Highlights in the Swiss Fuel Cell R&D Programme 2004

Head: Dr. A. Hintermann

Swiss Federal Office of Energy

Report to the IEA ExCo Advanced Fuel Cells, 13. – 14. October 2004, Seoul

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International Activities in the R&D/P&D Programme 2004

- EU Hydrogen and FC Technology Platform
- Member States Mirror Group
- ERA - NET
- EU-Projects / Activities:
  - FCTESTNET
  - IP REAL SOFC (Sulzer, EMPA, HTceramix and affiliations)
  - EU SOFC summer school (Patras, Greece)
- Lucerne, internat. Fuel Cell Forum 2004 (U.Bossel)
- IEA Implementing Agreement (IA) Advanced Fuel Cells
- IEA Annexes XV – XX of the IA Advanced Fuel Cells

2005: Modelling Seminar, Stuttgart, March 3 / 4 2005

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National Activities in the R&D/P&D Programme 2004

Networking activities:

- **Modelling seminar March 2004 40 participants**
- **FC-Day Biel, November 12th 2004**
- **Visible projects (SOFC- and PEM-technology):**
  - **SULZER HEXIS**
  - **HTceramix, SOFC-stackprovider and –Hotbox (500W)**
  - **Micro-SOFC OneBat (ETH-Zürich)**
  - **PEM-PowerPac, 1 kW (PSI/ETH-Zürich)**
  - **Hydroxy 3000, 3 kW PEM**
  - **Air cooled 500W PEM and 50W PEM-demonstrator**
  - **Fuel Cell SAM (6 kW PEM)**
  - **PAC-Car (400W PEM)**
  - **Brand new 30 kW News from Paul Scherrer Institut**

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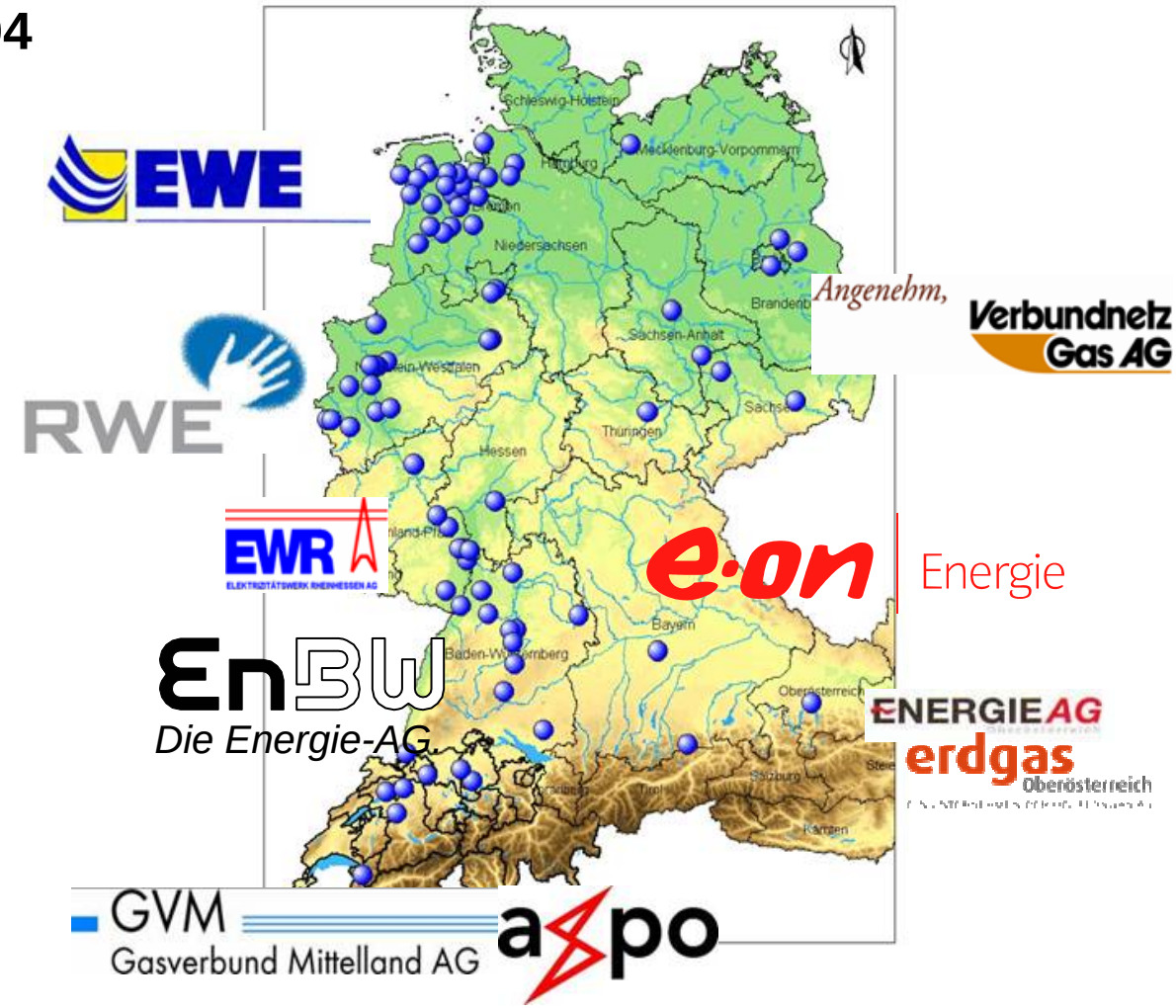
Status September 2004 (utility channel)



