

FUEL CELL POWER

The magazine for the power source of the future



HEADLINE NEWS

There are already markets for fuel cells as generators of low power for computers, CCTV, remote monitoring systems, LED lighting and reliable back up. This summer fuel cells are contributing to a variety of leisure activities, providing portable power for boats or bikes. They can either be refuelled with methanol, or hydrogen fuel cells can be recharged from micro wind and solar energy. Procurement of fuel cells by regional and local governments is helping to expedite the volume production of fuel cells. In Australia, the Victorian Government is installing fuel cells in homes and in the UK the City of Leicester is hosting the first fuel cell car project. Fuel cells also provide an efficient, quiet, space-saving power source for hospitals, schools, universities and data centres.

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BUSINESS BENEFITS OF FUEL CELLS

UPS Systems plc held a seminar earlier this summer in order to provide organizations in the UK with an insight into the commercial applications for fuel cell technology, featuring case studies to highlight the business benefits. The event brought together some of the industry's leading manufacturers to discuss and demonstrate the practical application of the latest products.



Karen Sperrey, Operations Director of UPS Systems plc, outlined the advantages of fuel cells and indicated that the fuel cell systems currently available for stationary and portable power range from the methanol powered 25Watt (W) EFOY fuel cell from Smart Fuel Cell AG (SFC) to Hydrogenics' hydrogen fuelled 12kilowatt (kW) systems. Applications include signaling, CCTV, standby power and telemetry, which is the remote measurement, monitoring and reporting of data. Advantages are long autonomy (unattended operating time) as well as reliability, low maintenance costs and reduced noise and emissions. UPS Systems plc can provide remote monitoring for the fuel cell itself via landline or cellular phones with their REMO™ system.

Severn Trent Water operates 22 fuel cell units, which provide 3W continuous power to monitor reservoir levels and telemetry flow. They expect to achieve 300 days autonomy, which means that expensive visits to the site are minimized. It is also important to have pollution and noise free energy in environmentally sensitive areas. Welsh Water employs 90W EFOY2200 fuel cells in four locations. One fuel cell provides power for security access to reservoir hatches and another powers telemetry equipment. The other fuel cells provide electricity where it would be uneconomic to access the grid, or where mobility is required. The fuel cells are monitored by the UPS Systems REMO™.



The London Borough of Islington has a 65W EFOY Pro1600 portable demonstrator, together with a 'Pro-Cube' container for the fuel cell and the methanol cartridge. The Pro-Cube is a 'plug & play' solution which can be hooked up as a mobile unit or integrated into the appliance. It is suitable for outdoor applications. The methanol fuel cartridges have a high energy density. An 8kg container delivers 10 kilowatt hours (kWh) electricity, compared with the 85 kgs weight of a hydrogen container or 110kgs for an advanced battery delivering 10kWh.

STORING INTERMITTENT ENERGY



Hydrogen fuel cell systems may be used to store surplus electricity from intermittent renewable sources.

The Environmental Energy Technology Centre in Rotherham employs 36kW of fuel cells in a hybrid system with a 229kW wind turbine. Low power fuel cells are ideal for operation at remote sites. Npower Renewables uses a 50W EFOY fuel cell to provide continuous power for remote wind speed telemetry measurements.

RELIABLE BACK UP FOR SOLAR POWER



The EFOY fuel cell is not dependent upon the weather and provides 100% reliable power for a photovoltaic system when the sun is not delivering enough energy. A 'plug & play' solution ensures easy integration. The fuel cell operates when additional power is required so the solar panel can be sized for optimum efficiency.

The EFOY fuel cell provides long autonomy, so that there are

considerable reductions in maintenance costs. It is a mobile, compact and reliable system, which can be operated indoors or outdoors. Installation is thief-proof. It has no hazardous emissions and is silent like a PC. Both the fuel cell and the fuel cartridge have the internationally recognized TÜV certificate for safety, reliability and quality. So far, SFC Energy has sold over 18,000 of its fuel cell units around the world. There are also applications for military use where weight reduction is important. The UK Ministry of Defence is testing loads, autonomy and functionality of the EFOY and BOC fuel cells.

GROWING MARKETS FOR LOW POWER GENERATORS

Stuart Dow of BOC explained that new devices, combined with increases in efficiency, have created an enormous range of applications that only consume a few 10s to 100s of Watts of power. He said that the computing power per Watt had achieved a 100 fold improvement over the last ten years and that the potential uses for a few Watts of power continue to increase. The latest LED lights are nearly ten times more efficient than conventional lights. He quoted Prof Clayton Christensen of Harvard University, who said that new technologies cannot be compared with standard industry metrics but have to find operating niches where they can grow to overtake the incumbents.

BOC's Hymera hydrogen fuel cell power generator provides a viable alternative to petrol and diesel generators and large batteries. It weighs 10kg, stores about 3kWh of electrical energy and with a fuel cell efficiency of 50% it provides 100W for 30 hours. Electrical energy density is 150Wh/kg, which compares favourably with about 35Wh/kg for lead acid batteries, about 80Wh/kg for alkaline batteries and 100Wh/kg for expensive lithium ion batteries.

One of the new technologies which consumes low power is the LED floodlight. Just 120W of security lighting illuminates the lorry. Benefits for the customer using fuel cells are grid independence, recharging capability, longer operating times and more flexible usage.



COMPARATIVE ELECTRICAL ENERGY STORAGE AT LOW POWER

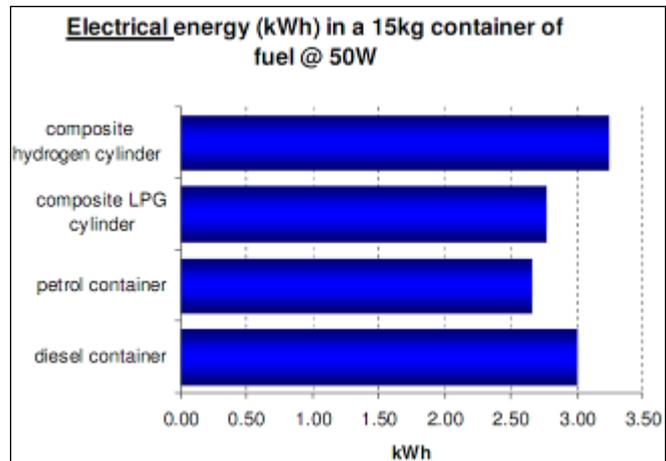
There is also the advantage that at low power a hydrogen cylinder may contain more electrical energy than conventional technologies

At low powers, hydrogen and fuel cells already have comparative fuel and logistic costs to taxed diesel or petrol.

