

# FUEL CELL POWER

*The magazine for the power source of the future*



## HEADLINE NEWS

The latest reports on the implementation of hydrogen and fuel cells were given at an international conference in Birmingham, UK. A Californian project is incorporating fuel cells in a 'Smart Grid' with hydrogen storage contributing to load balancing. Fuel cells help to reduce greenhouse gas emissions, as they are a clean and efficient method of distributed electricity generation. Electric vehicles will be essential to balance the load from intermittent renewable energy. Progress with the development of the hydrogen infrastructure is required by 2015 when the major motor manufacturers plan the commercialization of fuel cell vehicles. Hydrogen and fuel cells also have an important role in storing energy from intermittent renewable sources in rural and urban communities.

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# PREPARING THE GROUND FOR HYDROGEN AND FUEL CELLS

**Birmingham, UK**

At the 6th International Hydrogen and Fuel Cell Conference organized by Climate Change Solutions in Birmingham this spring, Sandy Taylor, Head of Climate Change at the City Council, said that they are very impressed by the level of investment in hydrogen in the USA. It is beginning to happen here in the UK, with initiatives by the Regional Development Agencies. Birmingham was at the forefront of the global industrial revolution and car manufacturing and is now taking the lead in the UK with clean energy and car production. The West Midlands is the low carbon area for the automotive industry and also leads the region's EU Knowledge and Innovation Community (KIC) on Climate Change, which will oversee research and help develop new markets and business opportunities, with hydrogen as a key player. Birmingham City Council is involved in green innovation and has a resolution to only purchase vehicles powered by electricity or liquefied petroleum gas by 2015. They are taking action against climate change and aim to reduce greenhouse gas emissions by 60% by 2026. Gareth Stanley of Advantage West Midland added that they are making significant investment in the area as an international hydrogen centre.

## DEVELOPING THE SMART GRID INCORPORATING FUEL CELLS

The Chairman of the conference, Kevin Kendall, Prof of Chemical Engineering at the University of Birmingham, introduced Prof Jack Brouwer of the National Fuel Cell Research Centre (NFCRC), Irvine, California. Prof Kendall said that he was also very impressed by the long term investment in hydrogen being made in the USA and believes that

something like this is needed in the UK. Jack Brouwer's presentation focused upon their work with smart energy and power for California, which has implications for the rest of the world. The present concerns with the electricity grid are demands for peak energy, greenhouse gas emissions and health problems caused by pollution with fossil fuels, as well as energy security. The limitations of the present grid are centralized control, slow response time and one way power flow.

The smart grid will have to deal with multiple points of connection and with electricity for charging electric vehicles. The smart grid will be flexible, it will integrate renewables, be sustainable and ensure security of supply. Data from wind farms shows how intermittent and unpredictable wind actually is. There is less wind energy at periods of peak demand in summer so that almost as much back up generation is required as previously. Solar power is more predictable but this can be affected by clouds. A lot more electricity will be needed for electric vehicles and people will want to recharge when they return home from work, which coincides with the peak demand at 5pm. A smart grid is essential to deal with this. Prof Brouwer considered the dynamics of the grid and the resources needed to meet the growing demand. The grid will incorporate several different types of fuel cells, including molten carbonate, solid oxide and PEM systems. By 2018 the hydrogen infrastructure in California will be needed to recharge over 50,000 fuel cell vehicles, which are planned by General Motors, Honda, Toyota, Mercedes and Hyundai Kia. California already has 24 hydrogen fuelling stations which are used by plug-in

FRONT PAGE: A hydrogen powered Microcab is refueled at the University of Birmingham.

hybrid fuel cell vehicles (PHFCV) powered by fuel cells and batteries.

The NFCRC set up the Irvine Smart Grid Demonstration with other participants, including Boeing, GE, A123 Systems, SunPower Corp, Itron Inc and the Electric Power Research Institute. The production, transmission, storage and use of electric energy in the future will be fundamentally intertwined with computation, control and communications. They have set up two new smart grid circuits which include 30 'smart' homes employing Edison SmartConnect™ meters, In-Home Displays, Programmable Communicating Thermostats, Home Energy Management Systems, Smart Appliances and Smart Electric Vehicle Supply Equipment. They are renewable-based, energy secure communities (RESCOs) incorporating efficient building envelopes and lighting, CHP, photovoltaics and energy storage. The project is addressing the intermittency of renewables, using a gas turbine to balance the load and monitoring the number of times it is shut down or started up.



Plug Power has contributed their Gensys Blue fuel cell but other fuel cells would be welcome in the demonstration! They would very much like to include wave or other types of marine power as soon as possible. Demand side management, with intelligent control of appliances, is very important. In the USA peak energy demand is in the summer and Europe is now changing from winter to summer peak demand. All these factors are being taken into account in the Irvine Smart Grid Demonstration,

which is costing \$40 million. In summary, they are bringing together energy for stationary and transport technologies, incorporating advanced sensors and controls, innovation and sustainability.

## HYDROGEN STORAGE FOR THE SMART GRID

Dr Rupert Gammon of Bryte Energy explained where hydrogen fits into the energy system. There has historically been separation between the heat, power and transport sectors but new energy sources of wind, solar, tidal, wave, nuclear and clean coal will go into the electricity grid before being transferred to the other sectors. Smart electrolysis will enable electric vehicles, whether powered by batteries or fuel cells, to help balance the electricity loads. 'Dispatchable' power sources will be needed, that is their power output can be easily turned up or down to meet requirements. Renewable energy sources are good for sustainability, but they are not dispatchable. For load balancing, gas turbines can be used, or pumped hydro, although there are not many suitable sites for this. Coal, with pre-combustion carbon capture and storage, could provide hydrogen, which is dispatchable.

Smart metering enables time shifting over short periods, for instance there can be sectoral transfer to battery electric vehicles. Hydrogen can be used to do this on a much larger scale. Wind power is usually available over several days, but electricity storage is expensive and hydrogen turns this into a high value fuel. By 2050 there will have to be an 80% cut in carbon dioxide emissions and electricity storage could all be transferred to hydrogen vehicles. All future smart grid projections, with the exception of large scale battery electric vehicle use, rely upon hydrogen storage. In response to questions, Dr Gammon said that batteries are much more efficient than hydrogen for storage, but you would need a vast bank of them. He would

not recommend storing hydrogen as a liquid.

