



16th WHEC DAILY REPORT

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Transportation fuels: the bumpy road to hydrogen

Professor Dan Sperling of UC Davis characterized the history of alternative transportation fuels as a history of failure. The future will be different. With the trend towards exploitation of carbon-intensive, unconventional fossil energy such as tar sands, the urgency of transitioning to clean alternative fuels is intensifying. Hydrogen could be different from previous failures. First, unlike all others, many auto makers are champions of hydrogen and fuel cells. Auto makers are skeptical of battery development but are convinced that fuel cells will be competitive shortly. They see fuel cell electric vehicles fitting perfectly with the evolution of vehicles away from mechanical and hydraulic systems, capable of offering new on-board electric-intensive services and products (such as powering electric tools), and opening up the design envelope for vehicles. Furthermore, as Prof. Sperling reported, as costs subside, consumers are likely to embrace electric-drive vehicles in general, and fuel cell electric vehicles in particular. Consumers see electricity as clean and superior to combustion engines, and seek an alternative to petroleum. They will also be attracted by the new accessories and services made possible by large on-board electricity capabilities.

Despite these attractions, a backlash against hydrogen has emerged. The communications media and politicians are now focusing on biofuels and plug-in hybrids as the fuels of the future, especially in the US. He suggested that this newfound enthusiasm misses the point that biofuels and plug-in hybrids, though attractive energy options, are not any more ready for the marketplace than hydrogen and fuel cell vehicles. Sugar-based ethanol is attractive in Brazil but that is a unique situation. Corn-ethanol is popular in the US, but it provides no air quality benefit and minimal greenhouse gas benefits and is land-intensive. The attractive biofuel option, widely acknowledged by all the key stakeholders, is cellulose-based ethanol - but process technology breakthroughs are still

needed, and the agricultural industry must be transformed for cellulose to become a viable option. Plug-in hybrids are also highly attractive energy options, but they face major cost barriers since larger batteries are needed than in gasoline hybrids such as the Prius. Plus, batteries will be deeply discharged, shortening battery life, further increasing costs.

The key to a hydrogen economy, he argued, is leadership from one or more car companies. Several are poised to do so. The risks and challenges are great, but the reward of being first could also be great. In the highly competitive auto industry, where there is often little difference between failure and profitability, several companies are pondering being pioneers. Partnership with policy makers and energy suppliers are necessary, and some regions will be more hospitable than others. But if a pioneer company succeeds, the benefits to the company could be well out of proportion to their sales - much as the Prius has created a halo of "greenness" and high technology for Toyota, playing a key role in the company's success.

Three hydrogen cars among the top ten at the Bibendum Challenge

Results of the last week's Michelin Bibendum Challenge - the battle of clean cars - have been released. As in the 2004 Challenge in Shanghai, the **Toyota Prius** hybrid snatched first place again. Yet there was great news for hydrogen cars, three of which landed among the top ten. The **FC Class A Mercedes** (with a 700 bar hydrogen tank) achieved 2nd place, the **Hy-Light Michelin/Paul Scherrer Institute prototype** in 4th place and the **Opel Zafira HydroGen 3** in 9th. The Bibendum Challenge provides a unique opportunity to compare "clean cars" in realistic conditions and hinges upon several criteria: acceleration, slalom capability, speed, on-road circulation and other specifications. For this year's competition 34 clean vehicles rallied against each other, among them 6 hydrogen-powered cars: the three cited

above, another FC Class A Mercedes, a Ford Focus FCV and the **Nissan X-Trail FCV which is part of the successful Ride-and-Drive demo at 16th WHEC.**

Stationary FC's : clean, reliable and cost effective solutions

Dan Rastler, Technical Leader, Distributed Energy Resource and Hydrogen Programs in **EPRI** (Electric Power Research Institute) USA, made a very keen review of the current status of development and commercialisation of stationary fuel cells systems. He provided perspectives on the type of applications within the electric power industry and insights to the requirements for wide-spread markets and barriers to market development.

The most deployed fuel cell is PAFC (Phosphoric Acid), which has showed reliability and durability. Molten Carbonate Fuel Cells (MCFC) are also in operation and could cover the 2-4 MW range. PEMFC (Polymer Electrolyte Membrane) is developing well in Japan. For SOFC (Solid Oxide), several field trials have occurred in this R&D phase. And finally, Direct Carbon fuel cells may develop in the far future.

In a context of dependency on fossil fuels and growth in electrical demand, Hydrogenics develops hydrogen products and infrastructures. Hydrogenics, today the world leader in hydrogen infrastructure solutions, proposes Onsite Generation solutions, power systems for backup power or light mobility and test systems. The back-up power market currently lacks a reliable, small, clean and low cost product.

Pierre Rivard, CEO of **Hydrogenics**, Canada, describes the HyPM Power module which is a reliable, flexible (in time for instance), clean, compact and cost effective solution in comparison with batteries, which are voluminous, unpredictable, sensitive to thermal issues and expensive from a total lifecycle point of view. Diesel engines challenged to meet the reliability requirements, need maintenance, emit greenhouse gas and noise.

