ISH2SUP
(245294)

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Project & partnership

In situ H2 supply technology for micro fuel cells

Duration: 2010-2012

Budget: 1.7 M€

Funding: European Commission FCH JU, Partners

Partners: Aalto University (FI), CEA (FR), Hydrocell (FI), myFC(SE)

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Motivation

- Market pull for mobile and portable fuel cell based power sources
  - Power gap of many mobile electronics devices, like laptops, smart phones, cameras, etc. in spite of improvements in Li-technology.
  - Light mobile power for outdoor activities
  - Emerging markets with poor availabilty of grid or no grid especially in developing countries
- Most of the existing products and on-going developments are based on PEM technology, either DMFC or H2-PEM
- H2-PEM would be preferred over DMFC provided hydrogen would be easily, safely and sufficiently available in situ.

-> There is a need of easy to use and logistically feasible fueling technologies to make hydrogen really mobile.

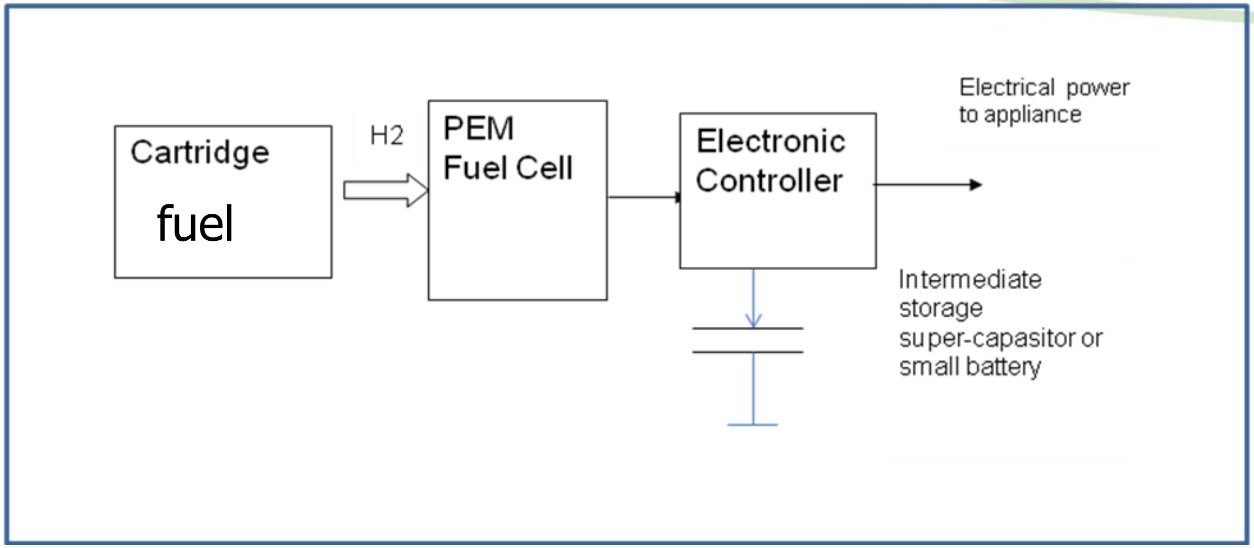
Goals

- Development of controllable new type of hydrogen production units (called fuel cartridges), which utilize sodium borohydride ($NaBH_4$) or methanol as the primary fuel .
- Integration of the fuel cartridge and a micro fuel cell unit
- Prove feasibility of the concepts taking into account the safety regulations
- Test case applications

  - 5 W mobile hand-held phone charger of 5 h operation time (per one cartridge)

  -10 W portable power source (use extender) for Laptop non-grid usage
- Envisioned application area: fuelling devices providing hydrogen gas in-situ and on-demand to a fuel cell power unit acting as a charger/use extender for laptops, smart phones, internet cameras etc in non-grid environments.