ITM Power is aiming to get the hydrogen infrastructure in place by 2015 to meet the automotive industry's target for volume production of fuel cell cars, said Stephen Jones. This will be subject to achieving large cost reductions in vehicle components and the recharging infrastructure. Regulations to reduce emissions and rising oil prices will help to close the price gap. He said that we should start with commercial vehicles, either i.c. engine or fuel cell powered, leading up to fuel cell cars. Storing hydrogen at 700 bar rather than 350 bar will not double the vehicle range, although the increase will be more significant with efficient vehicles. The deployment of hydrogen powered vehicles is being held back by the lack of the refueling infrastructure and the high cost of fuel cells, but he was glad to see the lead which Germany is taking with hydrogen fuelling stations, using some existing hydrogen pipelines. The initiatives in California are also important. ITM is aiming to get 'green' hydrogen from renewable electricity. They are developing the 'HFuel', a transportable hydrogen fuelling station for small fleets of i.c. engine or fuel cell powered vehicles, which will reduce the infrastructure costs for the field trials.

## REPLACING PETROL WITH ELECTRICITY OR HYDROGEN

Neil Butcher, Associate Director ARUP, was unable to deliver his presentation, which was read by Prof Kendall in his place. This outlined progress with the Coventry and Birmingham Low Emission Demonstrator (CABLED), which is part of a UK wide demonstration ranging from London to North East England and Glasgow. It is supported by the UK Technology Strategy Board. Neil Butcher put the case for battery electric vehicles, which are already efficient if they are powered by the grid. Their efficiency will improve substantially as more renewable energy sources are

employed and the losses incurred in the generation of electricity from fossil fuels are reduced. With the correct grid mix, battery powered vehicles could cut CO<sub>2</sub> emissions by 40%. CABLED involves 110 ultra low carbon vehicles powered by batteries, hydrogen fuel cells or plug-in hybrid technology. E.ON installed charging points for the battery electric vehicles and a new hydrogen station for fuel cell vehicles is being built in Coventry. ARUP is working with new energy technologies in cities around the world. Prof Kevin Kendall suggested that although the battery electric vehicle would be more energy efficient and have good performance for a range up to 80 miles, it would require 5 hours to recharge or 30 minutes for rapid recharging. In comparison, the hydrogen fuel cell vehicle would have a range of 200 miles and could be recharged in 3 minutes.

Iain Staffell of Birmingham University presented technical data about the operation of the fleet of Microcab fuel cell/battery hybrids which deliver mail on the campus. A 1.2 kW Ballard fuel cell operates in series with a 1.5kWh lead-acid battery to power a 10kW motor. The Microcabs are refueled at the University's hydrogen fuelling station and another station is being installed at the University of Coventry. In addition to the one at the University of Loughborough, this brings to three the number of hydrogen stations starting the 'Midlands Hydrogen Ring'. Iain Staffell believes that manufacturers will have to adopt whole-system optimization and vehicle downsizing in order to offer a more sustainable solution for personal transport.

## BATTERY - OR FUEL CELL ELECTRIC VEHICLES – OR BOTH?

Robert Steinberger-Wilckens of H2O e-mobile outlined the problems of urban mobility: air pollution, congestion and the very low efficiency of engines in urban driving, with petrol only 15% efficient and diesel 18%. CO<sub>2</sub> emissions

are also far above EU goals. Battery charging is much more efficient than hydrogen refueling, but high power levels are required. Hydrogen refueling costs more than battery charging but is much quicker and gives four or five times the range. There is a large surplus of hydrogen from industry which could be used to refuel vehicles. New lightweight vehicle designs are needed. A combination of batteries and fuel cells in a hybrid design allows for a reduction of the power rating of the fuel cell and extends the lifetime of the system components, thus reducing costs. In Phase II of their programme, H2O e-Mobile is aiming to reduce the vehicle weight to 600 kgs. A delegate said that high efficiency of battery electric vehicle assumes that the grid is powered by renewable energy, but it is at present much lower due to the losses in generating electricity from fossil fuels.



Denis Hayter of Intelligent Energy explained that their hydrogen fuel cell taxi will substantially cut the CO<sub>2</sub> emissions of taxis, which are very high in the London driving cycle. The fuel cell/battery hybrid taxi has been developed with Lotus Engineering and London Taxis International, with part funding from the Technology Strategy Board. It has 250 kms range, 120 kph top speed and hill climbing gradeability is over 25%. The drive train developed for the taxis will be suitable for other fleet vehicles.

## A STEP CHANGE NEEDED FOR GLOBAL TRANSPORT

Hugo Spowers said that Riversimple is concerned with the whole system design for transport, moving from

chemical to electrical power, with efficiency as the dominant factor. The key barriers to fuel cell powered vehicles are not technical but are due to people, politics and business. He does not regard the auto industry fuel cell car developments as technically feasible. They are forged by the constraints of yesterday, by a highly optimized business model, which is stuck at 38 mpg and does not meet today's needs. At present the petrol internal combustion engine meets all our needs, but does so very inefficiently and will be replaced by different fuels and power trains. Riversimple's regenerative braking efficiency is about 50%, compared with that of the Prius at only 10%. They cruise at 50 kph powered by a 6 kW fuel cell. They have 52% net system efficiency, with the ultracapacitors achieving 95%. It is important to note that their fuel cell costs 25 times less than a conventional system. By decoupling constant and transient power demands, they have been able to size the fuel cell for constant demand only, which is generally about 20% of peak demand. Although it is generally recognized that cost is proportional to power, it is not realized that cost is also proportional to power density. This means that in automotive use, to all intents and purposes, fuel cell cost is pro rata to the square of power. Jack Brouwer of NFCRC commented that innovative thinking is much needed. Concerning the regenerative braking system of the Prius, the batteries may not be as efficient as ultracapacitors but may be the better option if energy density is required rather than power. Hugo Spowers said that this was a possibility for hill climbing.

The aim of Riversimple's sustainable business model is to live off revenue not capital. Compared with other fuel cell cars, the Riversimple has the lowest top speed and lowest CO<sub>2</sub> emissions at 31g/km. They can maximize profits, with low running costs and longevity replacing high running costs and obsolescence. Rather than increasing costs, future changes, such as resource

depletion, will add value to their energy saving technology and recyclable materials. They will not have to invest in technical improvements to meet any likely future environmental regulations. The Riversimple is a local car, tethered to its base with a range of 240 miles. They aim to start operations in Oxford and Leicester by 2012, followed by York, Norwich, Peterborough, Bournemouth and Middlesbrough the following year, with several more cities involved in 2014. Competition encourages the auto industry to make incremental changes but Riversimple's open source intellectual property stimulates major step changes. Cars will be manufactured in quantities of 3,000 to 5,000 per annum, with end of life recycling and ensuring a balanced value stream for all stakeholders. Riversimple is planning to have 50 to 100 operational vehicles by 2012 and commercial operation by 2013.

