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

Gen-sets

Brussels, Fall 2017

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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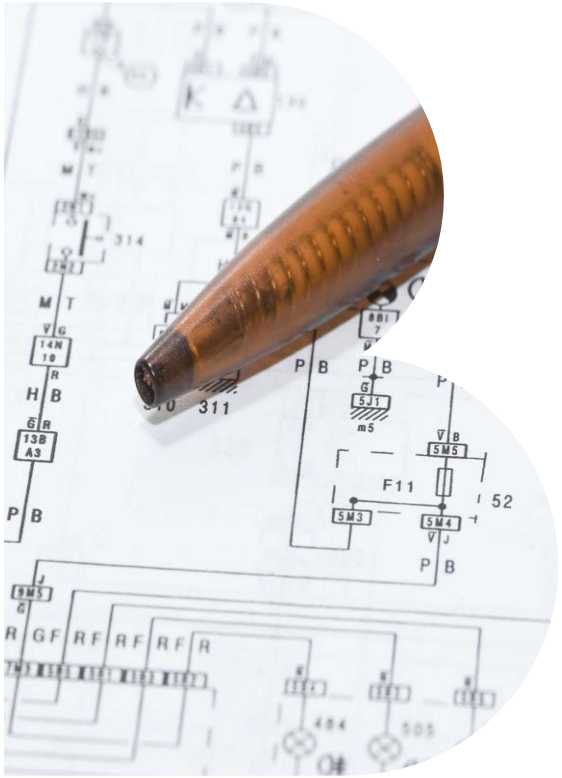

A

Low emissions and noise are among the key advantages of fuel cell powered gen-sets compared to conventional diesel systems

Fuel cell powered gen-sets

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Brief description: Fuel cell powered gen-sets are transportable stationary fuel cells that use compressed hydrogen gas to generate electricity via an energy converter (the fuel cell) to provide electricity for a wide array of potential applications that temporarily require off-grid power supply

Use cases: Fuel cell powered gen-sets can replace diesel gen-sets in any context where transportable, controllable power generation is needed (e.g. construction sites) and hydrogen can be supplied – to help reduce carbon, pollutant and noise emissions; they could be promoted e.g. in civil works tenders

Fuel cell powered gen-sets	
Key components	Fuel cell stacks, system module, hydrogen tank, battery, inverter, transport vehicle
Fuel cell technology	Proton exchange membrane (PEM)
Fuel	Hydrogen
Electrical efficiency (net)	up to 50% FC, possibly higher in the future
Output	n.a.
Approximate capital cost	n.a.
Original equipment manufacturers	BOC, Young Brothers, Plug Power, EPS
Fuel cell suppliers	Ballard Power Systems, Hydrogenics, EPS
Typical customers	Telecom providers, hospitals, construction and maintenance services companies
Competing technologies	Combustion-engine diesel generators

Source: Roland Berger

A

The wide field of application for mobile FC gen-sets ranges from construction sites to maritime on-board auxiliary power

Fuel cell powered gen-sets

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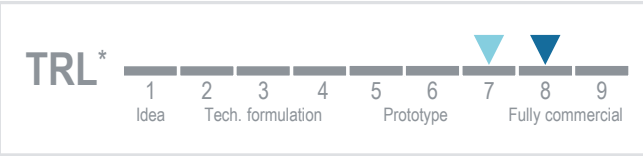
Overall technological readiness: Fuel cell gen-sets systems are commercially available in a variety of sizes, power ranges and application possibilities in non-European markets, various use cases are in commercialisation phase; in Europe, the segment is in the advanced protoype/demo phase



Demonstration projects / deployment examples (selection)

Project	Country	Start	Scope	Project volume
EVERWH2ERE		2017	FCH2 JU roject cooperates with two OEMs and a number of site operators including construction companies, festival organisers and some public authorities for the deployment (demonstration) of genset fuel cells	n.a.
Maritime Hydrogen Fuel Cell Project		2012	Field demonstration of fuel cell powered gen-sets in commercial maritime port setting of Honolulu hosted by Young Brothers Ltd. and U.S. Department of Energy (DOE), objective is to replace diesel generators in providing auxiliary power on-board of ships and to ships at berth	n.a.
TOWERPOWER demonstration project		2011	Development of low-cost fuel cell based power generator system called PowerCubeTM to replace diesel generators e.g. to power mobile communication towers	EUR 9.4 m

Products / systems available (selection)

Name	OEM	Product features	Country	Since	Cost
Ecolite-TH2	BOC	Low energy LED fuel cell powered lighting tower for construction/maintenance work, up to 750 hours runtime depending upon fuel cylinder configuration		n.a.	n.a.

