# ABSTRACTS

## SESSION D: EARLY MARKETS AND CROSS-CUTTING ISSUES

### 1.) In situ H2 supply technology for micro fuel cells- ISH2SUP-project

**Professor Aarne Halme**

**Aalto University School of Science and Technology**

Two novel solutions are proposed for fuelling micro fuel cells in which hydrogen is stored in a chemical form in a primary fuel and released in-situ on-demand basis. The technical implementation is a hybrid system, where the fuelling unit is combined with hydrogen PEM fuel cell providing the benefits of both the PEM and DMFC technologies. The primary fuel is stored in a disposable or recycled cartridge, which is changeable and logistically easily available. The electrical power is generated in a fuel cell utilizing gaseous hydrogen released on the demand from the cartridge. The system includes a small electrical intermediate storage (accu or super capacitor) and a control system for controlling the power release. Because the gas PEM has a higher volumetric power density its size is more compact than that of corresponding DMFC unit. Compared to metal hydride containers the liquid cartridges can store more energy in the same volume and can be made of lighter materials.

Two different technologies for producing hydrogen in-situ are considered. One is based on using NaBH as the fuel and the other on utilizing catalyzed electrolysis of methanol. The primary application area is fuel cell based power sources of portable electronic appliances (5-20W). The ISH2SUP-project concentrates to research and development of the cartridge technology and the electrical system. Development of micro-fuel cells is not included in the project but commercially available small fuel cells are used. The main practical targets are to prove the feasibility of each fuelling technology and to fulfill the RCS requirements of mobile/portable electronic appliances in consumer markets, and to scheme a logistics system for disposable or recyclable cartridges used for fuelling the proposed system.

**2.) Development of an Internal Reforming Alcohol High Temperature PEM Fuel Cell Stack (245202 FCH-JU-2008-1)**

**Presentation by Prof. J. Kallitsis**

The main objective of the project is the development of an Internal Reforming Alcohol High Temperature PEM fuel cell. Accomplishment of the project objective will be made through:

• Design and synthesis of robust polymer electrolyte membranes for HT-PEMFCs, which will be functional within the temperature range of 190-220°C.
• Development of alcohol (methanol or ethanol) reforming catalysts for the production of CO-free hydrogen in the temperature range of HT PEMFCs, i.e. at 190-220°C.
• Integration of reforming catalyst and High Temperature MEA in a compact Internal Reforming Alcohol High Temperature PEMFC (IRAFC). Integration may be achieved via different configurations as related to the position of the reforming catalyst.

The proposed compact system does away with conventional fuel processors and allows for efficient heat management, since the "waste" heat produced by the fuel cell is in-situ utilized to drive the endothermic reforming reaction. The targeted power density of the system is $0.15 W/cm^2$ at a cell voltage of 0.7V. Thus, the concepts of a catalytic reformer and of a fuel cell are combined in a single, simplified direct alcohol (e.g. methanol) High Temperature PEM fuel cell reactor. The heart of the system is the membrane electrode assembly (MEA) comprising a High-Temperature proton-conducting electrolyte sandwiched between the anodic (reforming catalyst + Pt/C) and cathodic Pt/C gas diffusion electrodes. According to the configuration and the operating conditions described above, the IRAFC is expected to be auto thermal, highly efficient and with zero CO emissions. In addition, the direct consumption of $H_2$ by the MEA (fuel cell) and the electrochemical promotion effect is expected to enhance the kinetics of reforming reactions, thus facilitating the efficient operation of the reforming catalyst at temperatures below 220°C.

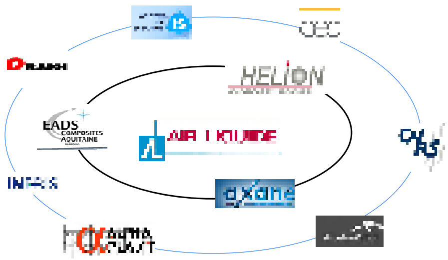
In this presentation we will focus on our attempts to develop membranes that can operate at temperatures up to 230°C and also test the methanol reformation catalysts tolerance against phosphoric acid. In the first case, new copolymers bearing side crosslinkable groups, like double bonds or carboxy groups combined with main and/or side pyridine units, have been synthesized and tested for crosslinking using different methodologies. In some cases, insoluble membranes with increased glass transition temperatures were obtained. The phosphoric acid doping ability was controlled through the control of the membrane chemical structure. In most cases the dynamic mechanical analysis of the membranes has showed, besides the Tg shift, the appearance of a plateau of the storage modulus E' denoting the effective network formation.
Selected crosslinked membranes have been used for MEA construction and testing. Single cell testing of these MEAs has shown that these materials can operate at temperatures up to 230°C. The MEA's performance at high temperature as a function of time was also tested and showed considerable improvement compared to the lower temperature operation.
On the other hand, the tolerance of the methanol reforming catalysts operating at temperatures between 200-240°C has been tested in order to explore their compatibility with the phosphoric acid imbibed membrane based MEAs. Different catalysts have been considered and tested. Finally the single cell and stack design was considered in order to find the best configuration that is more efficient for the studied case.