Main principle



ISH2SUP- concept: a micro hybride power system for non-grid environment

Approaches

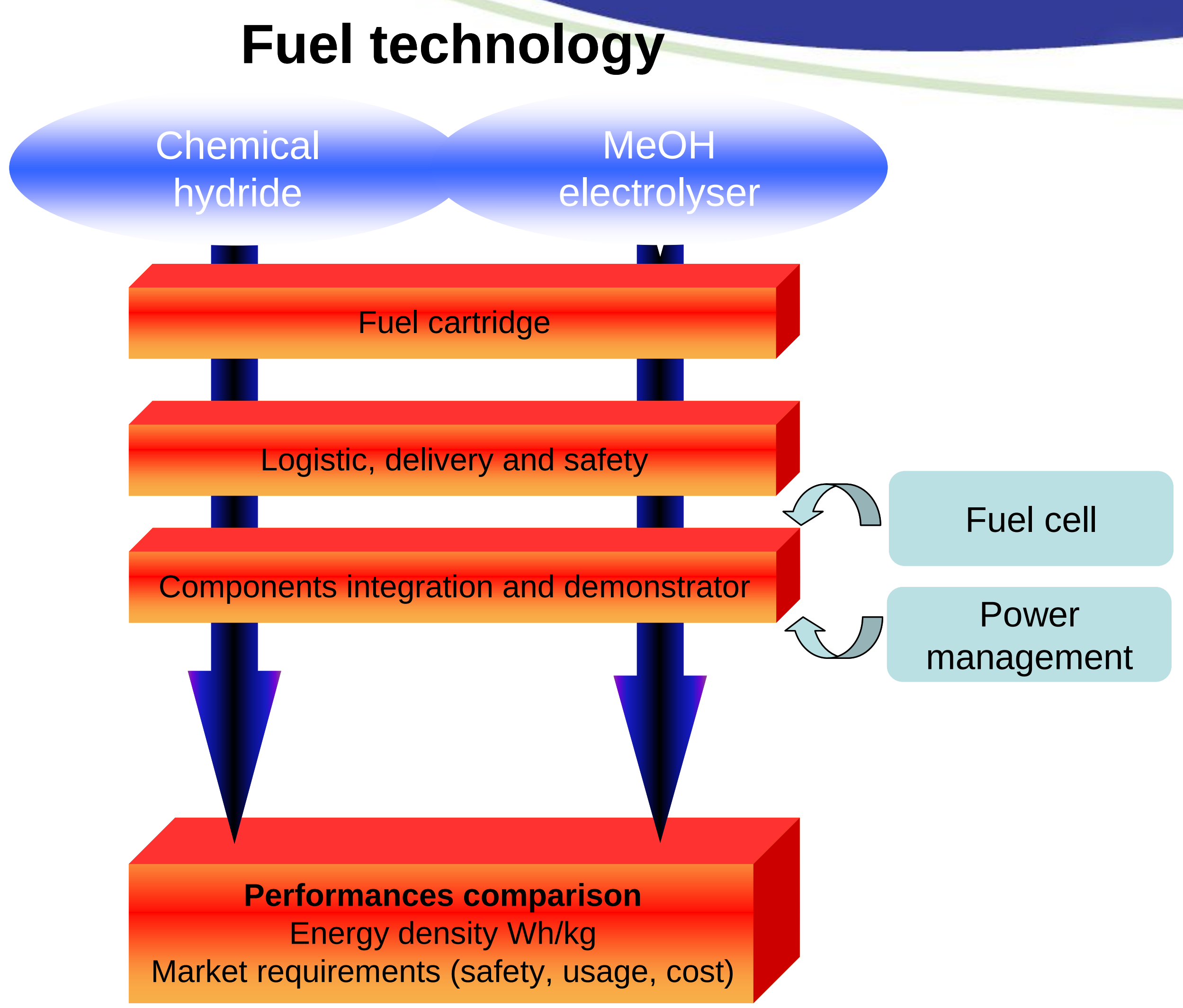
- The targeted power range is 5 – 20 W. In this range there are many electronic appliances for mobile use, like phones, laptops, cameras, etc
- In many of the applications the fuelling cartridge is intended to be used in the connection with a use extender rather than with a battery charger, which means that the power needed is lower than the device’s charger power.

Two principles:

- Production of hydrogen gas from a primary fuel
  - Methanol
  - Sodium borohydride
- Conversion of the generated hydrogen to electricity by a micro PEM fuel cell

  - in the case of methanol conversion the energy needed (0,7-1Wh/lH2) is provided by the fuell cell making the reformation autonomous.