Through its strong partnership with APC, a major actor in the UPS world market, Hydrogenics values its solutions, including in the growing Telecom replacement market, such as for Bell Telecom in Canada.

Portables: pure hydrogen micro systems achieve outstanding performance

Ged McLean, CTO of **Angstrom Power**, Canada, presents the technology and market

opportunities of the PEM Fuel Cell for portable power application for less than 5W applications. The aim is to demonstrate the potential of fuel cells to outperform battery technology thanks to fuel cell technology's intrinsic benefits: increased on-board energy density for longer runtimes, clean usage and environmentally friendly technologies, increasing safety usage by separation of power from energy, compactness, and instantaneous recharging. The author explains how and why the Fuel Cell systems based on pure hydrogen have a good potential for improvement over incumbent technologies. Emphasis is place on the fact that fuel cells can operate passively, requiring a minimum of volume and weight consuming balance of plant components to sustain operation. Present performance attained is over 400 Whr/l in 25 cc, giving 3W peak power and more than 1W average power. The hydrogen refuelling challenge is addressed through practical solutions with metal hydride technology and innovative distribution and production solutions such as a desktop electrolysis refueler.

In conclusion Ged McLean assumes that "in short, fuel cell for portable power applications could be a critical technology in building the hydrogen economy."

Giant exporting project of solar hydrogen from Maghreb to Europe

The huge solar potential of the Sahara desert will be employed to generate massive quantities of hydrogen by different means (thermochemical water-splitting, natural gas solar steam reforming, photovoltaics combined with water electrolysis, etc.) according to **Maghreb-Europe**, a consortium which was created during the 16th WHEC. This hydrogen will be used mainly for local needs and also could be exported to Europe through the existing trans-mediterranean NG pipes system. Major European industrial partners from Algeria, Tunisia, Marocco, Libya, Germany, France, Italy, Greece, Spain and others are already involved in Maghreb-Europe.

Shell: Clean and/or Green Hydrogen as vehicle fuel?

It is crucial to distinguish between "clean" and "green" hydrogen. In a fascinating presentation by Shell (**Gert Jan Kramer**, **Joep Huijsmans** and **Dave Austgen**), the authors made this clear distinction in connection with possible scenarios for the implementation of hydrogen as a vehicle fuel. **Clean Hydrogen** is defined as

hydrogen obtained from fossil fuels without net CO₂ emissions while **Green Hydrogen** is obtained from renewable sources. In the early decades of hydrogen roll-out, it is believed that hydrogen will likely be produced from fossil feedstock - ideally from natural gas, but alternatively from coal. Green Hydrogen made through electrolysis using "green electricity" will only become attractive in the long term (~2050) when the dual condition is met that renewable electricity has saturated the power sector and that electrolyser costs have come down significantly. Hydrogen from biomass may take an intermediate position. For the later stage of the "clean hydrogen" phase, hydrogen will be preferably centrally produced so as to allow for carbon sequestration. Another conclusion is that gaseous and liquid hydrogen turn out to be cost-wise and emissions-wise similar when the overall chains are considered. Advanced liquefaction options may even tilt the case in favor of liquid hydrogen if the liquefaction plant is located next to a LNG terminal.

Goltsov: mankind is at the crossroads of H₂ Civilisation and self - destruction

Over the last 5,000 years the human population has increased 144 fold and its energy consumption 2,650 times. Clearly, this trend is non-sustainable and will inevitably lead to self-destruction of mankind...just as primitive reducing bacteria have been destroyed by their own production of oxygen...or as seen in the 16th Century painting "Parable of the Blind" by Peter Brueghel the Elder, where a group of blind people stands on the verge of a great abyss. *"Just like the blind, mankind is running toward its destruction if it does not make the right decisions now,"* explains **Prof. Victor Goltsov** from the **Ukrainian Donetsk Technical University**. Goltsov was deeply inspired by the work of the prominent Russian scientist V.I. Vernadsky (1863-1945) who analysed the nature, defined the boundaries and explained the open, synergetic and evolutionary nature of the *Biosphere* (a term invented in 1875 by the Austrian geologist Edward Suess). Believing in the strength of human reason, Vernadsky supposed that the collective scientific thought will overcome the negative results of the technological development and will secure the rational transformation (and not annihilation) of the biosphere, for a maximum satisfaction of the material and spiritual demands of the mankind. This future evolutionary stage of the biosphere of the earth was designated by Vernadsky *Noosphere*, the sphere of reason (a term

introduced in 1922 by a French philosopher and mathematician Edouard Le Roy).

According to Prof. Goltsov, the hydrogen community must now establish how much time mankind has before the biosphere and ecosystems will enter into an irrevocable catastrophic phase of self-destruction. In any case the transition to Hydrogen Civilization will not be serene and mankind will have to solve and prevent antagonisms and instabilities occurring during this transition by geopolitical, international and worldwide legislative action.