Hydrogen and fuel cells also require less maintenance and have longer lifetime, which means lower service costs. They have much lower local environmental costs, in terms of both noise and air pollution.

SPACE SAVING POWER FOR DATA CENTRES AND OFFICES

For larger electricity generators, Mark Kammerer of Hydrogenics GmbH, outlined the advantages of hydrogen fuel cells. They ensure extended run times for uninterrupted power supplies (UPS). Compact high-density power generators save space and provide unlimited energy storage. They are modular, plug-in power generation units, with easy installation, interface and commissioning with standard UPS models. They can be upgraded for increased power. The systems have a highly efficient electrochemical conversion of over 50% for the prime operating range. They are impervious to start/stop cycling and more reliable than diesel engine plus generator combinations. Run time is predictable



with total accuracy and can be extended to weeks by additional hydrogen cylinders.

Hydrogen fuel cells are particularly suitable for data centres. Hydrogenics installed a 20kW system to provide standby power for Interlink Connectivity on the fifth floor of a 21 storey building in Toronto, where batteries would have been too bulky and a diesel generator too expensive. The fuel cell and the uninterrupted power supply are in the server room and hydrogen storage is in the adjacent room. Valuable data centre space is saved for revenue-generating equipment and runtime can be easily increased with additional fuel storage bundles. A 30kW system has been installed for an ICT communications company, Comtec Enterprises in Reigate, UK.



In the UK, UPS Systems plc made the first AC installation of a fuel cell standby system in their own office. The 12kW fuel cell system is linked to a 3 Phase uninterrupted power supply. They are working with supplier and customer partners to identify the first areas for fuel cell operation and to create solutions for an increasingly greater penetration into mainstream business.

FINDING THE BEST SOLUTION

Roger Foggitt, UPS Marketing Manager, found that two thirds of the delegates at the seminar had changed their opinion of fuel cells. Tom Sperrey, CEO of UPS, said that there has been a definite shift in the UK fuel cell industry. Last year they were educating the market about what fuel cells are and the benefits they have to offer organizations. This year it's clear that people are ready to buy and are actively looking for the best solution to meet their needs.

Since the seminar, Tom Sperrey said that they have taken new orders, and received several enquiries from companies wishing to adopt fuel cell technology. Estimates suggest that the market may be worth \$1bn by 2020. The forecast is that greater financial incentives at Government level for fuel cell integration will help drive acceptance and development of products in the market place. There is a wide range of fuel cell technologies of differing strengths,

some of which are available and cost effective now. Capital cost is falling over time and the key is technology selection. He thinks that 2010 could turn out to be a momentous year for fuel cells! www.upssystems.co.uk

NEWS

UK CONSULTATION ON MICRO-GENERATION

The Climate Change Minister, Greg Barker, has launched the UK Government's consultation on their micro-generation strategy, which is the first stage of their plan to help communities become more self-sufficient in the way they use heat and power. "I want to see more homes, communities and businesses generating their own energy" he said. "People and communities can save money on their fuel bills at the same time as generating an income and cutting carbon." Homes, schools and businesses are already guaranteed cash payments through the 'feed-in tariff' (FiT) for producing their own green electricity through technologies such as solar panels and wind turbines. However, support for fuel cells is limited to small systems up to 2kW.

Dennis Hayter, Chair of the UK Hydrogen and Fuel Cell Association (HFCA) has welcomed the commitment to support fuel cell systems up to 2kW but said that they are disappointed that larger scale CHP and electricity only fuel cells are not covered, particularly given the provisions available through the Energy Act 2008. They would like to see the upper limit for fuel cell installations (whether fuelled by fossil or by renewable fuels) set at 5MW to encompass the larger systems which are commercially available today. This would allow larger scale, decentralized, low carbon generation to benefit from the scheme, thereby contributing to carbon reduction objectives and accelerating progress in reducing the costs of fuel cell

installations. The HFCA has recently been formed through the merger of the UK Hydrogen Association and Fuel Cells UK. Dennis Hayter is also Vice President of Business Development at Intelligent Energy, which has developed fuel cells and fuel processing equipment for micro-generation. Those wishing to contribute to the consultation should email before 22nd December 2010: microgenconsult@decc.gsi.gov.uk

The Department of Energy and Climate Change (DECC) has overturned a ban on councils selling green electricity into the national grid. The Secretary of State for Energy and Climate Change, Chris Huhne, said that for too long, Whitehall's dogmatic reliance on 'big' energy has stood in the way of the vast potential role of local authorities in the UK's green energy revolution. www.decc.gov.uk

FUEL CELL BLACK CAB FOR LONDON

Intelligent Energy, Lotus Engineering, LTI Vehicles and TRW Conekt unveiled their fuel cell black cab at London's City Hall. It is powered by an Intelligent Energy hydrogen fuel cell system hybridised with lithium polymer batteries which enables the vehicle to operate for a full day without the need for refuelling. Capable of achieving a top speed of over 80 mph, the cab has a range of more than 250 miles on a full tank of hydrogen and refuels in about 5 minutes.



Kit Malthouse, a Deputy Mayor of London and Chair of the London Hydrogen Partnership said, "The black cab is a much loved London icon, but it is also a significant source of pollution. This prototype fuel cell black cab, which emits only water from its

tailpipe, is an exciting glimpse of how hydrogen technology could soon play a vital role in cleaning up air quality for urban dwellers." The Mayor of London, Boris Johnson, has committed to working with manufacturers to make all taxis operating in London with zero tail-pipe emissions by 2020. www.intelligent-energy.com

NEW METAL HYDRIDES FOR HYDROGEN STORAGE

IBC Advanced Alloys Corp., based in Vancouver, Canada, has signed an agreement with Hydrogen Link Inc. (HL) to advance HL's proprietary lithium beryllium hydrides technologies for hydrogen storage and fuel cell applications. HL is a leading materials research company focused on hydrogen storage, fuel cell and complementary technologies and has worked closely with McGill University.

