

Development of Business Cases for Fuel Cells and Hydrogen Applications for Regions and Cities

FCH Scooters





This compilation of application-specific information forms part of the study "***Development of Business Cases for Fuel Cells and Hydrogen Applications for European Regions and Cities***" commissioned by the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2 JU), N° FCH/OP/contract 180, Reference Number FCH JU 2017 D4259 .

The study aims to **support a coalition of currently more than 90 European regions and cities** in their assessment of fuel cells and hydrogen applications to support project development. Roland Berger GmbH coordinated the study work of the coalition and provided analytical support.

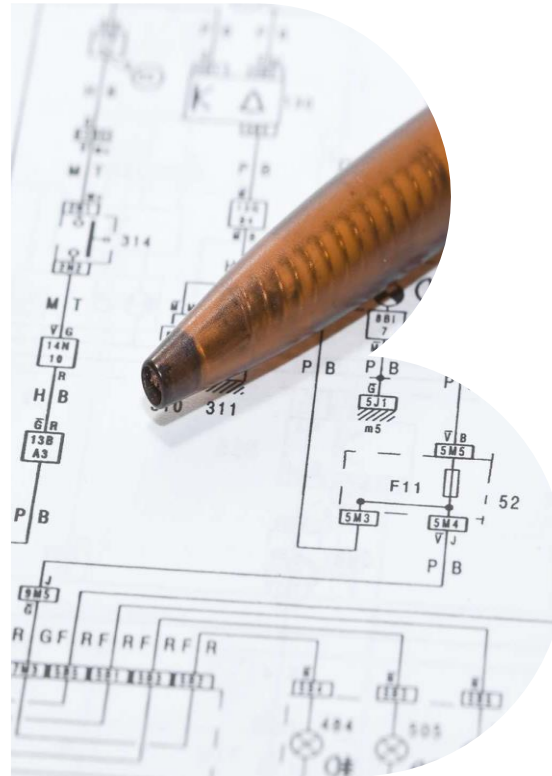
All information provided within this document **is based on publically available sources** and reflects the **state of knowledge as of August 2017**.



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A. Technology Introduction



FCH electric scooters offer a viable option for emission free and low noise mobility, especially within densely populated inner-city areas

Fuel cell electric scooters

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Brief description: Fuel cell electric scooters use compressed hydrogen gas as a fuel to generate electricity via an energy converter (fuel cell) to power an electric motor

Use cases: Cities and regions can use/promote fuel cell electric scooters for inner city services (e.g. police patrolling, postal services, deliveries, individual mobility of staff, etc.); cities and regions can establish "environmental zones" (zero-/low-emission-zones) to promote deployment

Fuel cell electric scooters¹⁾

Key components	Fuel cell stacks, hydrogen tank, electric motor
Output	3-4 kW
Top speed; range	50-70 km/h; up to 350 km (at constant 30 km/h)
Consumption	~0.23kg H ₂ /h (at rated power of 3.9 kW)
Fuel cell efficiency	~53% (at rated power of 3.9 kW)
Approximate capital cost	EUR 3,100 (APFCT)
Original equipment manufacturers	APFCT, Suzuki
Fuel cell suppliers	APFCT, Suzuki, Intelligent Energy Holding
Typical customers	Private consumers, public and private inner city services
Competing technologies	Battery EV, gasoline- or CNG-combustion

1) Mainly based on the FCH model offered by APFCT and the Suzuki Burgman

One FCH electric scooter already in pre-commercial stage, another model in advanced prototype demonstration phase





Fuel cell electric scooters

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Overall technological readiness: Fuel cell electric scooters are still in prototype phase; hybrid set-up combining battery power source with fuel cells are common; High price and lack of refuelling infrastructure as main obstacle for widespread market introduction.