## REGIONAL DEPLOYMENT OF HYDROGEN AND FUEL CELLS

Jonathan Williams of the University of Glamorgan explained that the use of ultracapacitors in their 'Tribrid' fuel cell bus substantially improves the efficiency of the regenerative braking system. The revolutionary lead acid battery they are using weighs 42% less than standard and is complemented by a 12kW fuel cell with a fuzzy logic controller. The bus has a range of 190 miles in the urban driving cycle, top speed of 55 mph and reduces CO2 emissions by over 30% if hydrogen is reformed from natural gas with electricity from the existing grid. In small volume production the Tribrid bus costs £100,000 but 50% grants are available. Richard Dinsdale of the University of Glamorgan outlined their programme to develop the hydrogen infrastructure, starting with two hydrogen refueling stations powered by renewable energy. This will enable the storage of energy from wind, tidal and wave energy. They are using PEM and solid oxide fuel cells, as well as i.c. engines, with the aim of building up

critical mass in their hydrogen infrastructure. Their region has been designated by the UK Government as the Low Carbon Economic Development Area for Hydrogen and their aim is that Wales should gain commercial advantage by the early adoption of sustainable hydrogen technologies.



Marieke Reijalt of the European Regions and Municipalities Partnership for Hydrogen and Fuel Cells (HyRAMP) said that they started in 2008 with nine European regions installing the hydrogen infrastructure and they now have thirty regions involved. In the UK, the Midlands, Outer Hebrides, the North East and London are members. Germany, Italy and Spain are also well represented. They work with the EU Fuel Cell and Hydrogen Joint Technology Initiative (FCH JTI) and the Directorates for research and energy. New EU regulations allow fuel cell vehicles to operate on the road in all member states. HyRAMP's members already operate about 50 buses and cars fuelled by 20 filling stations and around 70 special vehicles like bikes, scooters, fork lift trucks, boats and a plane. There are concrete plans for an additional 180 hydrogen buses and 500 passenger cars, which will be fuelled by up to 50 filling stations. The EU had been proud that Hamburg had the largest fleet of fuel cell buses in the world, but her presentation jokingly showed the bus fleet upside down! Europe no longer has the biggest fleet of fuel cell buses but this can now be claimed by Vancouver. In stationary applications, around a hundred fuel cells are already operating and a further 850 units are planned. This

compares with around 600 units operating in the USA and 3,300 residential units in Japan - with a further 5,000 by the end of 2010. HyRAMP is working to improve co-ordination with electric transport, including the EU Green Car Initiative, Smart Cities, the European Investment Bank and the Covenant of Mayors. They also collaborate with the International Energy Agency.

Alexander Franke of Baxi Innotech gave the latest details about the German Callux programme to install fuel cell CHP in domestic applications. They are concerned that emissions trading has had no effect on reducing CO<sub>2</sub> emissions. Decentralized micro CHP generation can make a major contribution to reducing the primary energy used in domestic buildings and fuel cell CHP is the most efficient technology available. They are now demonstrating 800 of their GAMMA 1.0 PEM 1 kWe fuel cell CHP units, with commercial launch planned for 2013. Iain Staffell from Birmingham University would like to see the UK Government doing something similar to reduce the capital cost of fuel cells.

## INVOLVING COMMUNITIES

Prof Martin Hills of the PURE Energy Centre discussed two communities using hydrogen to store renewable energy, one in a rural and the other in an urban area. Electrical power is abundantly available from hydro, wind and solar power in the Faroe Islands, but the grid could not cope with much more renewable energy. They solved the problem by using hydrogen storage and set up a wind turbine with an electrolyzer and fuel cell within a few months. At the Environmental Energy Technology Centre (EETC) in Yorkshire, the down time of the 30kW fuel cell depends on the sun and the wind. The hydrogen technology is working well and more urban and remote communities could make use of this to power transport, as well as for electricity generation, cooling, heating and cooking.

Clare Barnett outlined progress with the Hydrogen Village Program in Ontario, which aims to open new markets and expedite the commercialization of hydrogen and fuel cells. They are demonstrating the benefits of hydrogen, including improved energy security and reductions of greenhouse gas emissions and air pollution. They are dealing with regulatory issues and helping to overcome people's misconceptions about hydrogen safety. Small stationary fuel cells provide back up power and a larger 2.2 MW stationary fuel cell improves the efficiency of the natural gas distribution network. They are operating fuel cell powered electric vehicles, both on and off road, and are waiting for approval for a hydrogen train to be powered from forestry waste. Many early uses will be community based and will be integrated with alternative energy technologies such as nuclear, wind and solar power. The first system to come to market is likely to be the Toronto delivery truck.

## OPENING UP MARKETS FOR FUEL CELLS IN BUILDINGS

Bill Ireland of Logan Energy explained the role of fuel cells in meeting Government emission reduction targets. Natural gas powered fuel cell CHP systems cut CO<sub>2</sub> emissions by 40% or, if biofuels are used, there are zero carbon emissions. Other benefits of the fuel cell include greater energy security and cutting emissions of particulates. There are only a small number of fuel cells in the UK but the operational capacity is increasing to 0.5MWe this spring when a 200kW tri-generation system in the HQ of Southern Electricity starts up. For small fuel cells used for uninterrupted power supplies (UPS) payback can be in months not years, due to maintenance savings. The recent Feed in Tariff is abysmal, it is a major obstacle to the introduction of larger stationary fuel cells in the UK as it supports renewable energy, not fuel cells. At current gas

and electricity prices, the payback for CHP fuel cell units is 13 years, but the price of electricity compared to gas will increase as new plant powered by wind, nuclear energy or coal with carbon capture and storage are introduced. They are aiming for payback in 3 years. The electricity price increase projected by OFGEM is 5% per year. That would be about 60% by 2020, which would give a 20% return on investment. Fuel cells will have an important role in the new smart grid. Availability is over 95% and they can be operated anywhere as they are so clean and quiet. The latest fuel cell system employs quad generation - that is electricity, heating and cooling, as well as producing hydrogen, which can be used on site to power electric vehicles. The first markets are for data centres, hospitals, industry, commercial developments, universities and leisure facilities. Fuel Cells UK is continuing to campaign for larger fuel cells, up to 5MW, to be eligible for payments under the UK's Feed In Tariff scheme.

## TRANSPORT AND DISTRIBUTED ENERGY IN ASIA

From China, Prof Wei Guo Wang, Deputy Director of the Ningbo Institute, said that about 200 fuel cell vehicles were running at the 2010 Shanghai Expo. Solid oxide fuel cells are now ready for commercialization in 10 to 100 kW units. They are supplying fuel cells around the world at €4000/kW but the system cost is projected to reduce to a fifth of this in three years time.

Dr Rajendra Basu of the Glass and Ceramic Institute, India, said that the energy sector is the predominant source of carbon dioxide and methane emissions and a long term programme is needed to move from carbon to the hydrogen economy. India has a high economic growth rate and much expertise. They need distributed power and fuel for transport and are interested in SOFC, PEM, PAFC and AFC as well as hydrogen technology. Many large companies are involved, including Bharat, GE, General Motors, Reliance Industries,

Tata, Reva and Mahindra. Their National Hydrogen Energy Board road map projects 1 million hydrogen powered vehicles and 1,000MW of hydrogen based distributed power by 2020.