Lithium beryllium hydrides are a new group of metal hydrides for hydrogen storage. Being the lightest metals in the Periodic Table, lithium and beryllium, combined with hydrogen, show the highest viable and reversible hydrogen capacity at practical temperatures of all known metal hydrides. These materials offer a new prospect for hydrogen storage, initially for small-scale applications, such as laptops and other portable devices, where capacity is critical.

HL's primary research is the development of light-weight materials and catalysts for solid-state hydrogen storage, to assist with the practical and energy-efficient delivery of hydrogen for fuel cell and hydrogen internal combustion engine applications and thus provide an alternative to storing hydrogen under very high pressures. www.ibcadvancedalloys.com

GOVERNMENT ORDER FOR THIRTY CFCL BLUEGEN UNITS

In Australia, the Victorian Government's Office of Housing has ordered 30 of CFCL's Blue-Gen fuel cells. They plan to install the units in public housing properties in metropolitan Melbourne and regional Victoria. The A\$1.35m project will demonstrate the operation of the units and the benefits to tenants by the generation of low emission power and hot water for the home. It is planned to install the 30 BlueGen units from late 2010 to early 2011, for an initial two-year project period.



The first of VicUrban's Bluegen units is already operating. They can generate electricity in the home at almost three times the efficiency of current Victorian coal-fired electricity generators, cutting energy bills and reducing carbon emissions by up to two-thirds. Over a year, each BlueGen can produce twice the electricity needed to power an average Victorian home – the excess power can be exported to the electricity grid. BlueGen also produces enough heat to meet the average home's daily needs for hot water. Announcing the project, Victorian Housing Minister Richard Wynne said "The truly exciting thing about BlueGen is that it is highly energy efficient and produces very low levels of greenhouse gases. That's not only a win for the environment, but also a win for public housing tenants through lower gas and electricity bills."

CUTTING LARGE CAPITAL COST INFRASTRUCTURE.

Ceramic Fuel Cells' managing director, Brendan Dow, said "The Federal Government recently suggested that Australia will need to invest at least A\$100 billion in electricity infrastructure during the next decade in order to meet growing demand for electricity and replace ageing infrastructure. Under the current system of centralized electricity production and distribution, the primary reason for increases in electricity prices is the cost of power production and distribution infrastructure. A smarter alternative, one that is gaining traction particularly in Europe, is distributed generation – the creation of power close to where it is used. A network of highly efficient gas-powered electricity generators installed in homes, offices, buildings and factories is significantly less expensive because it dramatically reduces reliance on large capital cost infrastructure. We are confident that the Victorian Government will become an important strategic customer of Ceramic Fuel Cells, and that their involvement will assist with building momentum for the take-up of our units, both in Australia and overseas."

BLUEGEN RESULTS

The following results have been obtained from the operation of BlueGen at Aurora, the Victorian Government's sustainable urban land development agency.

- Current electrical efficiency of 58%, compared to about 25% efficiency for coal-derived electricity.
- Constant output of 1.5 kilowatts of electricity.
- Cumulative power exported to the grid since the start of

operation is 876 kilowatt hours of electricity – equivalent to approximately 12,500 kilowatt hours of electricity over the course of a year, which is about twice the amount used by the average home in Melbourne.

- Cumulative carbon dioxide savings compared to the Victorian grid of 823 kilograms – equivalent to 12 tonnes over the course of a year. These carbon savings would effectively make the average Victorian home 'carbon neutral': the average Victorian household produces around 10.7 tonnes of greenhouse gas emissions each year from energy used in the home.
- Creating enough heat for 200 litres of hot water each day.

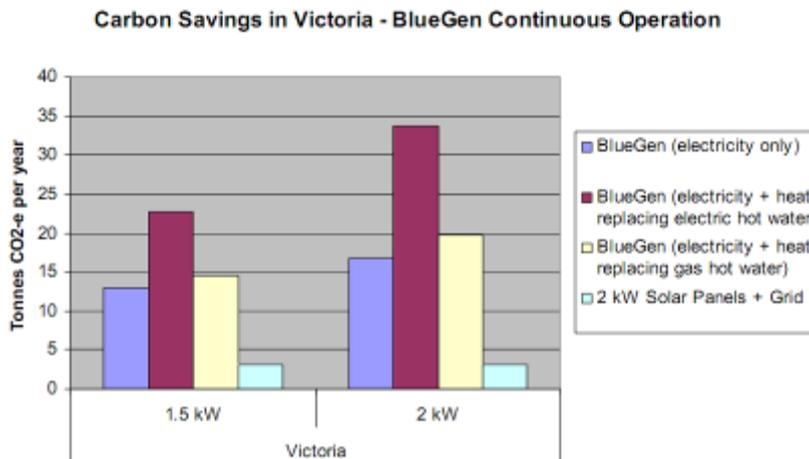
CARBON DIOXIDE SAVINGS GREATER THAN HOUSEHOLD EMISSIONS

A report by the Australian Government national science agency (CSIRO) has confirmed the significant carbon savings from CFCL's BlueGen gas-to-electricity generator. The report compares the greenhouse gas emissions of the BlueGen fuel cell unit with other means of providing electricity and heat to Australian homes and illustrates the potential carbon savings for households in the

states of Victoria and New South Wales.

The average household in Victoria produces around 10.7 tonnes of greenhouse gas emissions each year from energy used in the home. A home with a BlueGen unit can offset all of these carbon emissions – and more.

When continuously supplying electricity and heat and exporting surplus electricity to the grid, a 2kW BlueGen unit can save between 20 and 33 tonnes of carbon dioxide per year compared to the grid in Victoria. The savings would depend upon whether the heat displaces electric or gas heating in the home. The savings in New South Wales, where less coal is used for electricity generation, would be between 15 and 25 tonnes carbon dioxide per annum. By comparison, if an average home installs a 2kW solar PV system and imports the rest of its power from the grid, the carbon dioxide savings are about 3 tonnes per year. BlueGen also delivers many other environmental benefits: no nitrogen oxide or sulphur oxide emissions, and up to 95% less water is used than coal fired generators to produce the same amount of electricity. The Victorian Government is considering the cost effectiveness of extending the feed-in tariff provisions, which at present apply to small scale renewables, to low-emission technologies, including fuel cells.



