"/>	No
12. Did you engage with government / public bodies or policy makers (including international organisations)			
<input type="radio"/> No <input checked="" type="radio"/> Yes- in framing the research agenda <input checked="" type="radio"/> Yes - in implementing the research agenda <input checked="" type="radio"/> Yes, in communicating /disseminating / using the results of the project			
13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?			
<input checked="" type="radio"/> Yes – as a primary objective (please indicate areas below- multiple answers possible) <input type="radio"/> Yes – as a secondary objective (please indicate areas below - multiple answer possible) <input type="radio"/> No			
13b If Yes, in which fields?			
Agriculture	Energy	<input checked="" type="checkbox"/>	Human rights
Audiovisual and Media	Enlargement		Information Society
Budget	Enterprise		Institutional affairs
Competition	Environment	<input checked="" type="checkbox"/>	Internal Market
Consumers	External Relations		Justice, freedom and security
Culture	External Trade		Public Health
Customs	Fisheries and Maritime Affairs		Regional Policy
Development Economic and Monetary Affairs	Food Safety		Research and Innovation
Education, Training, Youth	Foreign and Security Policy		Space
Employment and Social Affairs	Fraud		Taxation
	Humanitarian aid		Transport
			X
			X

13c If Yes, at which level?		
<input checked="" type="checkbox"/>	Local / regional levels	
<input checked="" type="checkbox"/>	National level	
<input checked="" type="checkbox"/>	European level	
<input type="checkbox"/>	International level	
H Use and dissemination		
14. How many Articles were published/accepted for publication in peer-reviewed journals?		11
To how many of these is open access¹² provided?		2 (others TBC)
How many of these are published in open access journals?		
How many of these are published in open repositories?		
To how many of these is open access not provided?		
Please check all applicable reasons for not providing open access:		
<input type="checkbox"/> publisher's licensing agreement would not permit publishing in a repository		Decision from journal.
<input type="checkbox"/> no suitable repository available		
<input type="checkbox"/> no suitable open access journal available		
<input type="checkbox"/> no funds available to publish in an open access journal		
<input type="checkbox"/> lack of time and resources		
<input type="checkbox"/> lack of information on open access		
<input checked="" type="checkbox"/> other ¹³ :		
15. How many new patent applications ('priority filings') have been made? <i>("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).</i>		2
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	2
	Registered design	3
	Other	29
17. How many spin-off companies were created / are planned as a direct result of the project?		1
	<i>Indicate the approximate number of additional jobs in these companies:</i>	1
18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:		
<input checked="" type="checkbox"/> Increase in employment, or	<input checked="" type="checkbox"/>	In small & medium-sized enterprises
<input checked="" type="checkbox"/> Safeguard employment, or	<input type="checkbox"/>	In large companies
<input type="checkbox"/> Decrease in employment,	<input type="checkbox"/>	None of the above / not relevant to the project
<input type="checkbox"/> Difficult to estimate / not possible to quantify		
19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (FTE = one person working fulltime for a year) jobs:		<i>Indicate figure:</i>

¹² Open Access is defined as free of charge access for anyone via Internet.

¹³ For instance: classification for security project.

Difficult to estimate / not possible to quantify		□
I Media and Communication to the general public		
20. As part of the project, were any of the beneficiaries professionals in communication or media relations?		
○ Yes		X No
21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?		
○ Yes		X No
22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?		
X Press Release	X Coverage in specialist press	
X Media briefing	X Coverage in general (non-specialist) press	
X TV coverage / report	X Coverage in national press	
X Radio coverage / report	□ Coverage in international press	
X Brochures /posters / flyers	X Website for the general public / internet	
□ DVD /Film /Multimedia	X Event targeting general public (festival, conference, exhibition, science café)	
23 In which languages are the information products for the general public produced?		
□ Language of the coordinator	X English	
X Other language(s)		

Question F-10: Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES

- 1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]
- 1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)
- 1.3 Chemical sciences (chemistry, other allied subjects)
- 1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)
- 1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2. ENGINEERING AND TECHNOLOGY

- 2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)
- 2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]
- 2.3 Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as

geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

- 3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immuno-haematology, clinical chemistry, clinical microbiology, pathology)
- 3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)
- 3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

- 4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)
- 4.2 Veterinary medicine

5. SOCIAL SCIENCES

- 5.1 Psychology
- 5.2 Economics
- 5.3 Educational sciences (education and training and other allied subjects)
- 5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary, methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

- 6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)
- 6.2 Languages and literature (ancient and modern)
- 6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]

2. FINAL REPORT ON THE DISTRIBUTION OF THE EUROPEAN UNION FINANCIAL CONTRIBUTION

This report shall be submitted to the Commission within 30 days after receipt of the final payment of the European Union financial contribution.

Report on the distribution of the European Union financial contribution between beneficiaries

Name of beneficiary	Final amount of EU contribution per beneficiary in Euros
<i>Element Energy</i>	€ 134,499.46
<i>H2O e-mobile</i>	€ 76,307.16
<i>GESPA GmbH, Dietzenbach</i>	€ 3,535.84
<i>Air Liquide Alternative Technologies</i>	€ 1,770,497.03
<i>University of Birmingham</i>	€ 102,322.39
<i>Coventry University (+ Microcab)</i>	€ 1,059,090.11
<i>Birmingham City Council</i>	€ 7,095.03
<i>U Libre Bruxelles</i>	€ 201,183.57
<i>U Liege</i>	€ 117,727.21
<i>Jade-Hochschule Wilhelmshaven-Oldenburg</i>	€ 306,395.95
<i>NEXT ENERGY</i>	€ 99,131.77
<i>Universität Bremen</i>	€ 122,678.21
<i>TÜV Süd AG</i>	€ 21,274.17
<i>TÜV Süd PS</i>	€ 24,880.20
<i>Service public du Wallonie</i>	€ 4,043.52
<i>PLANET</i>	€ 131,078.43
<i>DFKI</i>	€ 170,678.29
<i>Riversimple</i>	€ 2,226,640.65
Total	€ 6,579,058.99