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On behalf of:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

Building Partnerships for a ENVIRONMENTAL PROTECTION made in Germany Sustainable Infrastructure

Factsheet series:

Fuel cells for distributed power supply

Part 2: Emergency power systems (EPS) and uninterruptible power supply (UPS)

Status: May 2021

Brief summary

Stationary fuel cell systems enable lasting and reliable energy provision on site. This climate-friendly alternative is particularly interesting for emerging and developing countries because mains power supply is to a large extent, neither stable nor available in all parts of the country. Instead of fuel cells (FC), backup generators with fossil fuels like diesel and petrol are currently used to power areas with poor grid access or to ensure uninterruptible power supply.

Using diesel causes:

- High transport costs
- High maintenance costs
- Price uncertainty
- High level of emissions (CO_2, NO_x, VOC, particulate matter and noise)
- High risk of diesel and equipment theft
- Deterioration of stored diesel and wax formation at cold temperatures

Stationary fuel cells offer:

- Alternative fuels and simplified logistics
- Relatively high efficiency
- High level of operational reliability and low maintenance costs
- Small unit size
- Zero local emissions (depending on the fuel zero CO_2 emissions)
- Low noise emission

References: [1-4]

Using fuel cells as emergency power systems (EPS) and for uninterruptible power supply (UPS)

The UN Sustainable Development Goal #7 aims ”to ensure access to affordable, reliable, sustainable and modern energy for all“. The challenge looms large and urgent: in 2018, 789 million people had no access to electricity[5], while 3.5 billion people depended on unreliable supply[6].

The diesel generator is the global standard for backup power generation[4], serving critical as well as non-critical infrastructure during temporary power cuts on the grid. As an alternative and depending on local factors, smaller petrol generators are also used[8]. By using backup generators, power supply shortages can be bridged, public life and safety maintained and economic damage averted[7]. However, substitutes for fossil fuelled gensets exist: hydrogen and fuel cell technologies open up a broad field of possible applications. When combined with renewable energies and batteries these technologies can replace diesel generators in any kind of application and in a sustainable and environmentally friendly way.

Status quo

Potential to reduce greenhouse gas emissions

Approx. 100Mt

of CO_2 are emitted by backup generators in emerging and developing countries every year[8].

Interruptions in power supply cause considerable economic damage

Estimates for selected emerging markets total up to

6.5% of GDP[9]

The market for EPS and UPS is particularly large in emerging markets.

Approx. 75%

of the 20-30m backup generator locations are emergency power systems with a total capacity of 350-500 GW[8].

40%

of the electricity demand in West Africa is provided by backup generators, in Southeast Asia the share is 2%[8].

Backup generators affect local air quality through NO_x, VOC and particulate matter

2 – 16%
of local particulate matter emissions in Indian metropolitan areas can be traced back to backup generators[10,11].

Through the use of backup generators in the immediate vicinity of homes and workplaces, people are directly exposed to emissions over a long period of time[8].

Demand for imported refined oil can create economic and political instability

40-70 billion litres
of diesel and petrol are consumed by backup generators every year[8].

Inelastic demand for fuel can cause extreme price spikes and thus impede sustainable economic development[12].

Market potential for hydrogen applications as EPS and UPS

Market outlook

- The sale of fuel cell systems as EPS/UPS outside the European market has great potential (e.g. in Southeast Asia, Africa), given that power supply is generally poorer than in industrialised countries[4, 10].
- Additionally, rising demand for electricity further increases the pressure on existing grids[10]
- Analysts expect a 6% CAGR global market growth in backup generators between 2020-2030 – also driven by emergency power systems in the output range of 7-14 kW[13].

Technical requirements

The requirements of fuel cell systems as EPS/UPS depend on site charcteristics and the local energy demand.

- Operation times can range from bridging periods of a few hours to several days, influencing the design of the system and required energy storage.
- Guaranteeing rapid response times, often in combination with restricted space availability.
- The required capacity of the fuel cell can be rather high, depending on the EPS/UPS application area: for example, hospitals may need 25 kW-1MW (and above), hotels 5 kW-150+ kW (and more).
- High reliability, particularly for use as part of critical infrastructure
- Seamless and reliable electricity supply, also following long system stand-by periods

Technical solutions

- Various fuel cell technologies such as Polymer Exchange Membrane (PEM), Direct Methanol (DMFC) and Solid Oxide Fuel Cell can be used, depending on system requirements.
- Electrolysis not only enables the full integration of renewable energies, but facilitates fully independent systems.

Transfer potential

- Generally, all weak grid locations with brownouts and blackouts are suitable for the use of fuel cell systems as EPS/UPS.
- The use of fuel cell systems as EPS/UPS is particularly interesting at locations with high rates of disruption and restricted space availability as well as for securing critical infrastructure.

Case study: EPS/UPS in Nigeria

The framework conditions create an attractive market environment

In 2019 approximately a third of the electricity production in Nigeria was provided by backup generators[14].

48 %
of electricity used in the commercial sector is supplied by backup generators[15].

86 %
of all businesses own or share a backup generator[15].

80 %
of all households with grid connection use a backup generator[16].

High costs of security of supply with backup generators

22 billion €
Is the annual cost of the fuel used for the operation of backup generators[16].

- Electricity production with backup generators is twice as expensive as electricity from the grid[16]
- The cost for PV electricity in 2025 are expected to be at the same level as grid electricity[5,15]

The fuel cell for EPS/UPS in Nigeria

- The great application potential should be explored through pilot projects.
- Coupling urban rooftop PV systems with electrolysis and fuel cells offers potentially long bridging periods and self-sufficiency
- Synergies with the progress of off-/ mini-grid development in Nigeria should be explicitly considered

Pilot projects of this kind can be funded as R&D projects under the Export Initiative Environmental Technologies

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Impressum

Publisher

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