DISTRIBUTED GENERATION

Several responses to the Prime Minister's Task Group's Energy Efficiency Issues paper have highlighted the benefits of distributed generation of electricity using fuel cells. The paper itself says that distributed generation can result in lower transmission line losses and higher overall energy efficiency if using co-generation or tri-generation, because waste heat can be used for heating and cooling. In their response, the Energy Networks Association (ENA) - the national body for Australia's gas and electricity network providers - says that Australia's energy use is projected to increase by more than 25% over the next decade which requires substantial investment to maintain and update the electricity infrastructure. This is already having an impact on electricity prices and will continue to do so. In the future, a typical customer could transform their energy profile by purchasing a 3kW combined heat and power fuel cell, and a 1.5kW solar PV system. They could reduce their reliance on the grid and move towards a more environmentally sustainable profile based on natural gas-fired generation, with only 15% energy conversion losses and 30% renewable generation. Jemena, a large gas and electricity distribution business, considers that stimulating small to medium-scale cogeneration fuel cell units in the residential sector will be key 'low hanging fruit' for delivering a national energy efficiency step change, given the low greenhouse gas emissions intensity and cost effectiveness of these systems.

CFCL LICENCES GRANTED

CFCL has granted a worldwide licence to NexTech Materials Ltd to supply their patented coating technology to other developers of solid oxide fuel cells. Based in Ohio, USA, NexTech Materials is a leading provider of technology solutions for the solid oxide fuel cell market. NexTech's customers are located in more than 35 countries.

CFCL has also appointed one of Australia's most progressive retailers, Harvey Norman, as a non-exclusive distributor of the BlueGen generators through their commercial division franchisee. The Harvey Norman Commercial Division sells a wide range of home energy products to commercial customers, such as architects and home builders. They will sell BlueGen units to their commercial clients and other foundation customers such as utilities and Government bodies. The long-term plan is to leverage the extended reach of the entire Harvey Norman retail stores to the consumer market.

AWARD FOR FUEL CELL



One of CFCL's BlueGen units is operating in Heinsberg, North Rhine-Westphalia in Germany. The Company has been awarded the prestigious Innovation NRW.INVEST AWARD by the Government of North Rhine-Westphalia. CFCL received the Award for their plant which is one of the first in the world for the volume production of solid oxide fuel cell stacks. At the presentation in Dusseldorf, Petra Wassner, Managing Director of NRW.INVEST, said: "Fuel cells with high efficiency are a key technology of the future. Ceramic Fuel Cells, with its innovative products, contributes to a more efficient and cleaner energy supply in North Rhine-Westphalia". The Australian Ambassador to Germany, Mr Peter Tesch, replied "I am convinced that Ceramic Fuel Cells will shape the world market and especially the German market of private energy supply." www.cfcl.com.au

NATURAL GAS, A NATURAL CHOICE?



In the first of an occasional series of articles about the next generation of fuel cells, Sergio Mollá puts the case for fuel cells powered by natural gas, which could be obtained mainly from renewable sources.

Sergio Mollá – Valencia, Spain

RENEWABLE METHANE

A variety of fuels from renewable sources is becoming available and several technologies are being introduced which could ensure that it is utilized efficiently. This will contribute to future energy security and minimize the environmental damage caused by the use of fuels. Natural gas will be used less for heating buildings as better insulation, heat pumps, fuel cell microCHP systems, and larger scale heating schemes are introduced. Hydrogen is being used for distributed generation, particularly in regions where it can be obtained from indigenous energy sources and store wind, solar or marine energy. It will also be used for balancing the electricity grid where it can compete with efficient redox flow batteries. For the larger scale production and transport of fuel, it is suggested that hydrogen could be combined with captured carbon dioxide to form methane. An infrastructure for transporting methane already exists in many parts of the world and this infrastructure could provide a gas distribution system for a methane-based fuel cell economy.

METHANE PRODUCTION

Methane gas can be obtained naturally from anaerobic digestion of organic wastes, and industrially by the gasification of renewable biomass to synthesis gas and by further catalytic combination to methane. According to the IEA report Energy Sector Methane Recovery and Use, if the methane which is currently emitted to

the atmosphere from mines and landfill sites were recovered and used, this would be a low-cost near term option for boosting energy security and curbing greenhouse gas emissions.

Hydrogen can be obtained via highly efficient thermochemical processes and could be chemically reacted with captured carbon dioxide to produce methane. Hydrogen may also be obtained by electrolysis with solar, wind and marine energy, as well as nuclear power. Before natural gas became available, hydrogen was often mixed with coal gas to produce town gas. It is now proposed that hydrogen could be combined with carbon dioxide captured from the air. The UK's Royal Society, in its report entitled Geoengineering the Climate, says that capturing carbon dioxide from the air would be effective but costly. However, the most expensive part would be storing the CO₂. If the CO₂ were instead recycled and combined with hydrogen to form methane it could contribute to a sustainable renewable energy source.

METHANE STORAGE

The energy storage capacity of methane gas is much larger than hydrogen at even lower pressures. For example, good sorbent materials, such as a MOF (metal organic framework), enable a tank of methane at 35 bar to contain as much energy as a hydrogen tank at 700 bar. MOF material exhibits a methane-adsorption capacity of 230 v/v at room temperature and 35 bar of pressure, higher than the U.S. Department of Energy target (180 v/v). Therefore, why not fill tanks with methane instead of hydrogen for fuel cell powered vehicles?

METHANE CONVERSION.

There have been great advances with solid oxide fuel cells (SOFC) which can be directly powered by dry

hydrocarbon fuels, such as methane and ethanol, without the need for an external reformer. They are based on a platinum-free technology, and although carbon deposition on anodes used to be a common problem for SOFCs, new catalyst formulations have overcome it. Nowadays, high efficiencies ($\approx 60\%$) and power densities ($>1 \text{ W/cm}^2$) can be reached. Interestingly, recent developments in microtubular SOFCs can achieve a rapid start-up since they are very resistant to thermal stresses, and new ceria based electrolytes have reduced working temperatures to $500\text{--}600^\circ\text{C}$. However, it would be desirable to attain a high performance at lower temperatures with the aim of broadening the use of less-costly corrosion resistant materials and enabling further reduction of thermal stress-induced damage.