## 3.) Early-Markets

**Marianne Julien, Program Director: Horizon Hydrogène Energie (H2E)**

Early hydrogen energy markets offer opportunities to optimize and reduce the cost of technologies, introduce codes and norms adapted to the use of hydrogen in small quantities and raise public acceptance of the use of hydrogen outside industrial fences.

These markets offer a natural path towards the transportation markets for players such as Air Liquide and its 19 partners, willing to build know-how and be ready for a wider use of hydrogen and hydrogen fuel cells.




Around this vision, 19 French partners have built the H2E Program in order to leverage their competences and build competitive offers to early customers as soon as 2012. Partners are industrial companies, technology associations and academic research centers.

This 7-year ambitious Program has a total budget of 190 M€ financed by the industrial partners (65%) and by OSEO Innovation (35%). More than 200 experts are directly contributing to seven work packages of the Program.

To develop the appropriate offers, we carry out simultaneously challenging commercial and technical roadmaps and make sure experiences gained with our early customers is fed back into our product & service specifications. Combining a H2 logistics capability and the design and maintenance of hydrogen Energy Systems (HyES) built on state-of-the-art fuel cells, we can fulfill early customers' needs for on-site & mobile electricity production. Either in places or at times where electricity from the grid is not available as an alternative to diesel generators (stationary), or for vehicles such as forklifts when electrical batteries do not provide the autonomy required (mobile).


Our market studies for Europe show great potential for the substitution of existing technologies through fuel cell solutions. Leverages to lead customers to take the decision to move from existing technologies are:

- complete the design of integrated systems (fuel cell + H2 storage + electricity storage) that meet the functional and ergonomic requirements of their activity
- reduce the total cost of ownership of the solutions
- build consensus among stakeholders for the safe and economically sound deployment of hydrogen-based solutions. Energy policies acknowledging the potential of hydrogen as an energy vector, regulations and norms and purchase incentives are key ingredients for the development of hydrogen fuel cell early markets.

Early markets offer opportunities to anticipate some of the breakthrough innovations required for the wider use of hydrogen in our energy infrastructure, especially for transportation. Breakthroughs are required in many domains: product design, manufacturing, regulation and standards, and new financing and incentive schemes, absolutely required to allow real customers to be part of the innovation process.

**4.) The Joint Research Centre's contribution to cross-cutting activities of the FCH-JU**

**M. Steen, G. Tsotridis, P. Moretto**

The presentation outlines how JRC contributes to the horizontal, cross-cutting activities of the FCH-JU under the Framework Agreement between both parties. The scope of the pre-normative activities undertaken by JRC, its involvement in European and international standardisation and regulatory activities and its efforts on dissemination, education and training are presented through a number of examples.

**5.) Riversimple's city car concept**

**Hugo Spowers, CEO, Riversimple**

Riversimple's vehicle technology has been developed using whole system design, optimising the system rather than the elements of the system. The technology demonstrator, launched in June 2009, is a highly efficient two seat vehicle powered by hydrogen fuel cells and has a body made of lightweight composites. Capable of 300mpg (energy equivalent) it can travel 240 miles on one tank of hydrogen. Its well-to-wheel emissions are only 31g$CO_2$/km using hydrogen from natural gas.

However, optimising vehicle efficiency is just part of Riversimple's story. The company has extended the whole system approach to the design of the entire business model. Hugo's presentation will explain this novel approach to vehicle commercialisation which has been developed with the business challenges of the 21$^{st}$ century in mind. He believes this strategy will enable Riversimple to: better address the needs of customers, increase affordability of adopting low carbon technology, decrease reliance on government funding for infrastructure, incentivise vehicle longevity, create fulfilling jobs on a local scale and minimise the impact that personal transport has on the environment.