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

Back-up power

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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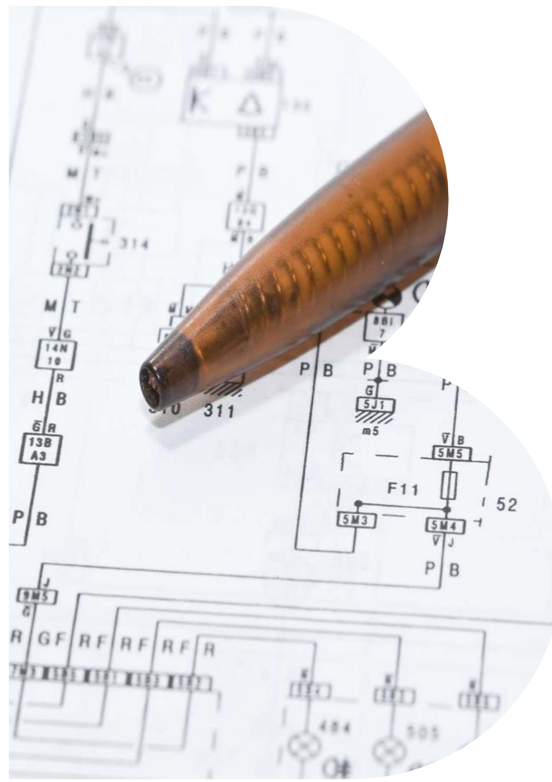
A. Technology Introduction



Fuel cell powered back-up systems have a strong value proposition by flexibly safeguarding security of supply during power failures

Fuel cell powered back-up systems

Brief description: Fuel cell powered back-up systems for uninterrupted power supply (UPS) use (typically) compressed hydrogen gas as a fuel to generate electricity via a fuel cell-based energy converter to act as bridges during prolonged power failures

Use Case: Cities and regions can promote fuel cell powered back-up electricity systems to improve reliability and quality of power supply for critical infrastructure (e.g. data centers, hospitals, public security) with a local zero-emission technology alternative, typically for bridging time of up to 72 hrs

Fuel cell powered back-up system for uninterrupted power suplpy (UPS)	
Key components	Fuel cell stacks, system module, hydrogen tank, battery (hybridised systems)
Fuel cell technology	Proton exchange membrane (PEM)
Fuel	Hydrogen
Electrical efficiency (net)	25up to 50% FC, possibly higher in the future
Output[1)]	0.2 kW_{el} – 8.8 kW_{el}
Approximate capital costs	n.a.
Original Equipment Manufacturers	Plug Power, Ballard, Proton Motor
Fuel cell suppliers	Hydrogenics, Ballard Power Systems
Typical customers	Telecom providers, hospitals, municipal emergency services, municipal utilities
Competing technologies	Batteries, combustion/diesel generators

1) Based on Plug Power portfolio

Source: Roland Berger

Even though several demo & commercial projects have confirmed the proof-of-concept, large scale deployment is still pending

Fuel cell powered back-up systems

Overall technological readiness: Various demonstration projects have shown technological maturity; high capital costs remain a barrier for widespread adoption, despite principle benefits compared to e.g. diesel-generator systems

TRL*: 1 Idea – 2 – 3 Tech. formulation – 4 – 5 – 6 Prototype – 7 – 8 – 9 Fully commercial (marker at 8)

Demonstration projects / deployment examples (selection)

Project	Country	Start	Scope	Project volume
Federal Agency for Digital Radio of Security Authorities and Organisations (BDBOS)	Germany	2012	Trial of more than 100 fuel cell back-up systems to power digital radio communication network used by German police and fire services (bridging time of up to 72 hours)	n.a.
Denmark Public Safety Network (SINE)	Denmark	2010	Installation and operation of fuel cell backup power systems at 120 radio base station sites throughout the Denmark SINE emergency service network	n.a.
Field test for portable generators, back-up and UPS power systems (FITUP)	EU	2010	Installation of 19 market-ready fuel cell systems as UPS/back-up power sources for customers in telecom and hotel industry with power levels in 1-10 kW range, demonstration of technical performance to accelerate commercialisation in Europe (coordinated by EPS)	EUR 5.3 m

Products / systems available (selection)

Name	OEM	Product features	Country	Since	Cost
GenSure	Plug Power	PEM fuel cell generator capable of delivering 150W of electrical power, hydrogen is delivered in standard steel cylinders	USA	n.a.	n.a.
Fcgen-H2PM	Ballard	Fuel cell backup power solution for outdoor operation as used for Denmark's emergency radio communication system	Canada	n.a.	n.a.