Consequently, from a technological point of view, it seems more logical and natural to use methane rather than hydrogen to generate power with fuel cells. This should be accompanied by more concentrated efforts in developing SOFCs (or other kinds of fuel cells) operating within the $350\text{--}500^\circ\text{C}$ range. Alongside this development we need full scale projects to demonstrate carbon capture from the air and its combination with hydrogen. I believe that capture of carbon dioxide from the air will be cheaper than transforming the whole current energy infrastructure into a pure hydrogen economy, since it will allow the use of carbon containing fuels, which have higher energy storage densities and therefore are cheaper to transport and store. It will also avoid the need for complex carbon capture and underground storage systems. Of course, the debate is open...

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NEWS

UTC FUEL CELL CERTIFIED TO FC-1 STANDARD

UTC Power's new PureCell® Model 400 fuel cell has been certified to the American National Standards Institute/CSA American Standard for Stationary Fuel Cell Power Systems. This industry standard assures customers that the 400 kW fuel cell meets rigorous safety and performance requirements. Neal Montany, Director of UTC Power's Stationary Fuel Cell Business, said that having FC-1 certification will help to accelerate deployment of their new model stationary fuel cell. The advantages of certification include reduced cost and time of fuel cell installation; facilitation of approval by local inspectors; increased access to clean energy funding sources and improved marketability. CSA marks are accepted by regulatory authorities in the occupational health and safety, electrical, gas, building and other fields in the United States. The PureCell Model 400 can provide up to 400 kW of assured electrical power, plus up to 1.7 million Btu/hour of heat for combined heat and power applications. The system has a 20-year overall system operating life and a 10-year fuel cell stack life. www.utcpower.com

FIRST CLEAN ENERGY MINISTERIAL

The UK Secretary of State for Energy and Climate Change, Chris Huhne, attended the world's first Clean Energy Ministerial, hosted by US Energy Secretary Steven Chu, according to a report by Nick Bridge at the British Embassy in Washington. The purpose of these meetings is to pool the best thinking in Government and industry globally in order to meet the urgent need for clean energy. A price must be put on carbon pollution and the costs of introducing new technologies shared. www.fco.gov.uk

CALIFORNIA LEADS WITH HYDROGEN AND FUEL CELLS

HYDROGEN AWARD FOR SCHWARZENEGGER



At the National Hydrogen Association Annual Conference and Expo in California, the 2010 Matsunaga Memorial Hydrogen Award was given to Governor Schwarzenegger. The Governor said that Senator Matsunaga was a great visionary and slowly all his dreams, including the hydrogen future, are becoming a reality. Senator Matsunaga worked for twenty years to create the hydrogen economy and it's evolving into green jobs for hardworking Americans and also reducing global warming.

Governor Schwarzenegger outlined several years' work developing hydrogen technologies in California and explained how they are planning to extend this to the rest of the nation and throughout the world. They now have 31 hydrogen fueling stations that are open or under construction and they are popping up all over the place! California also has hundreds of hydrogen-powered cars and buses. The city of Burbank has begun to use the world's first plug-in hybrid hydrogen buses, which are a combination of different technologies all coming together. In California many people are already making hydrogen from wind and from solar power and from farm and municipal waste. They are even testing home fuels so that everyone can make transportation fuels in their own backyard. Of course,

those that do will be laughing when the oil companies raise the price again and all of a sudden the price is \$4 or \$5 or \$6 a gallon.

THE NEW WAY TO POWER BUILDINGS!

Hydrogen is also modernizing the way that we use electricity, he continued. Bloom Energy, for instance, has created a new fuel cell that powers homes and buildings. This is really a wonderful development because you don't even have to go to the grid but your fuel cell is right next to your building. Up in Silicon Valley a lot of the buildings and homes are already using this technology. Now they are trying to do the same thing with government buildings, many of which will soon be powered by fuel cells.

EXCELLENT DRIVEABILITY WITH HYDROGEN CARS

Governor Schwarzenegger said that all of this is just the beginning. Back in 2004, he launched the Hydrogen Highway because the car companies said that they were not going to build any hydrogen-fueled cars if there were no fueling stations. California set out to prove to the nation and to the world that the hydrogen vehicles on our highways are safe and affordable. They wanted California to be the place where it all happens and it is happening right now. They are developing hydrogen communities and state-sponsored stations and, by 2017, they expect to have 45,000 hydrogen cars on the road in California. They are creating the roadmap for energy security and sustainability for the whole country. Right now it is hydrogen that gives the average consumer the same driving experience as gasoline cars or diesel cars. We need to get them into the hands of more everyday drivers and

with the help of the federal government and the car manufacturers we can do that. He said "I am 100 percent committed to this cause and I will continue fighting for the environment, to fight global warming and to go and fight for new technologies and new ideas."

UTILITY INSTALLS FUEL CELLS AT UNIVERSITIES.

The California Public Utilities Commission (CPUC) has approved the installation by Pacific Gas and Electric Company of two utility owned fuel cell power plants on the campuses of California State University and San Francisco State University. FuelCell Energy will supply two of their 1.4MW DFC1500 fuel cell units. The total value of the contracts is approximately \$12.6 million, which will include engineering, procurement and construction services for the installation of the power plants. The CPUC acknowledged that the installation of fuel cells on university campuses will help to advance the development and understanding of fuel cell technology. It also noted the important role of fuel cells in the State's future energy mix, as illustrated by the support of Governor Schwarzenegger.

The fuel cell power plants are expected to be operational in 2011. They will be configured to utilize the by-products of the fuel cell energy conversion process, including waste heat and waste water to meet campus needs. The California State University plans to utilize the waste heat for heating a swimming pool and utilize the waste water for landscape irrigation. San Francisco State University will use the waste heat for facility management. The state universities will incorporate fuel cell technology into their respective curriculums to teach students and the public about the benefits of fuel cell systems.