## VALESWOOD SPONSORS HYDROGEN FUEL CELL AWARD

Valeswood Fuel Cells launched its 12 volt 'Powerbox' at the exhibition. The Powerbox is easy to use and refuel and powers computers, cameras, phones, lighting systems and small electric motors. The Powerbox uses green hydrogen gas to create silent and pollution free energy. It is easy to transport and can be used in all sorts of locations. The Powerbox stores hydrogen in a unique metal hydride canister which fuels an air cooled proton exchange membrane fuel cell. It contains an advanced electric and gas monitoring system to deliver a reliable and long lasting source of electricity in the workplace, home or in remote places in the countryside. It meets all European and British safety standards.



Valeswood Fuel Cells sponsored the 2010 British Midlands Hydrogen Forum Award presented to Professor Rex Harris of Birmingham University for his lifetime achievement in the development of hydrogen fuel cells. The Award was made by Dr Rupert Gammon (right) to Professor Harris at the conference. Prof. Harris has been using hydrogen for the past 40 years and it powers his boat, the Ross Barlow.

**For presentations from Hydrogen and Fuel Cells for Clean Cities see [www.climate-change-solutions.co.uk](http://www.climate-change-solutions.co.uk) select EVENTS and scroll down below the programme.**

## FUELCELL ENERGY'S PROPOSALS FOR DISTRIBUTED ENERGY

FuelCell Energy has called for support for the plan by US Senator, Christopher Dodd, to spur broader use of fuel cell power plants and create U.S. jobs and manufacturing. Senator Dodd's proposal would encourage federal agencies and private business to increase their use of fuel cells as a source of electricity.

At FuelCell Energy's manufacturing plant in Torrington, Connecticut, Senator Dodd publicly announced a program to foster an immediate demand for fuel cell power plants. Building on aspirations set out in the 2005 Energy Policy Act, the proposal seeks to expand the number of U.S. government facilities powered by this form of clean energy. The program also seeks to broaden the use of fuel cells in the private sector by boosting the investment tax credit (ITC). Currently, when a business purchases a fuel cell for a highly efficient Combined Heat and Power (CHP) application, it is eligible for an ITC of up to 30% of the plant's cost (up to \$3,000 per kilowatt). The new plan increases the ITC up to 40% of cost (up to \$3,500 per kilowatt) for CHP applications.

The widespread utilization of FuelCell Energy's power plants would contribute to fulfilling many Government initiatives. It would increase power reliability, improve energy security by distributing smaller power plants, and ensure greater energy independence by utilizing domestic fuel sources. The resulting demand for fuel cell power plants would be expected to drive U.S. manufacturing and create new jobs.

### US GOVERNMENT IS WORLD'S LARGEST ENERGY USER

Many federal facilities are well-suited to the compact, quiet profile that on-site fuel cell power plants represent. Under the Dodd proposal, government

agencies would be required to identify qualified locations. "The U.S. government is far and away the No. 1 user of energy in the world; no one else even comes close," said R. Daniel Brdar, Chairman and CEO of FuelCell Energy. "A program like this is a chance for the government to lead by example, and put these home-grown technologies to use for creating jobs, building a market for clean-tech products and sustaining American manufacturing. The positive effects would ripple through our economy for years to come."

### KOREA INCLUDES FUEL CELLS IN RENEWABLE PORTFOLIO STANDARD

The Republic of Korea has announced the passage of a Renewable Portfolio Standard (RPS) which will mandate the introduction of 350 megawatts (MW) of additional renewable energy per year from 2012 through 2016, increasing to 700 MW per year through 2022. Carrying forward the policy introduced under Korea's feed-in tariff program, the Government has elected to designate fuel cells operating on natural gas and biogas as "New and Renewable Energy," fully qualifying under the new program.

"South Korea recognizes the inherent advantages of fuel cell power generation - clean, low carbon, dependable and reliable - and this announcement consolidates our place in the mandated mix of ultra-clean and renewable energy," said Ben Toby, Vice President of Global Business Development for FuelCell Energy. "With our successful track record in Korea, and our strong relationship with our partner, POSCO Power, we are confident that this new policy will help drive our international market growth. There is no other fuel cell company on the planet with the products that meet

Korea's need for baseload, clean power for grid-support as well as ours."

Highly efficient, clean and reliable fuel cells operating on widely available natural gas, as well as renewable biogas from wastewater treatment facilities, agricultural waste streams, and food and beverage facilities, will help South Korea achieve these RPS targets. There are already 24 MW of FuelCell Energy power plants operating in South Korea, providing baseload power to the grid, which complements and supplements power produced from intermittent sources like wind and solar. FuelCell Energy's fuel cells are twice as electrically efficient as other distributed generation of their size, which means less fuel is used. Because fuel cells produce power electro-chemically, without combustion, they produce near-zero emissions and have proven to be highly reliable since going commercial in 2003. FuelCell Energy currently has 97 megawatts of products installed or in backlog worldwide.

Considering the mandated requirement for the addition of substantial new renewable capacity before 2012, utility companies throughout South Korea are expected to move project development plans into high gear. To meet the expected demand, further the cost reduction progress, and consolidate market leadership, POSCO Power and FuelCell Energy have announced a strategy to localize certain manufacturing, under which fuel cell stack modules will be manufactured by POSCO Power in Korea from core components produced by FuelCell Energy in Connecticut. POSCO has already commenced operation of its new balance of plant facility in Pohang and is expected to begin the expanded scope of manufacturing later this year.

## RESULTS OF OPERATING HYBRID POWER PLANT IN TORONTO

FuelCell Energy has released data for the first year of operation of its 2.2MW ultra-clean hybrid power plant in Toronto. The system known as the Direct Fuel Cell – Energy Recovery Generation™ (DFC-ERG) significantly reduces air pollutants compared with other power generation alternatives, while achieving record peak electrical efficiency over 70%, average electrical efficiency of 62.5%, availability over 93% and reduced greenhouse gas emissions of up to 45%.



Since January 2009, Enbridge Inc. monitored the DFC-ERG plant under several configurations - matching operating modes for different markets - to measure its emissions and electrical efficiency. The results underscored the plant's successful operation over a range of scenarios.

## THE TECHNOLOGY

Natural gas is transported via pipelines under high pressure most of the time, but as the gas enters urban centers, its pressure is reduced at "letdown" stations so that it may be safely distributed to homes and businesses. A hybrid system incorporating a turboexpander and a Direct Fuel Cell in a letdown station enables the released energy to be converted to high grade electricity and heat. The heat from the fuel cell obviates the need for a boiler to maintain the temperature of the gas - a step which itself burns some gas, wastes energy and pollutes the air. This joint development effort of FuelCell Energy and Enbridge produces 2.2 megawatts (MW) of electricity, enough to power approximately 1,700 homes.