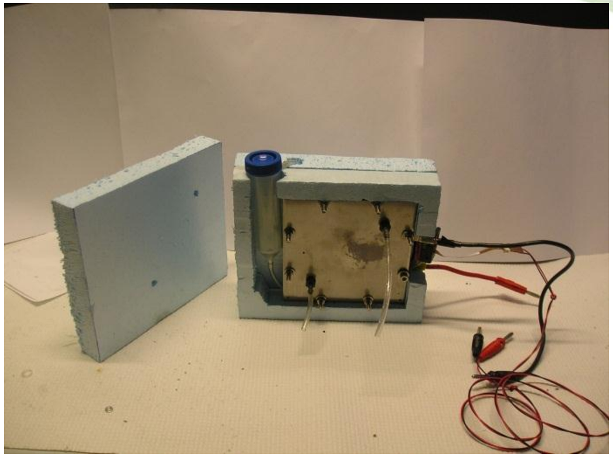
Overall approach

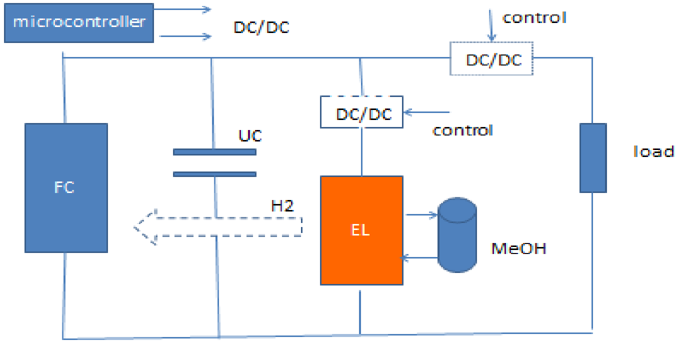


Acomplishements vs State of the Art

- Portable fuel cell power sources for electronics have been developed actively during last 10-15 years.
- Most of the developments are based on DMFC technology. Only few commercial success this far, however.
- Use of H2-PEM technology is limited because of limited hydrogen portability.
- ISH2SUP-project is targeted to improve this situation by developing and testing two less studied technologies to generate hydrogen in-situ from hydrogen rich sources in low temperature.

Electrolyser





Electrical schema of the electrolyser cartridge

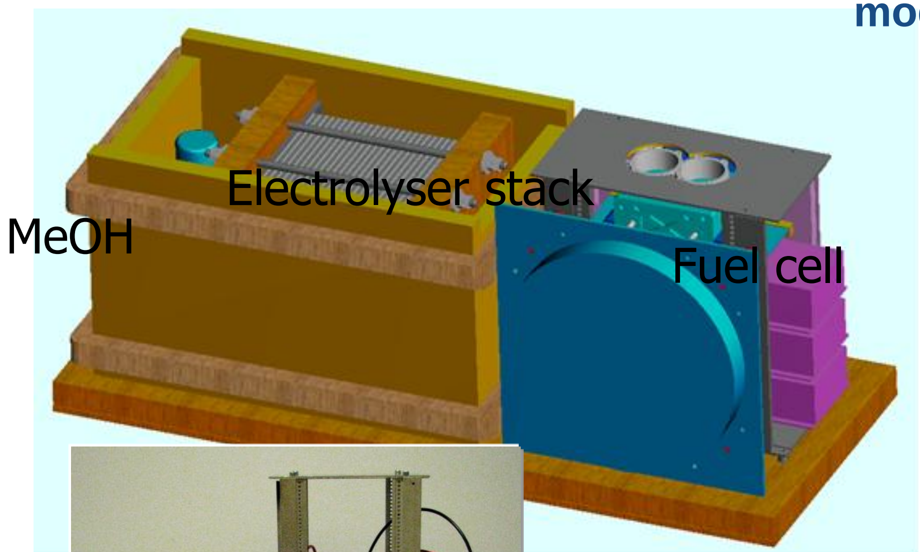
- Releasing hydrogen from MeOH in water solution needs only 0.7-1 Wh/l H2 electrolysis energy (Pt catalyst, 0.35-0.45 V)
- When burning in a PEM cell the released hydrogen can compensate the needed electrolysis energy + provide additional energy for application.
- In optimal conditions up to 50% of the fuel cell output can be directed to the application load.
- Electrolysis can be run in higher MeOH concentrations (tested up to 32%) than what can be used in DMFC without risk of CO poisoning.

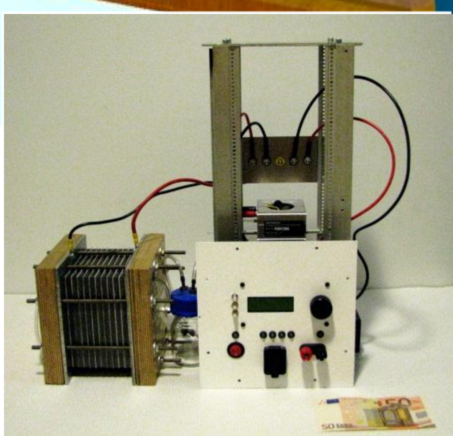
$NaBH_4$ cartridge

Designation	Range	Remarks
Functioning pressure drop (mbar)	50 - 600	-
Hydrogen flow(ml/min)	0 - 90	-
Energy (Wh)	23	Depending on fuel cell yield
Time to start (min)	< 1	For 5˚C< T < 45 ˚C
Hydrogen volume (l)	17	Measured at 20 ˚C
Cartridge Weight (g)	120	-
Cartridge Volume (ml)	110	-
Ranging temperature (˚C)	5-40	-
Storage temperature (˚C)	> 1	-
Time life before activation (year)	2	-