NEWS

SUPPLYING COMPONENTS FOR 100 MW PLANT

FuelCell Energy has a contract to supply fuel cell stack module assembly and conditioning equipment to POSCO Power, the Company's South Korean partner. The production equipment will be used to assemble and condition fuel cell stacks in South Korea, using fuel cell components supplied by FuelCell Energy. POSCO Power reports that the fuel cell stack assembly plant is expected to have annual production capacity of 100MW and expected completion is by December 2010. FuelCell Energy also announced that under a separate contract, POSCO Power has ordered a 300 kW DFC 300MA fuel cell power plant. This will be used by POSCO Power to develop market applications that target grid support, combined with the ability to provide emergency power for installations requiring an uninterrupted supply of power. In the event of temporary interruption of power from the transmission grid, the fuel cell power plant would then switch and provide power to the installations, including hospitals and multi-unit residential buildings. www.fce.com

PEM FUEL CELLS FOR DISTRIBUTED GENERATION

Ballard Power Systems and K2 Pure Solutions have finalized a sales agreement for deployment of a clean energy fuel cell power generator to be sited at a K2 Pure Solutions bleach plant in Pittsburg, California. This initial small-scale installation will be supported by California's Self Generation Incentive Program (SGIP), which has to date created over 337 megawatts of clean, rebated energy capacity for the state. Ballard's CLEARgen™ fuel cell system will convert by-product hydrogen into clean load-following electricity that will partially offset power demand at the

bleach plant. In supplementing its power requirements with the 163 kW fuel cell generator, K2 Pure Solutions will displace approximately 220 tons of CO₂ emissions annually, equivalent to removing almost 40 passenger cars from the road.



Ballard Power Systems has also completed the testing of a large 1MW PEM utility-scale distributed generation system. Installation and commissioning of the system for demonstration at FirstEnergy Generation Corp's Eastlake Plant in Ohio is planned for later this year. Ballard designed the generator to provide clean energy peaking capacity, which is particularly useful during heavy energy demand periods in the summer months. The Ballard generator is transportable so it can be relocated to other sites on a seasonal basis. www.ballard.com

LOAD LEVELLING FOR CARBON CAPTURE PROJECT

AFC Energy plc, developers of low-cost alkaline fuel cells, are supporting a project by B9 Coal, and its affiliate B9 Gas, to create a natural gas power station using revolutionary fuel cell technology. The project, which will incorporate up to 99% carbon capture, was announced in response to the UK Committee on Climate Change call for the application of carbon capture and storage to natural gas to be included in the Department of Energy and Climate Change carbon capture and storage demonstration competition. "We are offering a technically advanced solution to the problem of carbon

emissions and climate change", explained B9 Gas Director Alisa Murphy. "The combination of natural gas with alkaline fuel cell technology will become a game-changing template for clean energy generation with carbon capture." B9 Gas intends to integrate the known technology of steam methane reforming with AFC Energy's low-cost alkaline fuel cells to create a modular, on-demand, decarbonised power plant. The project will offer significant advantages over conventional natural gas power plants with turbines, primarily the ability to load follow by storing hydrogen to generate electricity during peak demand. "The inclusion of AFC Energy's technology in this bid illustrates another deployment opportunity for our low cost alkaline fuel cell systems", commented AFC Energy CEO Ian Balchin. "Recognition of the value that our fuel cell systems will bring is gaining momentum, with projects across a range of markets including the chlorine industry, waste to energy, clean coal gasification and now in conjunction with clean natural gas," continued Ian Balchin.

AFC Energy's low-cost alkaline fuel cells are also being considered for use in a new 49MW renewable plant in Tees Valley. The clean energy plant will use advanced gasification technology to convert waste to electricity. The scheme, which is being led by industrial gas supplier Air Products, will produce enough power for up to 50,000 homes in the region. The plant will offer the North East an environmentally-friendly energy solution by converting non-recyclable waste into clean electricity. The gasification process produces hydrogen which can be used as a feed stock for AFC Energy's fuel cell technology. The site, owned by Teesside-based Impetus Waste Management, has been designated as a New Energy and Technology Business Park (NETBP), placing the UK at the forefront of cutting European greenhouse gas emissions. www.afcenergy.com

CITY OF LEICESTER HOSTS FUEL CELL CAR PROJECT

A ground-breaking agreement that will see 30 highly energy efficient hydrogen fuel-cell powered cars on the streets of Leicester was signed in June by Riversimple and Leicester City Council. In the first project of its kind, the deal will see the Council and Riversimple cooperate to find both private citizens and organisations to test drive the vehicles and locate and staff a suitable refuelling point.



The prototype of the car was launched at an event in the grounds of Leicester's De Montfort Hall. The 12 month pilot will be up and running by the spring of 2012. If the pilot is a success, Leicester and Riversimple will also discuss the potential for Leicester being the site for a factory producing 5,000 cars a year. Riversimple plans to run a second pilot in parallel and is in serious discussion with another UK city.

The two seat vehicle was designed by a small team of British motorsport engineers and was built at Silverstone. It has a maximum cruising speed of 50 mph and a range on one tank of hydrogen of at least 200 miles. With a body made of lightweight composites it weighs only 350kg and thanks to novel design principles is able to do the equivalent of 300 miles per gallon. Hydrogen produces nothing but a few drops of water from the exhaust, although to achieve true "zero emission" credentials the fuel must be produced from renewable energy sources.

Customers will not buy the cars outright. They will pay a fixed monthly and all inclusive per mile charge to use the vehicles, similar to a mobile phone contract. The estimated monthly cost will be around £200 plus 15p per mile, including fuel. The pilot scheme will also involve Leicester University and De Montfort University and customers will provide feedback both to improve the car and the driving experience.

UK GOVERNMENT ENVISAGES RADICAL TRANSFORMATION

Riversimple has received the backing of Chris Huhne, the Energy and Climate Change Secretary, who said: "We need to harness cutting edge technology to reduce our dependence on fossil fuels if we are to tackle climate change. Nowhere is this more important than with passenger cars, which are responsible for almost 60% of domestic transport emissions. A radical transformation of our transport network is needed in the next forty years and this is another great example of British innovation developing low carbon solutions to bring that about."