## MONITORED RESULTS

While the DFC-ERG unit demonstrated an availability averaging 93% for the entire year, it exceeded 96% availability during the final six months of 2009. Similarly, although its average electrical efficiency of 62.5% compares favorably to typical conventional fossil fuel generation of about 35 to 40% efficiency, the plant's peak electrical efficiency topped 70% in some of the scenarios under which it was evaluated. In all of the tests, the benchmark for air quality was the clean air standard from California, which is the toughest in the nation. The system's high electrical efficiency allowed it to reduce greenhouse gas emissions by up to 45% compared to a conventional natural gas power plant.

## US AND INTERNATIONAL INTEREST

"All the time we were operating this plant and getting remarkable electrical efficiencies, we were seeing availability numbers in the 90s," said Chuck Szmurlo, Vice President, Alternative and Emerging Technologies, Enbridge. "That tells me this is a commercially robust

technology. We will submit our results to be independently verified and, when the review is complete, we'll disclose our data to the industry."

FuelCell Energy and Enbridge are making commitments for other systems totalling 18 MW in Connecticut and gas utilities in other U.S. states are also evaluating the technology. International interest in the Toronto project was stimulated by the evaluation by the Asia Pacific Partnership, a clean energy cooperative involving Australia, Canada, China, India, Japan, South Korea and the United States. "Enbridge's validation of the DFC-ERG system is a significant milestone, especially since the market potential is worldwide," said R. Daniel Brdar, CEO and Chairman of FuelCell Energy. "It gives gas utilities a way of improving pipeline efficiency, reducing emissions and delivering clean energy to the world's power grid as a by-product of their daily operations."

## THE FIRST MARKETS

As well as achieving very high efficiency for the gas utilities, FuelCell Energy's products can be powered by indigenous energy supplies. Food and drink producers utilize biogases given off during processing to power their fuel cells. Hospitals and prisons, which require secure supplies of electricity and heat, are reducing energy costs as well as harmful atmospheric emissions. Manufacturers rely upon fuel cells to provide both electricity and heat for 24 hours a day. Wastewater treatment plants can obtain a large part of their electricity and heat from the methane which may otherwise be emitted as a potent greenhouse gas. Educational premises enjoy reduced energy costs, while at the same time having on site a first class facility to train the engineers needed to service the growing fuel cell industry. [www.fce.com](http://www.fce.com)

# INSTALLING THE HYDROGEN INFRASTRUCTURE

## AIR PRODUCTS' RENEWABLE HYDROGEN FUELLING STATION

Air Products has announced a project which incorporates FuelCell Energy's DFC-H2® technology in a hydrogen fuelling station. The DFC-H2® can produce clean power and heat as well as renewable hydrogen. Air Products was awarded the main contract by the California Air Resources Board, with support from the South Coast Air Quality Management District and the U.S. Department of Energy. The project is based on the successful evaluation of the technology by the two companies during 2009.

The hydrogen will supply the state-of-the-art hydrogen fuelling station to be installed by Air Products at the Orange County Sanitation District's (OCSD) wastewater treatment facility in Fountain Valley, California. The system will be fueled with biogas from wastewater treatment operations and produce 300 kilowatts of power and up to 300 pounds of hydrogen per day. This hydrogen could be used for early market fuel cell applications, such as back up power and forklifts and is sufficient to fuel roughly 100 fuel cell cars. The electricity will be available for use by OCSD for its operations. Christopher Bentley, FuelCell Energy's Executive Vice President of Government Research & Development Operations said: "Our research indicates that hydrogen efficiently produced as a byproduct by the DFC-H2® can be less costly than hydrogen produced by other methods and can enable the expansion of ultra-clean, hydrogen production systems worldwide, while providing the benefits of distributed power generation."

## UK AWARD FOR HYDROGEN INFRASTRUCTURE

Air Products has been awarded the UK's prestigious Rushlight Hydrogen and Fuel Cell Industry Award for its Series 100 Hydrogen Fuelling Station. As the automotive industry increases its investment in developing fuel cell vehicles and power systems, the challenge of infrastructure is being addressed at the same time. The Rushlight judges recognized Air Products' Series 100 Hydrogen Fueling Station as a first step to do this in the UK, demonstrating the potential for further market penetration in the future. The current Series 100 systems in place form a 'backbone' of hydrogen fuelling facilities and the basis of a UK Hydrogen network. The further development of this network will strengthen the UK's hydrogen position globally, ultimately helping generate carbon savings. It also makes the UK an attractive place for Original Equipment Manufacturers (OEMs) to bring hydrogen vehicles and further develop the marketplace.



Air Products' latest hydrogen fuelling station is at Long Island, New York. They have already placed over 110 hydrogen fuelling stations in the United States and 18 countries worldwide. Cars, trucks, vans, buses, scooters, forklifts, locomotives, planes, other material handling equipment, and even submarines have been fueled with this trend-setting technology that involves Air Products' know-how, equipment and hydrogen. [www.airproducts.com/h2energy](http://www.airproducts.com/h2energy).

# REPORT FROM FC EXPO 2010, THE WORLD'S LARGEST FUEL CELL EXHIBITION

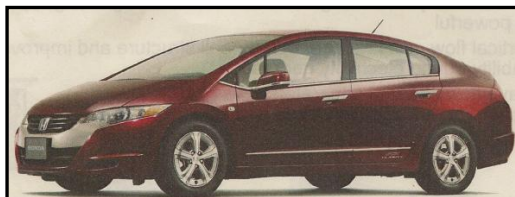


Ronald Hodkinson of Diverse Energy Ltd was very impressed by FC Expo 2010 which was held this spring in Tokyo. This is currently the largest fuel cell exhibition in

the world with over 500 exhibits. The show and conference were very well attended, with 47 countries participating and the conferences oversubscribed. In this report we will attempt to give an overview of the main developments and trends. In the Fuel Cell Exhibition there were two major developments first, the Honda FCX Clarity Car and secondly, SOFC by New Energy Foundation, Japan's CHP Group.

## HONDA'S FUEL CELL CHALLENGES THE INTERNAL COMBUSTION ENGINE

The Honda FCX Clarity Car represents a major breakthrough in technology. You could see it, touch it and drive it - it really works! The car was available for test drives throughout the conference and we understand that two vehicles are coming to Europe for a demonstration program. This vehicle contains Honda's revolutionary Vertical Flow Fuel Cell Stack, which is the secret of its performance.



The 52 litre stack weighs 67 kg and is 750mm long x 185 wide x 370 high. This stack gives 100kW peak power and up to 30kW steady state. The significance of this is that it is the first fuel cell to challenge the power density of an internal combustion engine.