100 systems are in operation

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HXS1000Premiere

Weight/Volume: 350 kg/100%

- 110 systems installed and operating under real conditions
- Basis for project Galileo
- Cumulative running time > 500'000 h
- Current average stack lifetime over 4'500 h

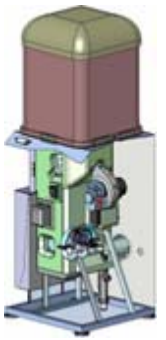
Project Galileo Mk I

223 kg/70%

30 systems in operation or under construction:

- CE-approval in Aug 04
- cum. 20'000 h lab experience
- 7 units: CH test sites
- 7 units: Industrial clients

Project Galileo Mk II



170 kg/40%

Further reduction of manufacturing costs (batch of 50):

- January 2005 initial operation

→ **Manufacturing costs below current sales price**

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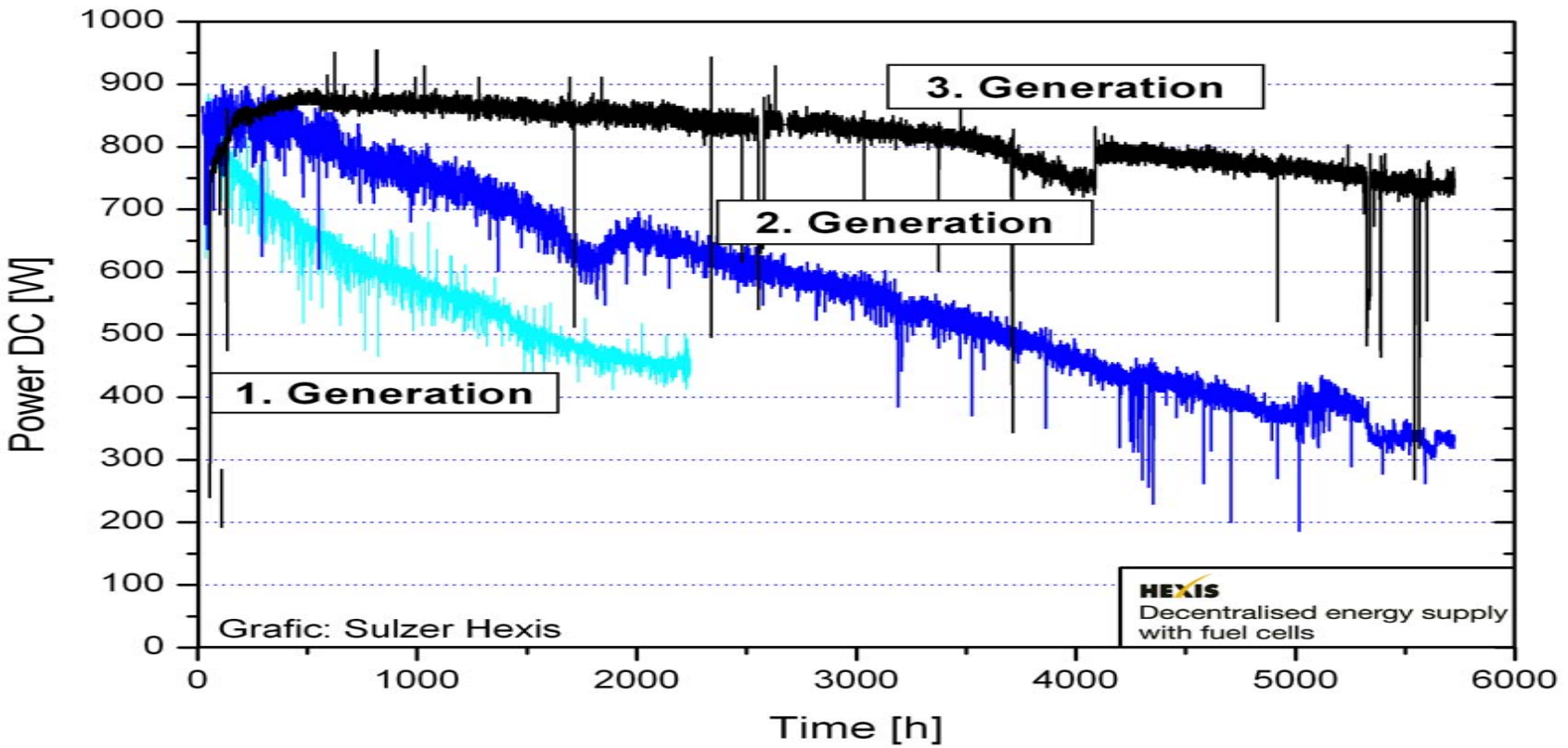