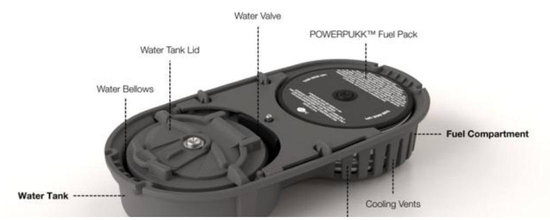
Prototypes

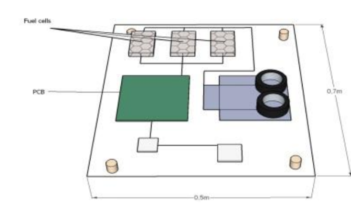
10 W electrolyser based power unit is made from scratch. Output 12 V





NaBH4 based 5 W charger is done by modifying an existing product of MyFC





Aligment to MAIP/AIP

- ISH2SUP –project belongs to “Early Market” Application area
- Project concrete goals are set to demonstrate and evaluate possible product prototypes already during the project time.
- The companies involved are interested to integrate the results in their products or develop a new product. Other interested companies are welcome to discuss about utilization of the results.
- Any products ready to markets cannot, however, be reached during the project. The earliest time to enter to markets is year 2014.

Expected results

- Prototype 25 Wh $NaBH_4$-cartridge for a mobile phone 5W charger (CEA, MyFC). Energy density (electrical) about 208 Wh/kg (LiFePO4 battery 110-120 Wh/kg).

- Electrolyser -fuel cell system prototype for a non-grid long term power source for 10 W devices e.g a laptop (Aalto, Hydrocell). Wh/kg density of the system depends on the fuel tank size. 200 ml 32% MeOH-water solution stores 320 - 400Wh/kg (electrical).

- Integrated electrolyser-PEM fuel cell stack system prototype comparable to DMFC with better Wh/ml MeOH conversion (Aalto).

- Control electronics for both of the fuelling concepts.

Cross-cutting issues

- WP4 in the project is devoted to the safety issues, regulations and standards related to the logistics and usage.
- The project include a special activity (dissemination manager) to disseminate results both scientifically and publicly to demonstrate people new possibilities to operate electronic devices in non-grid environment.
- Public information: presentations in seminars, 2 MSc thesis, 2 journal publications (under preparation), 1 patent application

Enhancing cooperation and future perspectives

Technology transfer:

- The research partners CEA and Aalto both have a national/in-house project in the same area including other partners than those participating ISH2SUP.

- Company partners myFC and Hydrocell are currently developing products which are directly connected to the RTD-work in ISH2SUP project.

- Technology transfer is regulated by the Consortium Agreement

Further perspectives

- The project is estimated to be delayed 3-4 months due to manpower shortage and some technical difficulties.
- The project DoW included a contingency plan concerning possible problems to get the enzyme catalyst work properly (with low enough energy). The plan had to be realized. Printable electrolysers are now developed using Pt catalyst to demonstrate one to use cartridge.

- Both of the concepts studied are not limited to the power range 5-20 W. Preliminary feasibility study to enlarge the area to 100 W – 1kW will be done during the project. This will open applications e.g. to portable tools, small backboard motors etc.

- Electrolysis by the aid of bio-catalyst may open up interesting possibility to produce hydrogen from different kind of bio-decomposable wastes including alcohols or sugars. The energy level around 3 W/l H2 may be obtain, which is considerable less than in water electrolysis. At the same time COD-value of the waste can be decreased. This is one way to continue the study made in the project with bio-catalyst.

Summary AIP/MAIP alingment

Expected output AIP Topic: Early Market Call: 2010	Objectives Project	Status at 100% of the project	Expected revised objectives
sodium borohydride cassette	*25 Wh*	done 100%	
MeOH electrolyser /Pt catalyst	*0,7 – 1 Wh/l H2*	done 100%	
MeOH electrolyser/entzyme catalyst	*< 1,5 Wh/l H2*	failed	Replaced with Pt catalysts to test printable one to use cassette
5 W mobile phone charger Using borohydride cassette+PEMFC	*demonstrator*	Done 60%	Not revised provided project continues
10W labtop use extender Using MeOH electrolyser+PEMFC	*demonstrator*	Done 80%	Not revised provided project continues
Integrated electrolyser-PEMFC	*demonstrator*	Done 30%	Not revised provided project continues
Control electronics/borohydride	*prototype*	Done 70%	Not revised provided project continues
Control electronics/electrolyser	*prototype*	Done 90%	Not revised provided project continues
Appliance test (demonstrators)	*Test results concerning efficiency values, usability and safety*	Done 10%	Not revised provided project continues