A glance in the exhibition hall

Thursday's tour of the exhibition hall began at **Renault's** booth, where they are presenting the progress made in fuel processing and fuel cell technology. The exhibits illustrate Renault's decision to opt for vehicles powered by fuel cells with reformers. This technology directly produces the hydrogen on demand and on board the vehicle, solving the problem of very high-pressure or cryogenic storage. On display are:

- The reformer, which transforms any kind of liquid fuels into reformat, a hydrogen-rich gas.
- The fuel cell. The produced water returns to the reformer.
- The multiple-fuel tank. Since the reformer can run on gasoline, diesel, bio-ethanol, synthetic fuels and other liquid fuels.

The Renault and Nissan Alliance are also very committed in hydrogen technologies and FCVs. In France, Renault plans to test vehicles powered by fuel cells based on advanced Alliance technologies.

We then made our way over to the Canadian booth, where we discovered a bit more about **Hydrogenics**. In a context of dependency on fossil fuels and growth in electrical demand, Hydrogenics develops hydrogen products and infrastructures. Hydrogenics is today the world leader in hydrogen infrastructure solutions with more than 1,600 products deployed worldwide since 1948. The company proposes Onsite Generation solutions, power systems for backup power or light mobility and test systems. The HyPM Power module is adapted to many early applications such as vehicles (delivery, buses, off-road vehicles) or back-up power.

The positioning of hydrogen and fuel cells is to propose a reliable, flexible (in time for instance), clean, compact and cost effective solution in comparison with batteries, which are voluminous, unpredictable, sensitive to thermal issues and expensive from a total lifecycle point of view. Diesel engines challenged to meet the reliability requirements, need maintenance, emit greenhouse gas and noise.

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Areva, a French nuclear and energetic engineering group, stands on the forefront of CO₂ free energy solutions. They also provide a global service including renewable energies solutions based on wind mills, biomass, hydrogen and fuel cells. Within the Areva Group its subsidiary, Helion has been developing energy solutions relying on electrolysis technologies and PEM Fuel Cells since 2001:

- backup power systems for industry, healthcare, data processing and banks,
- hydrogen & renewable energy systems for decentralized energy production
- FC systems for urban, public transportation & freight markets
- FC for co-generation
- FC systems in air independent environment
- FC test benches and teaching benches.

These prototypes and more are on display at their booth, N°22.

Our last stop was at the booth of **h-tec Hydrogen Energy Systems** from Luebeck, Germany. In 1996 h-tec's had its very first exhibition at the 11th WHEC in Stuttgart. At this time h-tec had harnessed a niche market of fuel cell educational material. They offer a step-by-step program including literature in several languages, hydrogen demonstration models and hands-on projects which are specifically designed for the classroom setting. The vision of h-tec is "for all schools worldwide will have a working fuel cell of their own." With the next generation in mind (the generation that will see the hydrogen economy come to life), h-tec aims to provide concrete and understandable information to the soon-to-be everyday consumer. www.h-tec.com

16th WHEC Posters Awards

On Thursday, five prizes were awarded to posters chosen by a jury of eminent experts of hydrogen technologies. The first prize of 1,500 Euro was awarded by CNRS, the French National Center of Scientific Research to **Dr. Sergei Grigoriev** and his franco-russian team of the Hydrogen Technology & Plasma Research Institute of the Russian Kurtchatov Institute (Moscow), University of Paris-Sud 11 and the «Compagnie d'étude des technologies de l'hydrogène» for the poster *Development of advanced PEM water electrolysis*. The second CNRS Award of 1,500 Euro goes to **Stéphane Abanades** and his colleagues from the Odeillo

Solar Energy Lab of the CNRS for their poster : *Hydrogen production by the thermal decomposition of methane using a high temperature solar chemical reactor*. The three Ademe Awards (H₂/FC minicars) were attributed respectively to **Arturo Vizcaino** and his colleagues from Escuela superior de Ciencias Experimentales y Tecnología, Spain for their poster *Pure silica SBA-15 supported Cu-Ni catalysts for hydrogen production by ethanol steam reforming* and to **Hirota Kawamura** and his research team of the CRIEPI Material Science Research Laboratory of Nagasaka, Japan for their poster: *Electro-chemical study of Pd-coated Perovskite Anodes in Sulfur-based hybrid cycle*, and thirdly to **Lidia Segura** and her colleagues of the university of Las Palmas, Gran Canaria, Spain for the poster *Analysis of hybrid systems for La Graciosa Island (Canary Islands)*.

Free tickets for the Group Exhibit H₂/FC - April 2007

At the booth of Tobias Renz FAIR-PR, operator of the Group Exhibit Hydrogen + Fuel Cells at HANNOVER MESSE in Germany, all conference participants are invited to join in a drawing for free Privileged Visitor Passes for the next Group Exhibit, April 16-20, 2007.

Unique Internet documentation of the 16th WHEC

All participants of the 16th WHEC in Lyon are cordially invited to view the three daily reports which were published during the week-long event as well as the many photos of presentations and exhibitions at www.fair-pr.com.

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