Impressive improvements regarding lifetime

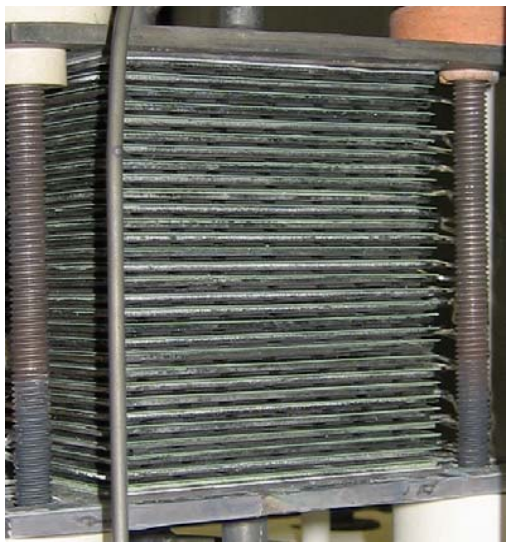
HTceramix's MISSION IS TO HELP THE SOFC INDUSTRY REACH THE THRESHOLD COST FOR MARKET PENETRATION

Within the last 4 years, HTceramix has developed a new stack based on its SOFConnex™ design. Based on scaleable manufacturing methods only, HTceramix has validated its cost projections at the level of 250 kW/yr. Stacks have the potential to achieve 330 Euro/kW at a production level of 250 MW/yr.

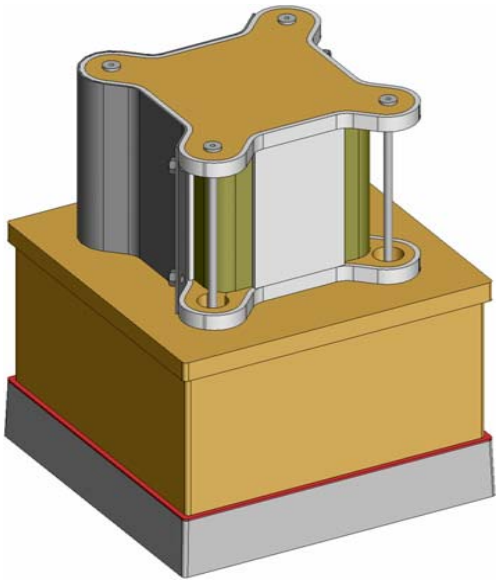
Contact:
HTceramix SA, 18, av des Sports, 1400 Yverdon-les-Bains
www.htceramix.ch **olivier.bucheli@htceramix.ch**
Tel: +41 24 426 10 83 **Fax: +41 24 426 10 82**