There are five major developments incorporated into this product and it is the totality of these that accounts for the exceptional performance:-

- The Membrane used is a JSR Corp Aromatic Membrane. This gives high current density and conductivity at an operating temperature of 95°C. An indication of the performance is the fact that the voltage is 0.66V per cell at 100kW peak power.
- The Cell Structure is 3-dimensional and gives the best effective plate area and exceptional cooling. We estimate the nominal active plate area to be around 300 sq cms. Honda calls this a Vertical Flow Fuel Cell Stack. The cooling has to be exceptional – at 100kW the stack dissipation is circa 50kW.
- The mechanical construction: long thin stacks with drawbars have long been a problem in mobile environments. Honda have solved this by using an aluminium rigid box girder for the case with spring packs at both ends. This prevents flexing when negotiating bumps in the road. One end of the stack has the gas services for H<sub>2</sub> and air on a manifold. The other end has the busbars with water cooling and is attached directly to the DC/DC converter, which boosts the actual stack voltage to 270V for the lithium ion battery pack. At peak power around 20kW is consumed for air compression so the stack gives

100kW and the battery pack 25kW to give 100kW at the motor. Peak air pressure we understand is around 2 bar and is not enriched.

- Vehicle layout: the fuel cell stack sits in the transmission tunnel between the driver and passenger. The gas services face forward into the engine compartment where the air compressor/humidification/filtration systems are sited. The back of the stack goes to the DC/DC converter with the 270V battery beneath the rear seat. The cables then go forward to the inverter pack over the motor/transaxle front wheel drive unit. The motor is a brushless DC PM Design. The hydrogen gas tank is in the boot and operates at a service pressure of 350 bar and holds circa 7kg of gas - enough for 300-400 mile driving range dependent on conditions.
- Wide temperature range performance: the aromatic membrane operates from -30°C to + 95°C. The stack is designed for all water to drain down when shut down and this contributes to fast warm up at low temperatures.

## HONDA'S FORMULA 1 TEAM TRANSFERRED TO FUEL CELL VEHICLES

Honda controversially pulled out of Formula 1 and put its team to work on fuel cell vehicles - a strategy that has more than paid off with the FCX Clarity. This development represents a huge step forward for Honda and the fuel cell industry. To overcome fuel supply problems, Honda offers a home electrolyser that permits high pressure hydrogen generation from a wall socket.

## JAPAN'S CHP FUEL CELL PROGRAM

The next big thing was the development of SOFC at the New

Energy Foundation - the Japanese Domestic CHP Fuel Cell Program. For the last seven years they have been developing a system based on PEM Technology and a steam reformer and several thousands are in the hands of Japanese consumers. This year has seen the introduction of high temperature solid oxide fuel cells, which brings Japan into line with other major players, such as Ceramic Fuel Cells. The reasons why this happened are as follows:

- Solid oxide works well in this application
- A single box reforms and produces power
- Clean water is not required for reforming
- System efficiency is higher with SOFC: 50% versus 40% on Natural Gas
- SOFC is cheaper to manufacture than the PEM/reformer System
- High temperature corrosion and life issues are slowly being overcome with SOFC

The New Energy Foundation has installed 132 SOFC units for trial over the last three years. The units operate on a variety of fuels - natural gas, LPG and kerosene. In all these cases the system efficiency has proved better than the PEM system, with natural gas giving the best results. We understand that the New Energy Foundation has not abandoned the PEM solution as recent developments at Honda show that further improvement in performance is possible. This situation is one of work in progress.

The main Japanese exhibits were from the Japan Hydrogen and Fuel Cell Demonstration Program and the New Energy Foundation. There were hundreds of smaller Japanese company stands promoting both stacks especially for bicycles and balance of plant equipment. The Japan Hydrogen and Fuel Cell 'Ride and Drive' was particularly popular, with eight vehicle types available for test and the HINO/Toyota FC Bus

ferried visitors to the local metro station throughout the show.

## EUROPE AND OTHER COUNTRIES

So who was at the show from Europe? Germany, France and Finland had Pavilions. Ceramic Fuel Cells were on the German Pavilion as they have an SOFC production facility there.

From the UK, ACAL Energy had their own stand with their FLOWCATH System. This is similar to a PEM fuel cell but instead of a stack/humidifier there is a stack/regenerator. The cathode reaction takes place in the regenerator, a separate unit to the stack where water and air react with a proprietary liquid catalyst. Why do this? It is claimed this is a 'No Platinum PEM Fuel Cell' but there needs to be more demonstration before any assessment can be made.

The other major European Stand was Morphic Technologies from Sweden. They exhibited a range of PEM stacks and fuel cell systems from 2 - 10KW and seem to be focussed on stand-alone systems. London's City University had a booth promoting positive displacement screw compressors. Other major Pavilions were the USA, Canada and Taiwan.

## RELATED TECHNOLOGIES, BATTERIES AND PHOTOVOLTAICS

What of the other Exhibitions? Fuel cells will be utilized alongside and complement battery electric vehicles, as well as renewable energy technologies. In the first ever Rechargeable Battery Expo there was a focus on batteries for traction and EVs. Pure EVs using nickel metal hydride (NIMH) or lithium ion will double the size of the global battery industry over the next 5 - 10 years and a wealth of mass production equipment was on display. One major theme was the emergence of traction batteries for rapid transit vehicles. On a smaller scale it seems that someone has finally cracked the problem of making a zinc secondary battery.

POWERGENIX based in California launched their range of nickel zinc rechargeable cells in A-D packages at 1.6V.

Honda's latest solar hydrogen station for refuelling the FCX Clarity was recently opened in California



The Tokyo PV Expo had 1000 stands which is a testament to the size of this industry. The main theme was larger and better solar panels. The New World Standard is a 2 x 1 metre panel which gives 250Watts - 30V at 8.33A. A single panel charging 2 x 12V 200AH batteries can supply 100Watts to a home with no mains connection - enough for lights, fridge, computer and TV if used intelligently. Alternatively large arrays of panels can supply megawatt size installations. Ten manufacturers had 2 x 1 metre panels including Sharp, Kyochera and Indosolar. Sharp demonstrated their latest panel which boasts an efficiency of 35.8% when used in space - a new world record.

[www.diverse-energy.com](http://www.diverse-energy.com)

## BLOOM ENERGY ANNOUNCES INDUSTRY-LEADING CUSTOMERS

The Bloom Energy Corporation, a Silicon Valley-based company, is committed to changing the way people generate and consume energy. The Bloom Energy Server™, a patented solid oxide fuel cell (SOFC) technology, provides distributed power generation, enabling customers to create their own electricity on site. The Company claims that it is a cleaner, more reliable and more affordable alternative to today's electric grid as well as traditional renewable energy sources.

