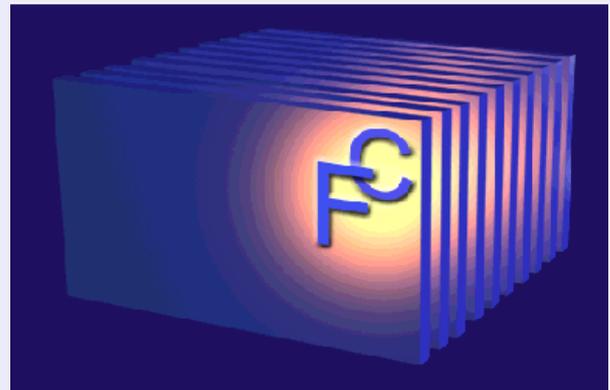




IEA Advanced Fuel Cells

Implementing Agreement



SPRING NEWSLETTER

www.ieafuelcell.com

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A word from the Chairman

Focusing on the transport sector, fuel cells are the only technology offering an uncompromising transformation of passenger road transportation that can be free from greenhouse gas emissions. Major car manufacturers such as Hyundai and Toyota are highlighting fuel cells now over other electric technologies. Longstanding stakeholders including Daimler, Ford and Honda as well as Hyundai and Toyota are working towards market introduction between 2015 and 2018. Other world players such as Volkswagen and BMW have stepped up their fuel cell development efforts.

As successful progress towards market-ready fuel cell cars is achieved, the challenge turns towards the fuel infrastructure – that is hydrogen infrastructure including mass storage and the fact that this needs more attention in terms of concepts and programmes for implementation in the respective countries. Notable hydrogen infrastructure projects are underway in Japan, Scandinavia, Germany and California in the USA. Regulatory procedures as well as codes and standards will need to be adapted, harmonised and created where necessary. The reliability of the fuelling infrastructure will be subject to enhancement during the initial implementation period.

Chairman: Prof. Dr Detlef Stolten

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Autumn Executive Committee Meeting – Jerusalem, Israel, November 2013

The 47th Executive Committee Meeting was held at the Ministry of Energy and Water Resources in Jerusalem, Israel. Israel joined as a member country at the beginning of 2013, and this meeting was an excellent opportunity to meet the key people working in this area in Israel.

We were welcomed by Dr Shlomo Wald, who drew attention to the focus of the Ministry of Energy on fuel alternatives, and that fuel cells are one of the key areas envisioned for the future to address this.

The Executive Committee was given the opportunity to see the work of and meet with several fuel cell companies in Israel, including [Cellera](#), [Ariel University](#), [Gencell](#) and [Phinergy](#).

It was decided during this meeting to begin work on two exciting new Annexes – one will focus specifically on electrolysis and the other on modelling of fuel cell systems.

National update from USA



**Presented by: Dr Nancy Garland,
US Department of Energy**

The US Fuel Cell Technologies Program's mission is to enable widespread commercialisation of a portfolio of hydrogen and fuel cell technologies through applied research, technology development and demonstration, and diverse efforts to overcome institutional and market challenges. Some of the key production targets set to overcome market challenges are:

- By 2020, reduce the cost of distributed production of hydrogen from biomass-derived renewable liquids and water electrolysis to less than USD 2.30 per gasoline gallon equivalent (gge) (less than USD 4.00 delivered and dispensed)
- By 2020, reduce the cost of central production of hydrogen from water electrolysis using renewable power to less than USD 2.00/gge at plant gate
- By 2020, reduce the cost of hydrogen produced from biomass gasification to less than USD 2.00/gge at the plant gate
- By 2015, verify the potential for solar thermochemical cycles for hydrogen production to be competitive in the long term and, by 2020, develop this technology to produce hydrogen with a projected cost of USD 3.00/gge at the plant gate

The total amount of Government expenditure on fuel cell technology in FY2013 was USD 98 million with a further USD 100 million requested for FY2014. A recent study by Pacific Northwest National Laboratory has analysed the impact that Department of Energy funding has had – notably 40 commercial hydrogen and fuel cell technologies, 65 emerging technologies and more than 450 patents in 2013. There are numerous research highlights with the Fuel Cell Technologies Program, including continuing:

- to develop and demonstrate fuel cell power system technologies for transportation, stationary and portable applications;
- research and development of technologies for low-cost, highly efficient hydrogen production from diverse renewable sources; and
- research, development and demonstration of technologies and processes that reduce the cost of manufacturing hydrogen production, delivery, storage and fuel cell systems.



There have also been demonstration highlights on market transformation and technology validation from Sandia National Laboratories, National Renewable Energy Laboratory and BMW among others.

The outlook in the USA is to continue to promote and strengthen R&D activities in hydrogen, fuel cells, safety and manufacturing – specifically addressing the issues of cost, performance and durability. One aspect that will be pursued is to leverage activities to maximise the impact of this technology through US and global partnerships and the H2USA, a public-private partnership designed to enable the widespread commercialisation of hydrogen vehicles in the USA.