Technical status and next steps

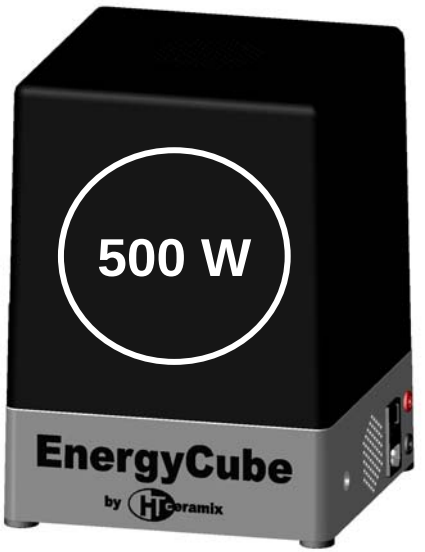
HTceramix currently provides cells and stacks (250 W) to system integration partners. HTceramix also helps other SOFC developers to solve the cathode current collection problem by its SOFConnex™ technology. In 2005, HoTbox™ and EnergyCube Demonstrators will become available.



Data 250 W stack:
0.45 W/cm^3
180 mW/cm^2
Operating T 800°C
Fuel utilisation 35%
Electrical efficiency 18%



HoTbox™:
Thermally autonomous stack
Compact, including T control
Outside T: 300°C
Approx price: 75'000 US$
Availability: May 2005

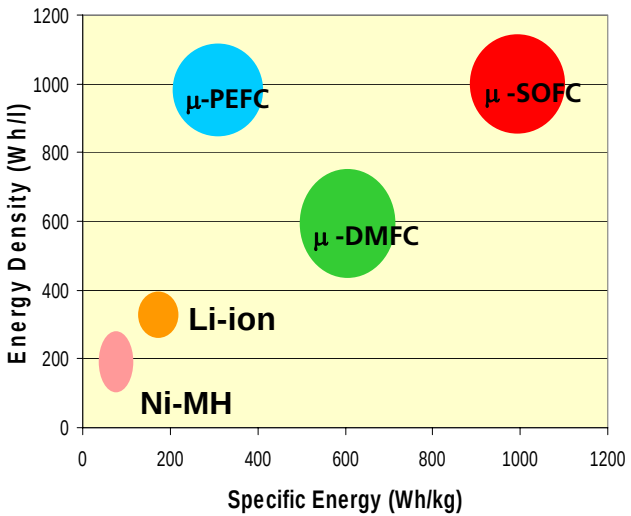


Data EnergyCube:
Electrical Power 500 W
Autonomous after start-up
233*233*522 cm
Fuel: Technical H_2
Approx price: 180'000 US$
Availability: July 2005

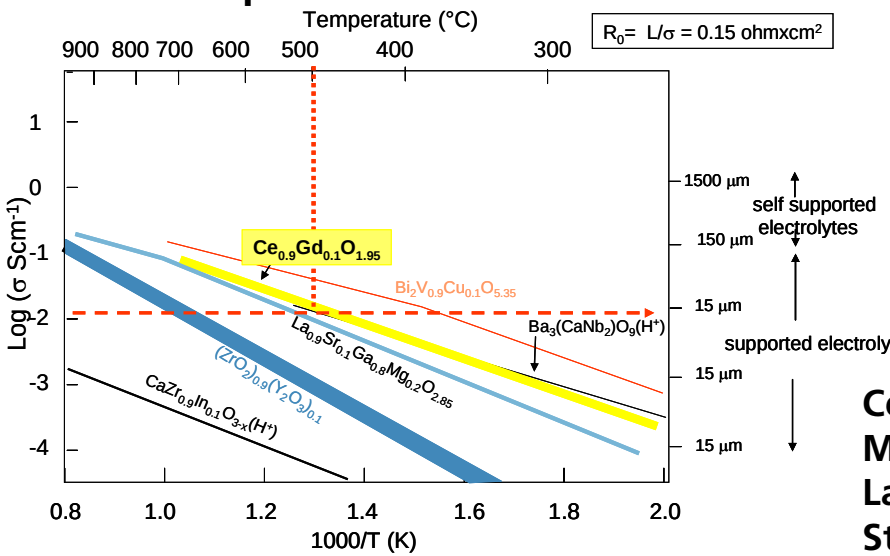
OneBat goals:

- Very high energy capacity (at least **3 times more than current batteries**)
- **Immediate charging** (using compressed gas as a fuel)
- Power network and **geographical independence**

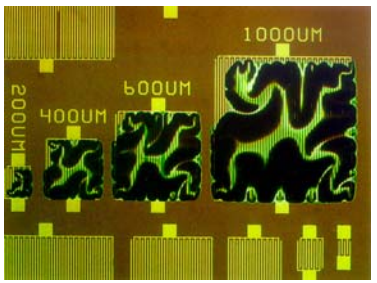
Systems Energy Densities:



Can we operate a SOFC at 500 °C ?



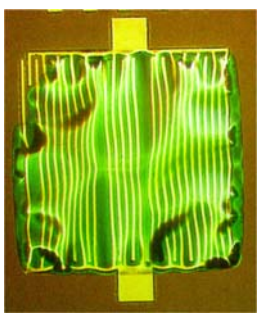
CGO Membranes with electrodes



$Ce_{0.8}Gd_{0.2}O_2$ electrolyte
Membrane thickness: 400 nm
Largest Membrane: 1 mm
Stable up to 350 °C.

- Values as announced by system developers
- μ-PEFC lays very high but metal hydride technology is not down-scalable
- All the published energy density values for μ-DMFC are significantly lower than press releases statements (e.g. "5 times longer run-time than Li-ion"…)

600 μm version



PowerPac (PSI / ETH-Zürich)

- 1 kW DC 24 V, 42 A
- Weight: 23 kg (w/o Tank)
- Volume:35 l
  (LxBxH 490x210x340 mm)
- Liquid-cooled
- DC unregulated 24 - 36 V
- Excellent dynamics,
  10 – 90% in < 50 ms
- Two button user interface
- Incl. data interface

- contacts:
- felix.buechi@psi.ch
- www.planetcapital.nl

Hydroxy 3000

- **Objectives:**
  - Test & analyse behaviour of FC systems in navigation conditions
  - Fresh water protection
  - Improve & demo technology
  - Training of students on FC systems
  - Prepare market and establish partnerships

The boat is intended for family leisure on lakes and channels. With zero emission and zero noise, the boat is a perfect means to get a maximum pleasure on motorized navigation.

Contact: HES-SO / EIVD CP /
CH 1401 Yverdon,
affolter@eivd.ch
Tel: +41 24 693 86 13
Fax: +41 24 693 86 17
http://iese.eivd.ch/hydroxy