Riversimple is in the process of a second round fundraising, targeting £20 million from investors. The principal backer thus far, the family of Ernst Piech, a member of the Porsche dynasty, is committed to participating. This fundraising is being supported by Innovator Capital Limited and Sustainable Development Capital LLP.

TURNING WORDS INTO ACTION

Hugo Spowers, Riversimple's founder, said at the event: "We are delighted to have found in Leicester a city which realises that the goal of sustainable

transport means that words have to be turned into actions. By signing this deal we will both become pioneers. The

age of fossil fuelled cars may not be over yet but it is surely dying. Contrary to what we usually hear, sustainable, near pollution free transport is possible, here and now, using existing technology”



Hugo Spowers (Left) showed the vehicle to Leicester City Council's Head of Environmental Sustainability, Neville Stork (Centre) and the Council's cabinet member for regeneration and transport, Cllr Abdul Osman (Right).

Cllr Osman signed the memorandum of understanding between the Council and Riversimple at the event and said: "This is great news for Leicester, and confirms the city's status as leading the way in environmental terms. We recognise that we have a duty to our citizens, their children, and to the country, to reduce pollution and help prevent global warming, as outlined in our One Leicester 25-year vision to reduce our carbon emissions. We have already taken delivery of an electric scooter and are looking at what role such vehicles can play within the city. This hydrogen fuel cell car is another example of revolutionary technology being used to meet future transport needs. This is yet another step in making Leicester a better place to live, and proposals to build the cars locally, if the scheme proves successful, could also mean a major jobs boost for the city." www.riversimple.com

NEWS

FUEL CELL BUS DELIVERY

In the coming six months, AC Transit will be taking delivery of the twelve next generation fuel cell buses ordered from UTC Power. The three AC Transit buses which are already equipped with UTC Power fuel cell systems have now traveled more than 255,000 miles, with an average fuel economy that is 65% better than the control fleet of diesel buses running on the same routes and duty cycle. A PureMotion® Model 120 fuel cell powerplant aboard an AC Transit bus surpassed 7,000 hours in service with the original cell stacks. Jaimie Levin, AC Transit's Director of Alternative Fuels Policy and Hydrogen Fuel Cell Program Manager, said that they are looking forward to applying the success of UTC Power's newest fuel cell systems in their new fleet of next-generation buses as they enter passenger service. www.utcpower.com

FRANCIS BACON MEDAL



At the 8th International Fuel Cell Science, Engineering & Technology Conference in New York, organized by the American Society of Mechanical Engineers, the Francis Bacon Medal was awarded to Osamu Yamamoto, Professor Emeritus of Mie University for his work with fuel cells. Prof Yamamoto (left) is seen here with Conference Co-chairs Prabhakar Singh (centre) and Nigel Sammes (right). Photo courtesy of ASME Nano Institute. Proceedings of the meeting are available. www.asme.org

ITM POWERING HYDROGEN VEHICLES

TRANSPORT OPERATORS START HYDROGEN TRIALS

DHL Supply Chain, London Stansted Airport and the Forestry Commission have signed agreements to participate in Hydrogen On Site Trials (HOST) of ITM Power's transportable high pressure refuelling unit HFuel. The development of the unit is supported by the Technology Strategy Board and partners Gateway to London and Revolve Technologies. The trial will begin next year with the operation and refueling of two hydrogen internal combustion engine Ford Transit vehicles from Revolve Technologies. The hydrogen will be produced at the point of use, on sites operated by participating companies and in the Gateway to London development area.

Membership of HOST will provide each partner with one week's free trial of HFuel and the two Revolve hydrogen powered Transit vehicles. They will then have an option to lease both HFuel and the vehicles for additional weeks. ITM Power's CEO, Graham Cooley, said that the trials are an important part of demonstrating the potential of ITM Power's HFuel technology to the marketplace and they expect other transport logistics companies to be joining the HOST scheme in the near future.

Keith Tress, Head of Engineering, DHL Supply Chain, said that the development of ITM's HFuel refuelling station to power vehicles could make a significant contribution to their goal of reducing CO₂ by 30% by 2020. David Johnston, Managing Director of London Stansted Airport, added that they look forward to discovering and testing how hydrogen could be developed as a viable alternative fuel for airport vehicles.

Jeffrey Livingston, Head of Mechanical Engineering Services at the Forestry Commission stated, "The Forestry

Commission has been 'greening' resources through the use of alternative fuels and the potential use of 'green' hydrogen, a clean fuel derived from water and renewable sources of energy, fits well with this policy." John Williams, Chief Executive of Gateway to London, said that he was delighted to see that major logistics companies have signed up to trial ITM Power's green hydrogen refuelling system, along with improved performance hydrogen engine transit vans. Sustainable transport logistics will be vital for London to realize the goals announced at the recent launch of the Green Enterprise District.

ITM CEO APPOINTED TO US FUEL CELL COUNCIL

Dr. Graham Cooley has been appointed to the Executive Committee of the US Fuel Cell Council (USFCC). Dr. Cooley said that they see the US as a vital early adopter of hydrogen technology and ITM's novel membrane technology will have a significant role to play in the future development of the hydrogen economy. Ruth Cox, Executive Director of the U.S. Fuel Cell Council commented: "We are pleased to have Dr. Cooley on our Executive Committee. His knowledge of the clean energy industry and hydrogen technologies will be invaluable to our team. ITM Power's range of electrolyzers and other clean energy products will also greatly enhance the portfolio of clean energy solutions available to American homes and businesses."

QUENTIN WILLSON BACKS HYDROGEN CARS



Quentin Willson, the TV motoring journalist, visited ITM Power to prepare for the Bridgestone Brighton to London Eco Rally, in which he drove a hydrogen powered vehicle. He said that we need incentives from Europe and our own Government to create a hydrogen transport industry in the UK. We could be world leaders at this, selling the technology everywhere, but we need a clear message that this Government will back clean hydrogen transport 100%. Quentin Willson believes that there is a lot of confusion and myth about 'green' cars, particularly about range, cost and performance. The biggest challenge is getting people to drive these cars, he said, but once they do, all doubts evaporate. Huge strides are being made in this area and we are keen to demonstrate at the Bridgestone Eco Rally that sustainable motoring really has hit the mainstream.