Demonstration projects / deployment examples (selection)

Project	Country	Start	Scope	Project volume
Hydrogen scooter testing and verification program		2010	Phase 1: Evaluation of 30 APFCT fuel cell powered scooters in road tests conducted by Taiwan Institute of Economic Research (TIER) Phase 2: One year verification project by offering 80 APFCT fuel cell powered scooters to public, analysis and monitoring via GPS data	n.a.
HyChain Mini-Trans		2006 - 2011	Development of FC vehicle fleet in four regions in Europe (DE, E, FR, IT) to generate enough market volume for applications, e.g. fuel cell scooters	EUR 37.7 m (total project)
HySy Rider by HySyLab		2005 - 2008	FC expertise network; Development of fuel cell powered scooter (HySy Rider) as part of viability study in Piedmont region;	n.a.
European Development of a Fuel-Cell Reduced-Emission Scooter (FRESCO)		2001 - 2005	Make FC suitable for scooters & improve viability by developing a modern mass production-type scooter	EUR 3.6 m

Products / systems available (selection)

Name	OEM	Product features	Country	Since	Cost
Burgman	Suzuki	 Pre-commercial version on public roads in Japan and UK; First fuel cell scooter to earn European Whole Vehicle Type Approval (WVTA)		2010	n.a.

Zero tailpipe emissions and low noise pollution improve standard of living, especially in inner-city, densely populated areas

Fuel cell electric scooters

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Use case characteristics

Stakeholders involved



- > OEMs, fuel cell suppliers, hydrogen suppliers
- > Public and private city service providers (e.g. police force, postal / delivery services, local / regional authorities, etc.)
- > Private or fleet customers (e.g. rental companies)

Demand and user profile



- > Range, performance and refuelling process similar to conventional scooters

Deployment requirements



- > Hydrogen refuelling infrastructure, incl. production, distribution, storage and refuelling stations
- > Compliance with local road traffic regulation and associated certifications

Key other aspects



- > For some use cases (e.g. Loughborough Met Police) back-to-base refuel strategy to avoid necessity of currently not established refuelling infrastructure

Benefit potential for regions and cities

Environmental



- > Zero tailpipe emissions
- > Low noise pollution (depending on speed and road surface, close to zero)
- > Potential substitution of larger, stronger polluting vehicles like combustion engine powered cars

Social



- > Public health benefits (esp. urban areas) on residents adjacent to major inner-city routes

Economic



- > Longer lifetime compared to battery modules
- > Lower OPEX compared to battery powered scooter sharing operations

Other



- > Extended operating range and lower refuelling time

Premium price and refuelling infrastructure as well as further technical development to be addressed as critical issues

Fuel cell electric scooters

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Hot topics / critical issues / key challenges:

- > **Premium price**, high premiums to be paid by customers buying fuel cell electric scooters, especially in Europe
- > **Space limitation**, due to established scooter designs, lack of space for accommodating fuel cell system, including tanks
- > **Refinement of use cases and value proposition**, i.e. focus on scooter sharing, touristic or other scooter rental services, delivery services, etc.
- > **Hydrogen infrastructure**, location and coverage of hydrogen refuelling stations; high cost for hydrogen and its distribution/storage as hurdle for overall commercial attractiveness
- > **Technological readiness**, most models still in prototype phase; Suzukis Bergman in (pre-) commercial stage
- > **Environmental sustainability**, well-to-wheel emissions largely depend on resources used in hydrogen production

Further recommended reading:



- > Suzuki fuel cell scooter overview:
http://www.intelligent-energy.com/uploads/Suzuki_case_study.pdf
- > Hychain Minitrans Project Overview:
<http://www.ap2h2.pt/download.php?id=19>
- > FRESCO information sheet:
https://ec.europa.eu/research/energy/pdf/efchp_fuel_cell18.pdf

Key contacts in the coalition:



Please refer to working group clustering in stakeholder list on the share folder

<https://sharefolder.rolandberger.com/project/P005>

B. Preliminary Business Case



Many potential use cases for FC scooters can be identified, supported by the operational characteristics of FCH scooters