3 kW PEMFC boat
7 passengers
11-15 km/h
7 x 2,5 m
1300 kg

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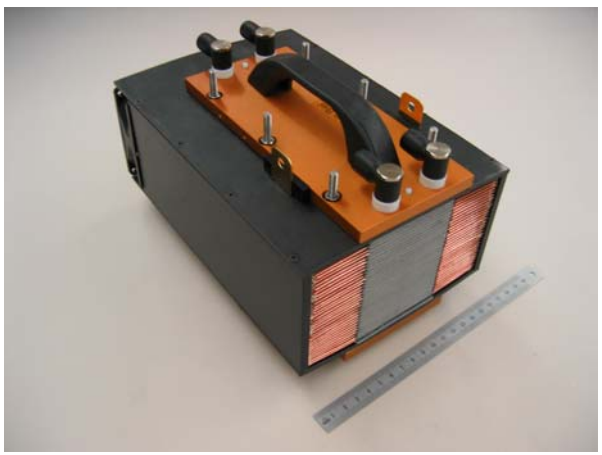
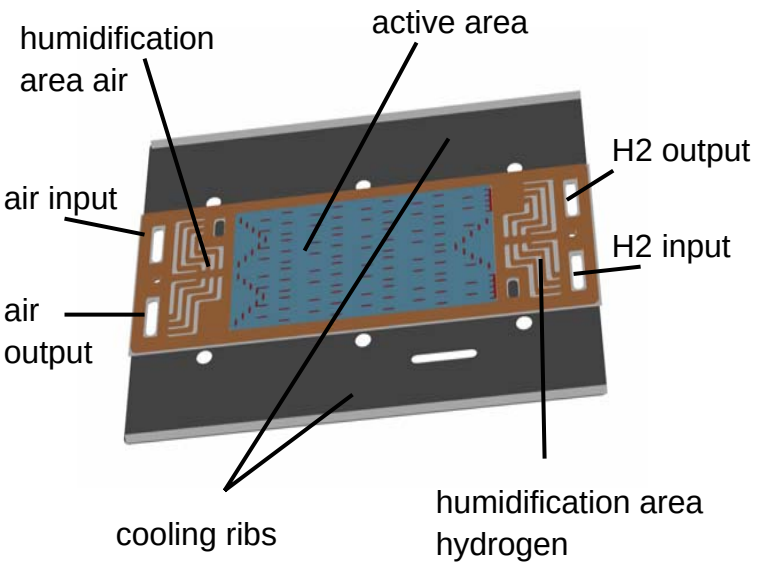
Air Cooled PEFC-Stack

- The University of Applied Sciences in Biel has developed a fuel cell stack with new cell design.
- The cell has an internal humidification of both process gases (air and hydrogen).
- Each cell has two cooling ribs for an air cooling, the fan is adapted at the stack.
- The stack has 30 cells with an active area of 60 cm^2 each.
- The dimensions of the stack are 160mm x 240mm x 150mm.
- This low pressure cell is design for 18W.





Berner Fachhochschule

Hochschule für Technik und Informatik HTI

Contact: martin.ruge@hti.bfh.ch

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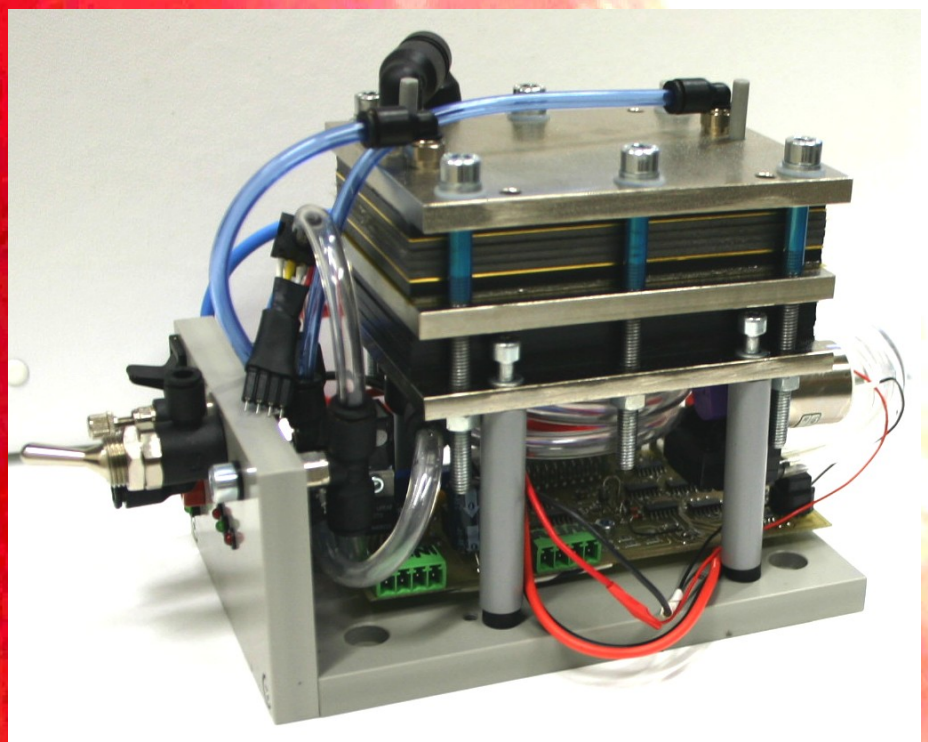
50W PEM-Demonstrator by Prof. Walther FH Biel