DECARBONIZING THE AUTOMOTIVE SECTOR

For domestic users, ITM Power has announced that it will be developing an alpha prototype small hydrogen fuelling appliance (SHFA) for the NextEnergy Centre, a US business accelerator for new and alternative energy. The 350 or 700 bar home refueller will be suitable for the next generation of hydrogen-powered vehicles currently being developed by major automotive companies. It will be capable of generating up to 5kg of hydrogen per week and it might

provide a substantial part of the US public hydrogen fuelling network for commuter vehicles. The Steering Committee providing technical oversight for the project includes General Motors, Ford Motor Company, Chrysler, Daimler AG, Toyota, Nissan, Hyundai-Kia Motors and Volkswagen. NextEnergy's role is to support the US Department of Energy's Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project. They will integrate the hydrogen infrastructure components for use by vehicular and stationary distributed power generation systems. They will provide a flexible test platform to advance the development and validation of commercial on-site generation technologies. Chuck Moeser, Senior Consultant at Next Energy, commented; "We are delighted to be working with ITM Power, a pioneer in the field of home refuelling. The de-carbonization of the automotive sector is a significant focus for the US."

PREPARING FOR COMMERCIAL LAUNCH

ITM has announced its first sale and field trial of their HPac@10 unit which will supply hydrogen to the fuel cell laboratory at the University of Birmingham, UK. Excess electrolytic hydrogen will be used by the University's fleet of fuel cell vehicles. HPac@ is a high gas rate hydrogen generator producing a minimum of 10 litres/min of hydrogen. This product is targeted at the built environment for energy storage and backup power. Telemetry is being integrated into the unit so that ITM can monitor its performance and schedule testing from its sites in Sheffield. The Hydrogen and Fuel Cell group at the University will work closely with ITM and provide feedback on the performance of the unit. ITM aims to achieve European Conformity (CE) certification of its electrolyzer products, as they progress towards commercial launch in early 2011. www.itm-power.com

LEISURE AND MICROGENERATION MARKETS



Acta S.p.A, based near Pisa, Italy, unveiled the world's first hydrogen-powered tender at the European Sailing Championships in Viareggio this summer. The new tender, branded "HIDRO" incorporates Acta's award-winning hydrogen generator and demonstrates the potential of the hydrogen generator to transform the way in which recreational boats and vehicles are powered. Acta has developed the tender in partnership with Callegari S.p.A., a leading Italian manufacturer of inflatable boats and dinghies.

Two HIDRO tenders serviced sailing boats at the Championships, prior to their full commercial launch, which will be at the Genoa Boat Show in October. The tenders run on a hybrid battery / fuel cell outboard motor system, powered by hydrogen from Acta's hydrogen generator which is, in turn, powered by solar PV panels.



Acta demonstrated a number of ground breaking products at its hydrogen village, established in Viareggio during the championships,

which received an enthusiastic reception from spectators and competitors alike. Visitors were able to test drive Acta's hydrogen bikes, which are recharged via a hydrogen generator connected to solar PV panels.

Paolo Bert, Chief Executive, commented: "This year has seen our market-leading hydrogen generator become the crucial foundation for a new age of clean energy mobility in recreational boats, vehicles and camping equipment. Acta's presence at the championships has enabled us to demonstrate how these technologies complete the missing hydrogen link in the renewable energy value chain. We have been able to demonstrate the ease with which these products can be recharged from solar energy in a cheap and environmentally-friendly way. We now look forward to promoting and developing this domestic-scale solar-hydrogen infrastructure into many new markets.

Acta's product line includes a range of compact hydrogen generators as well as various portable, mobile and backup fuel cell devices that can make use of locally generated hydrogen in UPS, marine, automotive, electric cycling, scooter, camping and domestic applications. Acta is focusing on delivering its products to markets with high volume demand for high-value environmental solutions. It is seeking to accelerate the commercialisation of its products via partnerships with original equipment manufacturers (OEMs), distributors, and agents in these sectors and intends to drive down production costs at high volume via contract manufacturing. The Company manages a growing overseas distributor network targeting a global fuel cell market estimated to be worth US\$26 billion by 2020.

GRANT FOR WIND STORAGE AND MICROGENERATION

Acta has received a €780,000 grant for the development of a domestic power generation, storage and recovery system, linking a microgeneration wind turbine to their hydrogen generator and fuel cell system. This award is part of a total funding of €1.3 million for the 18-month project, granted by the local government of the Tuscany Region and involving Acta, the University of Pisa, and Aequalis Srl, a specialist local wind turbine developer. The combined system is being developed for use in

homes that are not connected to the electricity grid and for remote renewable energy storage applications. It will also act as a demonstrator for larger-scale peak energy shaving applications. Energy generated from a wind turbine will be used to produce hydrogen from water using Acta's electrolysis technology. The Company believes that future applications will include distributed power microgeneration and storage, and ultimately that the system can be scaled up to utility-sized installations for use with commercial wind farms. www.actaenergy.it

EVENTS

27th-28th September 2010, Tenth fuel cell forum f-cell, Stuttgart.

The program is broken down into the topic fields of stationary, mobile, and portable applications, as well as micro fuel cells. There are also forums regarding global markets, innovations from science, infrastructure and hydrogen production & storage, as well as drive technologies.

www.f-cell.de.

6-7th October 2010, Fuel Cells Science & Technology, World Trade Centre, Zaragoza, Spain

Fuel cell technology is now being used across a range of market applications, improving our understanding of the opportunities for further innovation in areas such as fuel cell product cost and durability. This conference will address the key scientific, engineering and technology challenges

underpinning this innovation. It will bring together researchers and technologists working on areas such as new fuel cell materials, degradation mechanisms, and system engineering, to discuss the current state-of-the-art in this fast moving and multi-disciplinary field. Organized by Elsevier, the organizers of the Grove Fuel Cell Symposium

www.fuelcelladvances.com

30th March 2011, 7th Annual International Conference and Exhibition, Generating the Hydrogen and Fuel Cell Society, NEC, Birmingham, UK.

The conference will involve UK and international speakers from business and public sectors. There will be presentations, networking and partnering. There are now opportunities for speakers, sponsorship, workshops and exhibitions. www.climate-change-solutions.co.uk

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 www.futureenergies.com www.fuelcellpower.co.uk