The company introduced its groundbreaking technology at an event hosted at eBay Inc. Headquarters, along with California Governor Arnold Schwarzenegger, General Colin Powell, and several of their early customers. The materials used in the manufacture of the SOFC are affordable and in abundant supply. Bloom's fuel cell technology is distinct in four primary ways: it uses low cost materials, provides unmatched efficiency in converting fuel to electricity, has the ability to run on a wide range of renewable or traditional fuels, is easily deployed and maintained and can provide power '24/7'. Each Bloom Energy Server provides 100 kilowatts (kW) of power and takes up roughly the area of a parking space. This is enough power to meet the needs of approximately 100 average U.S. homes or a small office building. For more power, customers simply deploy multiple Energy Servers side by side. The modular architecture allows customers to start small and "pay as they grow".

### 3 TO 5 YEAR PAYBACK AND CUTS CO2 EMISSIONS

Bloom's customers have deployed this technology in order to lower or fix their energy costs, while significantly cutting their carbon footprint and enhancing

their energy security by reducing their dependence on the grid. Customers who purchase Bloom's systems can expect a 3-5 year payback on their capital investment from the energy cost savings. Depending on whether they are using a fossil or renewable fuel, they can also achieve a 40-100% reduction in their carbon footprint as compared with the U.S. grid.



"Bloom Energy is dedicated to making clean, reliable energy affordable for everyone in the world," said Dr. KR Sridhar, principal co-founder and CEO of Bloom Energy. "We believe that we can have the same kind of impact on energy that the mobile phone had on communications. Just as cell phones circumvented landlines to proliferate telephony, Bloom Energy will enable the adoption of distributed power as a smarter, localized energy source."

Dr Sridhar continued, "Our customers are the cornerstone of that vision and we are thrilled to be working with industry leading companies to lower their energy costs, reduce their carbon footprint, improve their energy security, and showcase their commitment to a better future. Whether a customer wants to reduce its carbon footprint or its energy bills, or both, the Bloom Energy Server provides the solution,"

Since the first commercial customer installation in July 2008, Bloom's Energy Servers have collectively produced more than 11 million kilowatt hours (kWh) of electricity, with CO2

reductions estimated at 14 million pounds – the equivalent of powering approximately 1,000 American homes for a year and planting one million trees.

## POWDER TO POWER - HOW IT WORKS

Founded in 2001, Bloom Energy can trace its roots to the NASA Mars space program. Sridhar and his team were charged with building technology to help sustain life on Mars using solar energy and water to produce air to breathe and fuel for transportation. They soon realized that their technology could have an even greater impact here on Earth and began work on what would become the Bloom Energy Server. The Bloom Energy Server converts air and nearly any fuel source – ranging from natural gas to a wide range of biogases – into electricity via a clean electrochemical process, rather than dirty combustion. Even running on a fossil fuel, the systems are approximately 67% cleaner than a typical coal-fired power plant. When powered by a renewable fuel, they can be 100% cleaner. Each Energy Server consists of thousands of Bloom's fuel cells – flat, solid ceramic squares made from a common sand-like "powder."

## FOUNDATION CUSTOMERS

Bank of America's 500kW installation will help to eliminate their need for diesel generators, it will dramatically reduce the company's carbon footprint and provide energy cost stability. It will power one of its largest 24/7 call centers located in Southern California. As part of its Energy & Climate Protection strategy, Coca Cola is committed to improving the energy efficiency of its plants and fleet while reducing greenhouse gas emissions in cold drink equipment. Coke's 500kW fuel cell installation at its Odwalla plant in California will run on re-directed biogas and is expected to provide 30% of the plant's power needs while reducing its carbon

footprint by an estimated 35%. Cox Enterprises is a leading communications, media and automotive services company, which aims to conserve resources, embrace renewable forms of energy and reduce the company's greenhouse gas emissions. Cox sited its first 400kW biogas powered Bloom Energy Server at its KTVU television station in Oakland, California. eBay Inc has set an ambitious carbon reduction goal of 15% by 2012 over a 2008 baseline as part of an overall strategy to run their business in ways that have less impact on the planet. The company has installed two solar arrays and has collaborated with Bloom to pioneer a first-of-its-kind installation that, as of spring 2010, will be powered by 100% renewable biogas.

FedEx Corporation seeks to diversify its energy supply whenever possible, relying on energy sources such as wind and solar power. An early adopter of solar technology, the company is evaluating five 100kW Bloom Energy Servers to complement solar power at its hub in Oakland, California. Google was Bloom Energy's first customer in July 2008 and was attracted to the solution because of its fuel flexibility, easy deployment and payback period. Google's 400kW installation powers a facility that includes an experimental data center. "As we work hard to reduce Google's environmental footprint and improve our sustainability, we're pleased to be able to use on-site clean power generated by Bloom Energy," said Rick Needham of Google's Green Business Operations.

Staples Inc has pledged to reduce its absolute carbon emissions by 7% by 2010 and has evaluated many alternative energy sources. Staples' first 300kW installation is located at their Ontario, California distribution center and the company believes Bloom Energy Servers can provide significant power for their large facilities and distribution centers in the future. Mark Buckley, vice president of environmental affairs, said "Through

our relationship with energy leaders like Bloom, Staples is not only able to reduce our operating costs but we are reducing our environmental footprint in the local communities in which we operate." Walmart have set a vision of supplying their operations with 100% renewable energy and have completed the deployment of 400kW Energy Servers in two southern California retail locations. "We hope to use our scale to help bring these technologies to market in a fast and cost effective way," said Bill Simon, Chief Operating Officer of Walmart. [www.bloomenergy.com](http://www.bloomenergy.com)

## NEWS

### CFCL WELCOMES BLOOM

Another leading manufacturer of solid oxide fuel cells, Ceramic Fuel Cells Ltd (CFCL), has welcomed the media attention that Bloom has generated. Bloom can help to educate the media, policy makers and the general public about fuel cells and the enormous benefits of distributed generation. Bloom's solid oxide fuel cell products are for a different application and target market. Bloom is making large 100kW units for commercial and industrial installations, while CFCL is focused on small generators of 1-2kW for residential markets. It is quite difficult to scale fuel cells up and down between these market segments. Fuel cells are a bit like batteries: they are best suited to certain sizes, for example a watch battery cannot be scaled up to power a car or vice versa.

### CFCL BUILDS UP CUSTOMER BASE

Ceramic Fuel Cell's BlueGen combined heat and power unit has now received European Conformity (CE) Approval for use throughout Europe. The testing program assessed the BlueGen and its components for compliance with all relevant European safety codes and requirements, addressing the Gas Appliance

Directive (GAD), the Electromagnetic Compatibility Directive (EMC-D) and the Low Voltage Directive (LVD). BlueGen units generate electricity in the home far more efficiently than the current European power grid, cutting energy bills and significantly reducing carbon emissions.