2.8MW fuel cell power plant using FuelCell Energy's DFC3000 units



National update from Finland

Presented by: Jari Kiviaho, VTT

The focus in Finland has been the development solid oxide fuel cell (SOFC) stacks since 2007. From 2009 onwards, there has been a close collaboration between VTT and Elcogen – VTT bringing a focus on stack design, modelling, characterisation and post-test analysis, while Elcogen's expertise lies in cell and stack manufacturing, and commercialisation. The collaboration has been based on Elcogen's high performance cells and VTT's facilities, know-how and intellectual property rights on components and stack design.

This collaboration has so far delivered single cells and stacks that have shown low degradation and good performance. As a result, Elcogen is now selling 500W stacks and has released a 1.5kW stack with improved performance.



Elcogen stack being tested for performance at VTT facilities

VTT has also been active with its 10kW SOFC research unit that is fuelled by natural gas and uses a Versa Power Systems stack. The system has been running fully automated 24/7 with a total operating time to date of over 5,000 hours, achieving a direct current (DC) efficiency of 60% and nitrogen oxides (NOx), sulphur oxides (SOx), volatile organic compounds (VOC) and carbon monoxide (CO) emissions at or below detection limits. From 2010 to 2013, system performance has improved from 43% to over 50% through lower parasitic losses from blowers, current collection and power conversion.

In other news, Convion Ltd took over the Wärtsilä fuel cell development programme from 1 January 2013, with the aim of commercialising the 50–300kW products based on SOFC technology.



Another development is the 50kWe proton exchange membrane fuel cell (PEMFC) project, which uses by-product hydrogen from the chlor-alkali industry. The motivation for this project is to confirm PEMFC technology readiness for use as peak power and reserve power in a system with solar and/or wind electricity generation. Some of the project goals are to achieve 5,000 hours of operation by March 2014, develop control strategies and study the effects of hydrogen quality on PEMFC performance.

Country profile: Israel



Dr Igor Derzy, from the Office of the Chief Scientist, introduced fuel cell activities in Israel to the group. At any one time, 10 projects are underway in the area of batteries, hydrogen and fuel cells. The Prime Minister's Office has a Directorate on replacement fuels. Recently, natural gas has been discovered in Israel, and the country is working to identify a good use for this resource.

The best way to appreciate the status of fuel cell activity in Israel is through the companies that were visited during this meeting.

Cellera

Cellera has been in operation for six years, and produces an alkaline fuel cell that uses an anion exchange membrane. The application is stationary back-up power, and there is a system on test at a nearby cell phone tower, running through simulated and actual power outages. Cellera has projects underway with CommScope, a US telecoms provider, VW and 3M (facilitated by the US Department of Energy (DOE)).

Ariel University

Dr Alex Schechter introduced the work of the fuel cells and materials group at Ariel University. This focuses on materials and devices, and system challenges encompassing direct methanol fuel cells (DMFC), polymer electrolyte membrane fuel cells (PEMFC), urea hydrogen generator, platinum replacements and core shell catalysts. Portable hybrid devices (fuel cells and batteries) and microbial fuel cells are also the focus of research.

Gencell

Gencell develops alkaline fuel cells for back-up power targeted at the cell tower industry. The current product is the G5, due to go on sale in the second half of 2014. A large focus for this company is standards and it is already collaborating with the DOE, TÜV in Germany and working to obtain the CE mark (a mandatory marking for certain products sold in the EU).

In the future, the focus will be on portable systems and the next generation product will be ammonia based. The company has a strong focus on material development, and has systems on test in Israel (at an electricity company and a hospital), the USA and Mexico (four units, investor in Mexico).

Phinergy

Phinergy produces an aluminium based battery, targeted at the electric vehicle market. Advantages are an indefinite shelf life, potentially 20,000 hours of operation and the value it brings as a range extender in electric vehicles. Automotive applications have been tackled as the first application as the CEO identifies it as the most challenging area.



Fuel cells in the news

Home fuel cells suitable for condominiums to be sold by Tokyo Gas

Tokyo Gas and Panasonic have announced that their new 'Ene-Farm' home fuel cell for condominiums will be sold commercially from 1 April 2014. This is the first fuel cell system where the fuel cell power unit, hot water unit and backup heat source unit can all be stored in the pipe shaft of a condominium. This opens up a market sector that was previously restricted to domestic properties with suitable ventilation (for example, with space outside). The units will be able to generate between 250W and 700W and will extract the hydrogen required from the mains natural gas supply by the use of a fuel processor. This is then reacted with oxygen from the atmosphere to generate heat for hot water supply and electricity.

Appearance of Panasonic's 'Ene-Farm' product installed in the pipe-shaft of a condominium



The benefits expected from this system are a reduction in primary energy use of approximately 37%, which correlates to around a 49% reduction in carbon dioxide (CO₂) emissions when operating at the rated electricity generation. This, for an average household in Japan, would mean savings of around JPY 30,000 to JPY 40,000 (USD 305 to USD 420) per year on energy bills.

Tokyo Gas is aiming for sales of 500 of the condominium 'Ene-Farm' units in 2015. Tokyu Land Corporation and Sohgo Real Estate have already expressed their interest in adopting this system in their properties, totalling around 456 units.

