Your Application – Our Experience

Your application requires the supply of electric energy up to 5 KW? You need an innovative, self-sufficient, reliable and beneficial solution for the current supply?

Possible applications:

- Backup power supply
- Power supply for small, mobile vehicles
- On-board power supply
- Portable power supply
- Off-grid power supply
- Your application

Your application requires still fundamental research and development? Feel free to contact us!

Our experience is in the development and testing of efficient power supply modules on the basis of direct methanol fuel cells in the kW class. For over 10 years we pursue consistently these research and development activities.

Our strength is in the use of an integrated research approach for the development of DMFC system from one source. All the scientifically and technically relevant subsystems and their interaction are taken into account. After testing the system components are analyzed. In turn, the results of these analyses reflects in the next generation of our developments.

Our works include the investigation of electro-chemical reactions at optimized electrode structures, the optimization of cell components like the membrane electrode assembly (MEA) or the flow-field and their methods of production, the characterization of MEAs, up to the stack and system development. These works are supported by physicochemical basic research.

Your Business Area – Our Development Focuses

Your business area requires new, innovative products?

Your enterprise is active in one of the given below or in similar business areas?

Business Areas:

- **Products** in the field of mobile, portable or stationary power supply up to 5 kWel
- **Services** in the field of the power supply
- **Development and production** of
  - Industrial products
  - Power electronics (DC/DC-converter; controller)
  - System components (actors, sensors)
  - Stacks
  - Bipolar plates
  - Membrane-Electrode-Assembly (MEA)
  - MEA- components (catalysts, membranes)
  - Batteries

Your enterprise has the courage for investment in innovations? Feel free to contact us! We would like to develop together with you **your application ready for the market.**

Our development activities focuses on increasing overall efficiency, power density and long-term stability of fuel cells, while simultaneously decreasing manufacturing costs in following areas:

- **MEA composition and production**
- **Electrochemical characterization**
- **Durability studies**
- **Stack-development and – production**
- **System-development and -testing**

Important flanking activities are carried out in the area of analysis in the context of research into the structure-activity relationships of functional layers and the space-resolved electro- and physiochemical characterization of fuel cell components.

Contact

Direct Methanol Fuel Cells (DMFC)
Electricity generation from methanol

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Costs of Direct Methanol Fuel Cells (DMFC)

JÜLICH
FORSCHUNGSZENTRUM

Direct Methanol Fuel Cells

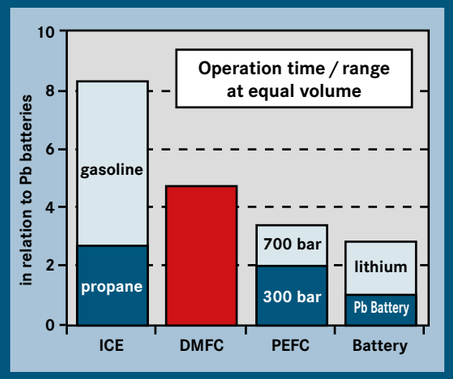
Electricity generation from methanol

Direct methanol fuel cells (DMFCs) directly convert the liquid fuel methanol into electric current. In comparison to other fuel cell systems that operate with pure hydrogen or hydrogen-rich gases from reforming processes, the fuel is supplied directly.

Apart from the high energy density of methanol, the DMFC is characterized by easy handling and trouble-free refueling.

Energy source	Energy density in MJ per liter
Methanol (liquid)	**15.9**
Hydrogen (gaseous) @ 700 bar	**4.7** (approx. 3.4 incl. Tank)
Hydrogen (gaseous) @ 350 bar	**2.7** (approx. 2 incl. Tank)

Direct methanol fuel cells are attractive for various applications, above all, however, as replacements for batteries or accumulators, since DMFC systems permit longer operating times due to the high energy density of methanol.



Advantages of a DMFC:

- Long operation times/large range
  - High energy density of methanol
  - Efficient conversion
- Fast refuelling
- Simple system setup