*) Technology Readiness Level ▼ ≤ 5 ▼ 6-7 ▼ 8-9

Source: Roland Berger

A

Besides noise and emissions reduction, fuel cell powered gen-sets reduce the risk of diesel spillage

Fuel cell powered gen-sets

Use case characteristics

Stakeholders involved

> Users: telecom providers, public institutions, construction and maintenance services
> OEMs, fuel cells and hydrogen suppliers
> Permitting and licensing authorities

Demand and user profile

> Flexible off-grid operations in need for temporary, off-grid and controllable power supply such as lighting for construction/ maintenance work, ships in port

Deployment requirements

> Hydrogen production and delivery services
> Appropriate hydrogen storage infrastructure

Key other aspects

> Operation under all weather conditions as self-start in low temperatures possible
> Operation in residential neighborhoods as well as underground possible

Benefit potential for regions and cities

Environmental

> Zero emissions of pollutants (esp. NO_x) and greenhouse gases (esp. CO_2)
> Low noise pollution due to almost silent operation
> No risk of diesel spillage

Social

> Higher safety and decreased exposure to harmful emissions e.g. for construction workers (compared to traditional diesel generators)

Economic

> Long-term cost saving potential compared to conventional diesel generators, provided that capital cost come down and hydrogen cost decrease further

Other

> Reduction of diesel consumption and stability of power supply

Source: Roland Berger

A

Cost-efficient fuel supply concepts have to be delivered – Economies of scale can help bring down costs

Fuel cell powered gen-sets

Hot topics / critical issues / key challenges:

> Cost-efficient fuel supply concepts for delivery of hydrogen to the site of usage

> High requirements regarding purity level of hydrogen needed for fueling PEM-based gen-sets

> Need for further product availability in Europe

> Further reduction of capital cost through economies of scale necessary for large scale implementation of gen-sets (as with other stationary fuel cell)

> Lack of component standardisation within value chain (similar for a number of stationary fuel cells)

> Limited EU-wide rules and standards for hydrogen storage and transport

Further recommended reading:

> TOWERPOWER project

> FITUP project

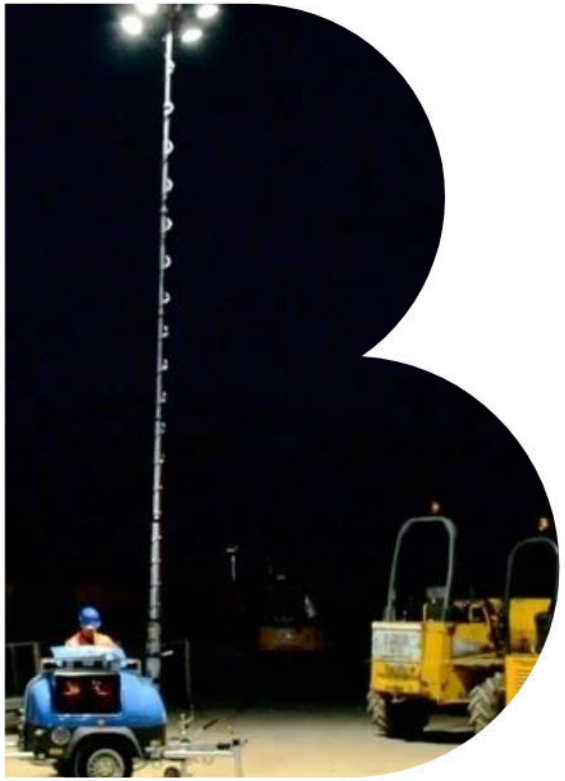
Key contacts in the coalition:

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

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

Source: Roland Berger

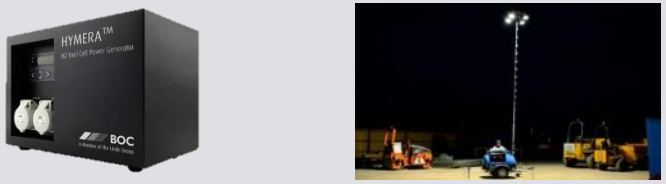
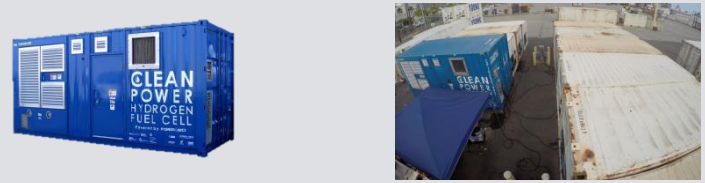
B. Preliminary Business Case