Ceramic Fuel Cells is continuing to build up its order book for BlueGen units from major utilities and other foundation customers in Germany, the United Kingdom, The Netherlands, Japan and Australia, including E.ON Ruhrgas, EWE, RheinEnergie, Alliander, Gastera, Mitsui & Co and Osaka Gas. Ceramic Fuel Cells has also deployed fully integrated power and heating products with two leading energy companies, E.ON UK in the United Kingdom and GdF Suez in France. From mid-2010 Cosvegas will operate a BlueGen unit in Lausanne to evaluate the technology for further deployment in Switzerland. The latest order in the UK has come from Ideal Boilers, an established developer of high efficiency and low emission electricity generation units for homes and other buildings. Ideal Boilers will demonstrate the fuel cell at their manufacturing facility in Hull. [www.cfcl.com.au](http://www.cfcl.com.au)

### MARKET GROWTH FOR STANDBY AND PORTABLE POWER

UPS Systems' Managing Director Tom Sperrey has forecast significant commercial growth for the UK fuel cell industry this year. While countries like Germany, Japan and America have embraced fuel cell technology, the UK has until now lagged behind, with high capital costs serving as a major barrier to widespread adoption of fuel cell technology. However, Tom Sperrey believes the UK fuel cell landscape is to change in the next 12 months, as costs fall with new products entering the market.

"2010 is bringing with it a new wave of fuel cell activity," he said. "Already new products are launching into the market and companies continue to

show interest in learning more about fuel cells and adopting clean technology. We are currently discussing fuel cell system roll-outs with several major corporates and NGOs. Under a grant from the Technology Strategy Board (TSB) we are part of a consortium working to develop new technologies that reduce the use of expensive materials in fuel cells. As these developments are rolled out commercially, we expect capital costs to fall and make the technology financially attainable for more businesses."

"Growth hotspots at present are traffic signalling, remote monitoring and security, using smaller hydrogen and methanol fuel cells, with power ranges between 25W to 150W for prime power and up to 15kW for standby power," he continued. "Because smaller fuel cells are reliable, durable and portable, they are better suited to these types of applications. In these growth hotspots, fuel cells offer extended runtimes. For example, a fuel cell equipped with a 28 litre canister of methanol can easily operate equipment continuously for up to six months without human interference, thereby reducing the costs of manpower, transport and materials associated with sending someone to replace batteries on a regular basis. Smaller units have the potential to revolutionize the UK fuel cell industry. They are suitable for a range of applications and are proven technology in a growing number of commercial installations. With falling capital costs, and increased savings through lower running and maintenance costs, these smaller units are beginning to achieve widespread adoption across the UK. As capital costs fall, further applications become viable and create greater demand for fuel cells as an alternative and sustainable source of power."

In summary, Tom Sperrey's predictions for 2010 are:

- Costs for smaller fuel cells will continue to fall

- Fuel cell growth hotspots will be in low power applications
- When servicing is taken into account, fuel cell extended runtimes will give businesses a much cheaper source of power
- By working together with research partners, UPS Systems are helping to develop technology that will drive down fuel cell capital costs even further.



UPS Systems exhibited the EFOY Pro 2200 at the Data Centre World Conference this spring. The EFOY Pro 2200 offers 38% more power than the EFOY Pro 1600; it generates 90W of electricity and is suitable for a range of prime and standby power applications. As with all fuel cells in the EFOY range, the EFOY Pro 2200 is a 'plug and play' solution - customers do not need special expertise to install it. "EFOY has proved that, in some situations, its fuel cells can save users up to 90% in operating and maintenance costs, so the argument for investing in fuel cell technology continues to grow," said Tom Sperrey. In addition, the new unit offers several benefits for traffic regulation, surveillance and remote monitoring applications.

**Traffic regulation:** The EFOY Pro 2200 is robust and doesn't require maintenance, so it can be left alone for long periods. An EFOY Pro 2200 using a 28-litre methanol cartridge can power a 50W traffic signal serial blinker for 26 days, while a traditional battery can only power it for one day.

**Surveillance:** The EFOY Pro 2200 is suited to powering security cameras and other surveillance applications.

Using a 10-litre methanol cartridge, it provides 11.1kW of electricity – enough to power a 25W camera for three weeks without intervention. The compact fuel cell fits into small spaces, and is quiet and emission-free, so systems can run undetected.

**Remote monitoring:** Like other fuel cells in the EFOY range, the EFOY Pro 2200 can be used in hybrid installations that take advantage of renewable energy sources such as solar or wind. Such configurations recharge the batteries that power electrical equipment. This makes the EFOY Pro 2200 suitable for standby power

applications and for operation in remote areas where there isn't easy access to the grid. The EFOY Pro 2200 can be located outside, and can operate in all weather conditions.

The manufacturers of EFOY fuel cells, Smart Fuel Cell AG, have shipped more than 16,000 fully commercial products to industrial and private end users for more than five years. They have created a convenient supply infrastructure for their fuel cartridges, which deliver week-long autonomous energy and can be obtained from more than 1,400 sales points in Europe. [www.upssystems.co.uk](http://www.upssystems.co.uk) [www.sfc.com](http://www.sfc.com)

## EVENTS

**13th May 2010 Fuel cells - real world applications for business. UPS Systems, Hungerford, Berkshire.** This event will provide delegates with an insight into the commercial applications for fuel cell products, featuring case studies that highlight the business benefits of fuel cells and showcasing working demonstration units. Topics covered are: current state of the market, fuel cells for prime and standby power, portable and stationary fuel cell installations, lowering the cost and the future of the industry. The event includes lunch and is free of charge. [www.upssystems.co.uk](http://www.upssystems.co.uk)

**19th – 20th May 2010, All-Energy 2010, Aberdeen, Scotland.** The largest renewable energy show ever held in the UK covers international developments and includes the role of hydrogen and fuel cells. Technical tours and the 'Giant Networking Evening' are features of this free event. [www.all-energy.co.uk](http://www.all-energy.co.uk)

**14th – 16th June 2010, ASME 8th International Fuel Cell Science, Engineering & Technology Conference, Brooklyn, New York.** [www.asmeconferences.org/fuelcell2010](http://www.asmeconferences.org/fuelcell2010)

**29th June – 2nd July 2010, European Fuel Cell Forum, Lucerne, Switzerland.** [www.efcf.com](http://www.efcf.com)

Fuel Cell Power provides information about all types of fuel cells. It has been set up by the family and friends of the late Dr. F. T. Bacon, OBE, FRS, the fuel cell pioneer who was concerned about the effects of discharging the by-products of combustion into the atmosphere.

Information can be obtained from: Jean Aldous, Editor, Fuel Cell Power, The Gallery, The Street, Woolpit, Suffolk, IP30 9QG. Telephone : 01359 245073

[www.hydrogen.co.uk](http://www.hydrogen.co.uk) [www.futureenergies.com](http://www.futureenergies.com) [www.fuelcellpower.co.uk](http://www.fuelcellpower.co.uk)