Please visit the Panasonic [website](#) for technical information.

A major milestone of 2 billion kWh of fuel cell power generation has been achieved by FuelCell Energy customers

FuelCell Energy has achieved a major milestone in successfully generating 2 billion kWh of electricity through its Direct FuelCell[®] (DFC) power plants. This has been achieved since the first commercial installation in 2003. What is notable is that the first billion kWh of generation was only reached in January 2011, which highlights the increase in uptake of this technology.



FuelCell Energy's Direct FuelCell® electricity generation plant

Some 110 DFC plants have been installed in more than 50 locations globally. These plants are producing environmentally friendly power and usable heat while virtually eliminating emissions of NO_x, SO_x and particulate matter (PM₁₀), and substantially reducing carbon dioxide emissions compared with the average US fossil-fuel power plants. Through the use of the DFC plants, these 2 billion kWh of power generation have avoided the emission of approximately 16,900 tonnes of these criteria pollutants as well as approximately 1,068,000 tonnes of carbon dioxide, equivalent to removing more than 499,000 passenger vehicles from the road.

Toyota unveil its fuel cell electric vehicle proposed for sale in 2015 at CES 2014

The 2014 Consumer Electronics Show (CES) in Las Vegas, USA saw the unveiling of Toyota's fuel cell vehicle, the FCV concept. The prototype vehicle has been tested for over a year and has consistently delivered a driving range of around 300 miles (482km) and a zero-to-sixty acceleration of about 10 seconds in some of the most extreme on-road testing in North America. Refuelling has been shown to take between three and five minutes to fill the hydrogen tanks. The vehicle will boast a total output power of 100kW, and the possibility exists of using the vehicle as an electricity supply for a household of up to a week in case of an emergency where the electricity supply is cut.

This comes on the back of 20 years R&D in fuel cells, and over 11 years of testing and development of prototypes in North America. During this time, Toyota has successfully managed to dramatically reduce the cost of building fuel cell powertrains to such an extent that the company estimates a 95% cost reduction in the powertrain and fuel tanks of the vehicle it will launch in 2015 compared to the original prototype.



The Toyota FCV concept four-door mid-size sedan unveiled at the CES 2014 in Las Vegas

In other news, Toyota has partnered with the University of California Irvine's Advanced Power and Energy Program (APEP) to help map out potential locations for new hydrogen refuelling stations through modelling. The purpose of this partnership is to produce a potential cluster map of hydrogen fuelling stations in the San Francisco Bay area, Silicon Valley, Los Angeles, Orange County and San Diego County. The initial results from the modelling show there would only need to be 68 stations based on the assumption that owners would want to be within 6 minutes of a refuelling station and a vehicle population of 10,000. The Californian State has already approved funds of USD 200 million to build up to 20 stations by 2015, with the aim of having as many as 100 built by 2024. The work done in the APEP model will help guide the construction of these.

Please visit <http://www.toyota.com/fuelcell/> for more information.



Forthcoming Annex meetings

- Annex 22: 2 – 3 October 2014, Cancun, Mexico in conjunction with the ECS meeting
- Annex 25: 7 – 8 October 2014, Hobro, Denmark
- Annex 26: Winter 2014 (date to be confirmed), Grenoble, France
- Annex 27: 11 – 12 September 2014, Messina, Italy

The plan is to hold the 49th ExCo in conjunction with the Annex 26 meeting in Grenoble, France, winter 2014 (date to be confirmed).

Join our work

We welcome new participants to our work at expert, company and country levels. Participants from IEA member countries (ieafuelcell.com/contact) may join the work of our Annexes, please contact the following people:

Annex 22: Polymer Electrolyte Fuel Cells, Dr Di-Jia (DJ) Liu: djliu@anl.gov

Annex 23: Molten Carbonate Fuel Cells, Dr Tae Hoon Lim: Thlim@kist.re.kr

Annex 24: Solid Oxide Fuel Cells, Dr Jari Kiviaho: jari.kiviaho@vtt.fi

Annex 25: Stationary Fuel Cells, Bengt Ridell: bengt.ridell@grontmij.se

Annex 26: Fuel Cells for Transportation, Dr Rajesh Ahluwalia walia@anl.gov

Annex 27: Fuel Cells for Portable Applications, Dr Martin Müller: mar.mueller@fz-juelich.de

Annex 28: Systems Analysis, Dr Can Samsun: r.c.samsun@fz-juelich.de

Electrolysis Annex, Dr Louise Evans: Secretariat-AFCIA@ricardo-aea.com

Modelling Annex, Dr Louise Evans: Secretariat-AFCIA@ricardo-aea.com

If you are from a non-member country, please contact Dr Louise Evans at Secretariat-AFCIA@ricardo-aea.com who would be delighted to discuss membership with you, either on a country basis or on a company basis. Please visit ieafuelcell.com/joining to see the benefits of joining our work.

Special thanks to the following companies and organisations for their permission to use the pictures in this newsletter: Elcogen/VTT, Panasonic, FuelCell Energy Inc and Toyota.