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

Source: Roland Berger

A

Due to its flexibility, FC powered back-up systems have the potential to benefit a large range of (especially energy-critical) infrastructure

Fuel cell powered back-up systems

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Use case characteristics

Stakeholders involved

- Telecom providers, datacenters as well as public institutions like schools, hospitals, prisons etc.
- Hydrogen suppliers
- Permitting and licensing authorities

Demand and user profile

- Typically critical infrastructure depending on security of electricity supply and very rapid, flexible reaction to shortages/outages in supply (e.g. data centers)

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

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 in operation
- No risk of diesel spillage

Social

- Guarantee of municipal emergency services and critical infrastructure

Economic

- Cost saving potential compared to conventional diesel generators with lower service/maintenance costs – prospectively also lower fuel costs
- No need to replace fuel as frequently (contrary to diesel generator applications)

Other

- Increased reliability to start
- Modular scalability ensures flexible adaptation according to demand

Source: Roland Berger

System standardisation and the refining of the value proposition are key topics on the industry side

Fuel cell powered back-up systems

Hot topics / critical issues / key challenges:

> Clear value proposition as pure back-up vs. hybrid or distributed generation solutions given relatively low system average interruption durations across Europe (e.g. compared to North America)

> Lack of component standardisation across stationary fuel cell industry to advance cost reduction

> Limited EU-wide rules and standards for hydrogen storage and transport in order to safeguard quality requirements

> High requirements regarding purity level of hydrogen needed for fuelling back-up system

> Further reduction of capital cost through economies of scale necessary for large scale implementation of back-up systems

Further recommended reading:

> Fuel cells in uninterruptible power supply: http://www.fuelcelltoday.com/media/1637153/using_fc_uninterruptible_power_supply.pdf

> Stationary fuel cells in distributed generation: https://www.rolandberger.com/de/Publications/pub_advancing_europe_s_energy_systems.html

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

FC back-up power systems are an attractive alternative for areas affected by insufficient grid reliability

Use case and application characteristics

INDICATIVE

Description

> Fuel cell powered back-up electricity systems **can improve the reliability, "resilience" and quality of power supply for critical infrastructure** (e.g. data centers, hospitals, public security facilities, telecommunication infrastructure) by **bridging power outages** and providing **gird-independence**

> Depending on **local regulation, grid reliability the specific use case**, back-up power needs to be available for several hours or even a few days

Technical characteristics

> Fuel cell **powered back-up systems for uninterrupted power supply** (UPS) typically use compressed hydrogen gas (or has a fuel to generate electricity via a fuel cell-based energy converter

> They can **bridge power outages for up to ca. 95 hours** (depending on the size of the fuel cell and storage of hydrogen or fuel availability)

Competing technologies

> Diesel generators, Batteries

Sources: Roland Berger, Industry publications

B

High CAPEX costs can be counterbalanced by lower operating- and maintenance costs, but need to be reduced further

Business case and performance overview – PRELIMINARY & INDICATIVE

Technical/operational

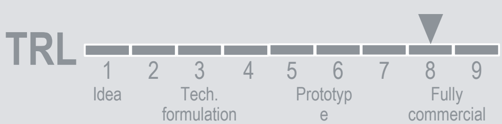
> Various **demonstration projects** have shown **technological maturity**

> Several variations and types of **FC back-up power** solutions are already **commercially available** and can be bought from multiple providers

> **Challenges:**

– High **regulatory standards** for reliability of back-up power systems (e.g. for hospitals)

– Structurally more robust power grids in Europe than in other industrialised or emerging markets, lower risk of (longer) power outages



Economic

> **FC back-up power systems demonstrate high system efficiency** and are low in maintenance- and operating costs (e.g. potentially less expensive total fuel cost, as diesel tanks typically have to be periodically refuelled irrespective of actual use)

> **High CAPEX costs** remain a big hurdle as rare but economic operational periods can't offset high upfront investment

> **Total expenditures on FC back-up power** systems are expected to be **lower** than total expenditures on battery/diesel back-ups in the medium- to long-run, under favourable conditions

> **Key business case drivers**:

– System CAPEX

– Cost of hydrogen vs. cost of diesel

Environmental

> **Zero tailpipe (i.e. tank-to-power) emissions** of CO_2, pollutants such as NO_X and fine dust particles as well as significant noise reduction for FC back-up power solutions – key benefit for residents as well as outside environment

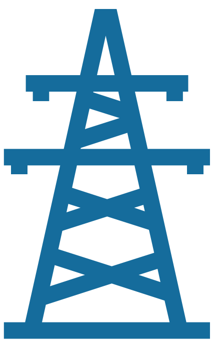
> Well-to-power CO_2 emissions depend on fuel source, use case characteristics and efficiency (i.e. fuel consumption) – **potential for zero well-to-power emissions for FC back-up power systems with "green hydrogen"**

Source: Roland Berger

B

Nevertheless, a sufficient hydrogen supply infrastructure needs to be in place in order to accelerate deployment

Key considerations concerning fuel cell back-up power systems



> **Necessary system reliability, competitive TCO (incl. reasonable capital cost) and secure fuel supply** are among the most important assessment criteria for operators wanting to adopt fuel cell back-up power

> **Relatively lower OPEX potentially offset higher CAPEX for FC back-up power** in the medium to long run, depending on the specific deployment conditions and cost reductions of FC system

> **Sufficient hydrogen supply must be ensured** since **all back-up power systems located within the same area must be refilled at the same time** (after a power outage has occurred)

> **Governmental incentives** will be **necessary to shift the highly regulated back-up power industry standard** from diesel to fuel cells

> **Authorities place increasing importance on decarbonisation and emissions reduction** and hence stimulate the development of zero-emission back-up power solutions, also in order to avoid potential oil spills; additionally, **supranational regulations** from EU-level will require CO_2 monitoring and 'cap and trade' policies might be introduced in a second step

Source: Roland Berger

Please do not hesitate to get in touch with us

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Source: FCH2 JU, Roland Berger