Possible application cases for FC gen-sets vary greatly, especially with respect to their energy demand

Possible use cases for FC gen-sets[1]

EXEMPLARY AND INDICATIVE

	1 Construction sites	2 Refrigerated containers
		
Description	Construction sites need to ensure sufficient energy supply to satisfy **temporary energy demands like lighting**, especially during night and winter times in **remote areas** such as constructions at highways, rail tracks or in tunnels. In contrast to diesel generators, FC generators are a **quiet and environmentally friendly** alternative	Refrigerated containers need to be supplied with **energy during all transportation phases** – during storage times as well as while being transported. FC generators fitted in a redesigned container represent an efficient solution to supply them with energy, independent from local energy supply. **One FC generator can provide power for up to ~10-12 containers**
Characteristics		
- Output	~150-175 W peak power	>100 kW
- Capacity	~6-7 kWh (assuming 50% efficiency and a standard tank)	~10-12 h runtime on one tank fill (90 kg H_2)
- Price	EUR ~2,000 – 2,500	EUR ~ 700,000 – 800,000
Competing Technologies	Diesel	Diesel

1) Additional use cases could for example include lighting towers, CCTV towers, environmental monitoring, offshore power and wildlife photography

Source: Roland Berger, BOC, Fuel Cell & Hydrogen Energy Association, Sandia National Laboratories, Fuel Cell Today

Outside of Europe, fuel cell gen-sets are already commercialised – the European market should look to catch up

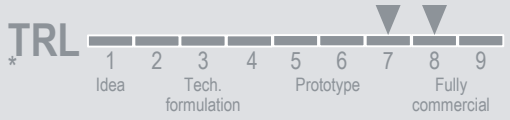
Business case and performance overview – PRELIMINARY & INDICATIVE

Technical/operational

> Fuel cell gen-set systems are **commercially available** in a variety of sizes, power ranges and application possibilities **outside of Europe**

> However, in **Europe** the segment is still in the advanced **prototyping/ demonstration-project phase**

> **Challenge:** hydrogen fuel supply and storage on-site – fit-for-purpose for transportable stationary fuel cells, e.g. hydrogen infrastructure must become available at container storage facilities



Economic

> **Higher system efficiency**, lower maintenance and operating costs have the potential of counterbalancing relatively higher capital costs of FC gen-sets vs. conventional generators

> **Key business case drivers**:
- Cost of hydrogen vs. cost of diesel
- Gen-set CAPEX vs. generator CAPEX
- Hydrogen supply and hydrogen infrastructure costs, esp. refuelling station CAPEX (incl. utilisation) and OPEX

Environmental

> **Zero tailpipe (i.e. tank-to-power) emissions** of CO_2, pollutants such as NO_X and fine dust particles for FCH gen-sets as well as significant reduction of noise and vibrations – key benefits for workers as well as outside environment

> **Lower noise emissions as key benefit for storage**, esp. if located close to urban areas

> Well-to-power CO_2 emissions depend on fuel source, use case characteristics and efficiency (i.e. fuel consumption) – **potential for zero well-to-power emissions for FCH gen-sets with "green hydrogen"**

Source: Roland Berger

To accelerate FC gen-set deployment in Europe, the hydrogen infrastructure needs to improve significantly

Key considerations concerning FC gen-sets

A 

Direct usability by Regions & Cities: due to its diverse field of application, e.g. at municipal construction sites, FC gen-set deployment can be enhanced directly by Regions & Cities, especially as demonstrational projects in order to increase technological readiness and hence foster commercial availability in Europe

B 

Hydrogen supply infrastructure: An extensive hydrogen infrastructure needs to be developed by public authorities in order to facilitate FC gen-set deployment for companies, e.g. for construction sites, event locations

C 

Capital costs: High CAPEX costs are among the major concerns faced by operators interested in deploying FC-powered gen-sets

D 

Environmental benefits: Increasing emphasize on decarbonisation and emissions reduction is accelerating the deployment of zero-emission gen-sets, supranational cap and trade policies might further stimulate the attractivity of FC gen-sets for operators

Source: Roland Berger

Please do not hesitate to get in touch with us

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Source: FCH2 JU, Roland Berger