Competitiveness of DMFC-Systems

Initial Conditions

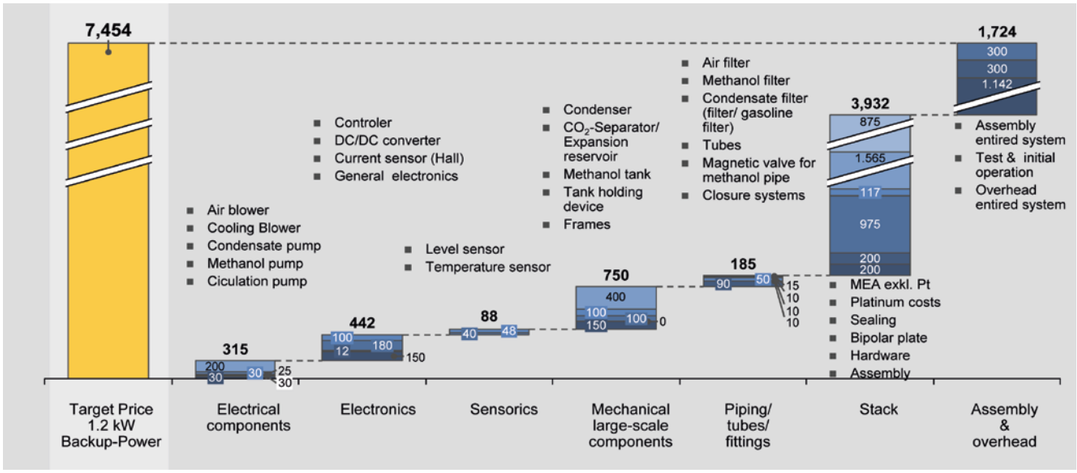
- A DMFC system in in kW range was developed by the FZJ
- More than 10,000 h operation under real load profile demonstrated
- An application of the technology as backup-power seems reasonable
- Cost competitive (compared to PEM Fuel Cell)

Operation Conditions by the Example of an UPS of 2 kW

- 2 kW electrical power
- 10 years in use - total operation time of 5,000 h
- Necessary electrical energy per year: ~1,000 kWh
- Operating time from 30 minutes (as short as possible) to 72 hours (bridging the weekend period)
- Temperature range from 5 °C to 45 °C
- Remote monitoring

1.3 kW DMFC System

Calculated Target Price DMFC-System (100 units per year): approx. 7,500 €/kW

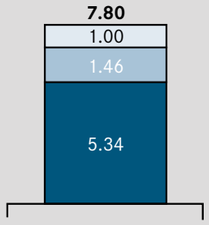


Status: 14.11.2011
Source: FZJ, ME
DMFC: Direct Methanol Fuel Cell
MEA: Membrane Electrode Assembly
Pt: Platin (interest expense and recycling costs)
UPS: Uninterruptible Power Supply

Comparison of Operating Costs for Off-grid Systems in €/kWh

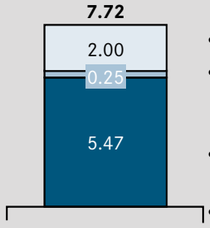
The DMFC system shows the lowest operation costs with ~4 €/kWh

PEM



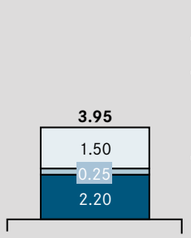
- PEM system cost ~10,000 €
- 550 € per bundle of 12 cylinders (70.5 €/kg H_2)
- Costs of bundle changing ~150 €
- 10 bundles a year

PEM with fuel processor



- PEM + fuel processor cost ~20,000 €
- Price of methanol 2.90 €/l
- Cost per delivery 100 € and 150 € for changing the fuel reservoir
- Refueling once a year for ~500 h
- Standby energy consumption

DMFC



- DMFC system cost ~15,000 €
- Price of methanol 2.90 €/l
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energy-specific costs | changing costs | plant depreciation

Competition Technologies

- Diesel-driven generator
- PEM Fuel Cell with and without fuel processor
- Li-Ionen batteries
- Pb-batteries

Competition Technologies in comparison with DMFC

- **Diesel-driven generator**
  - Higher maintenance costs
  - High emissions (noise, vibration, exhaust gas, heat)
- **PEM Fuel Cell with and without fuel processor**
  - At present not available in 1 kW class
  - High costs for H_2-connection (armature >1.000 € incl. installation)
  - High logistic expenses (H_2-transport in bottles and rental fees of bottles)
  - No re-filling of H_2-bottles on site possible
  - High additional expenses for fuel processor (investment ~10,000 € for 5 kW, time-consuming start-up procedure, standby energy consumption)
- **Li-Ionen batteries**
  - Decking of 72 kWh (90 kWh required, invest. ~45,000 €)
- **Pb-batteries**
  - Multiple backup cases not possible (due to long re-charching duration)
  - Voluminous
  - 120 kWh (@ 40 % discharge) ~12,000 €
  - High maintenance costs (durability ca. 8 years)