Use case characteristics

Description

- > **A variety of real-life application cases for FC-electric scooters exist:**
 - Police patrolling
 - Delivery and postal services
 - Scooter-sharing
 - Staff mobility
 - ...
- > Depending on the application case, a typical operator would deploy **~10-100 FC-electric scooters**
- > Refueling of FC-electric scooters takes place at **public refueling stations** or at **company-owned depots**
- > FC-electric scooters will be able to **enter inner-city environmental zones** and hence provide operators with a competitive edge in comparison to conventional combustion-engine scooters

Technical facts¹ & competing technologies

	FCH scooter	BE scooter
Propulsion	2.5 – 12 kW	~2.5 kW / 60V 30AH battery
Range	150 – 250 km	<100 km
Max. speed	60 – 70 km/h	50 – 60 km/h
Refuelling time	<1 minute	~4 – 8 hours

Alternative technologies include: conventional fossil-fuel powered scooters and LNG scooters

1) The technical characteristics for FCH scooters as well as BE scooters strongly vary depending on specific use case and product/prototype under consideration

Despite being in the prototyping phase, Suzuki FC scooters were the first FC vehicle to receive a mass production license

Business case and performance overview – PRELIMINARY & INDICATIVE

Technical/operational



- > FC scooters commonly display a **hybrid set-up, combining a battery power source with fuel cells** – they can be classified as FC-electric scooters
- > FC-electric scooters are still in the **prototyping phase** – however, Suzuki Burgman FC scooters were the **first FC vehicle to receive a "Whole Vehicle Type Approval" (WVTA)** in the EU
- > They display **favorable range and refueling times** compared to battery-electric scooters
- > **Challenge:** Lack of refueling infrastructure is inhibiting a widespread market introduction



Economic



- > **Higher system efficiency**, lower maintenance and operating costs are counterbalancing relatively higher CAPEX costs in comparison to conventional combustion-engine scooters
- > FC-electric scooters are zero-emission vehicles, thereby **enabling companies to operate inside environment-zones or zero-emission zones**
- > **Key business case drivers:**
 - Cost of hydrogen vs. cost of diesel
 - System CAPEX
 - Cost of infrastructure (strongly dependent on whether public refueling stations or a private depot infrastructure will be used)

Environmental



- > **Zero tailpipe (i.e. tank-to-wheel) emissions** of CO₂, pollutants such as NO_x and fine dust particles as well as significant noise reduction for FC-electric scooters – key benefit for drivers as well as outside environment
- > Well-to-wheel CO₂ emissions depend on fuel source, use case characteristics and efficiency (i.e. fuel consumption) – **potential for zero well-to-wheel emissions for FC-electric scooters with "green hydrogen"**

*) Technology Readiness Level

Public FC scooter deployments will increase awareness, thereby kick-starting commercialization

Key considerations concerning FC-electric scooters

To be validated by
demo projects



- > **Demonstration projects initiated by public authorities** will kick-start the deployment of FC-electric scooters by increasing public awareness and improving the public's perception regarding FC-electric scooters (see real life FC scooter trials "London Metropolitan Police ")
- > **Technical characteristics and resulting operating possibilities**, including range and refuelling time, exceed the potential of other competing technologies e.g. BE scooter
- > **Incurring costs, fuel supply logistics** and **proficient maintenance personnel** are among the major **hurdles** faced by operators interested in FC-electric scooters
- > **Public hydrogen infrastructure** needs to be expanded to accelerate the deployment of FC-electric scooters and improve company-internal TCO calculations
- > **Authorities place increasing importance on decarbonisation and emissions reduction** and will hence stimulate the development of zero-emission vehicles
 - The establishment of **inner-city environmental-zones** further **benefits the FC-electric scooter deployment** by offering companies using emission free vehicles (e.g. FC-powered) exclusive access to city-centers

Please do not hesitate to get in touch with us

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