50W PEM Fuel Cell



Data:

- **Hydrogen/Air System, no cooling system**
- **50 W Fuel cell; 10.8V without charge**
- **DC-DC converter: 24V/30 W output**
- **Charge controlled air pump**
- **Cell monitoring electronics**
- **Price: approx. 5‘000 USD**
- **Contact: peter.walther@bfh.ch**

Project financed by SFOE

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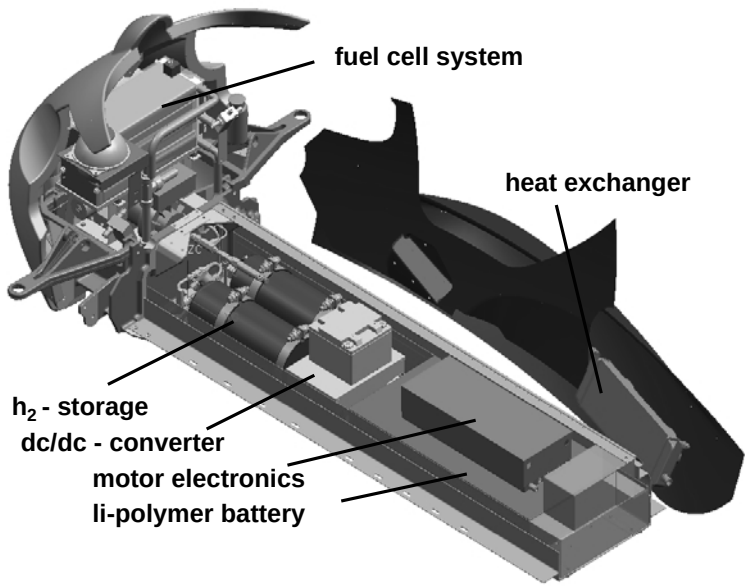
Fuel Cell SAM

- The University of Applied Sciences in Biel has developed a fuel cell – battery – hybrid system and integrated the system in a electric vehicle called SAM.
- Hybridvehicule with 6kW PEM fuel cell system and lithium ionen polymer batteries, supplies total power of 15kW.
- Two metalhydride cylinders stores 400g of hydrogen, which allows a range of the vehicle of 200 km.



- The vehicle has been developed for local traffic in the cities.
- SAM reaches a maximal speed of 85 km/h and offers two seats.

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PacCar of ETH-Zürich/PSI at Shell Eco-marathon

Data:

Owner: ETH Zürich / PSI

Seat: 1

Weight: 115 kg

Lenght: 2.8 m

Engine: 400W PEM Fuel Cell

Energy: hydrogen

Storage: Metal hydride (HERA)

Consumption:

- 15 g hydrogen/100 km
- 0.059 l gasoline/100 km

Top speed: < 40 km/h

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Paul Scherrer Institut, January 16th 2002: Test Drive across the Simplon Pass

Power: 27 kW Fuel Cell net,
50 kW Supercap (for 15 sec)

Top Speed: 115 km/h

Acceleration: 0 – 80 km/h: 15 sec

Fuel Consumption: NEDC

- Excl. Purging: 6.2 l gas equiv/100 km
- Extrapolation: 5.2 l gas equiv/100 km

- Curb wight 1922 kg
- FC system 496 kg
- SC module 168 kg
- EM System 301 kg

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Paul Scherrer Institut, October 13th 2004: HY-LIGHT at Challenge Bibendum in Shanghai

Power: 30 kW Fuel Cell Stack, based on H_2 and O_2
32 - 45 kW Supercaps (for 17 sec)

Top Speed:	130 km/h
Acceleration:	0 – 100 km/h: < 12 sec
Range:	400 km (at 80 km/h)
Fuel Consumption:	< 25 kWh/100 km compr. H_2
Curb weight	850 kg

HY-LIGHT, a purpose designed vehicle

Project partners:

- Michelin
- Paul Scherer Institute

Contact: D. Laurent or Ph. Dietrich, PSI

- Electrical damping and steering
- Advanced wheel motors in front wheels
- Hydrogen storage integrated in the car structure

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