FUEL CELL POWER
Generating electricity, heat and hydrogen, cleanly, quietly and efficiently
STATIONARY POWER ISSUE

HEADLINE NEWS
Fuel cells ensure grid resiliency. FuelCell Energy’s multi-megawatt fuel cell provides electricity and heat on site and helps to balance intermittent supplies of renewable energy.

Fuel cells can be instantly ramped up and down to meet peak demands. They are an essential part of the new efficient smart grids being deployed.

Fuel cells require little space and are so clean and quiet that they can be installed in or near to schools, hospitals, commercial and residential buildings.

CONTENTS
Fuelcell Energy’s parks enhancing grid resiliency p.2
International meeting calls for efficient local energy p.8
Intelligent Energy’s world markets p.14
ClearEdge fuel cell benefits for operators p.16
Logan Energy’s global customers p.18
Fuel cells mitigate climate change p.19
Elsevier economics of mitigating climate change p.20
Cyanus Atratus cost effective fuel cells p.22
CFCL’s BlueGen in Europe p.23
NEWS p.21, p.24
EVENTS p.26
FUEL CELL PARKS ENHANCE GRID RESILIENCY

WORLD’S LARGEST FUEL CELL PARK OPERATIONAL IN SOUTH KOREA

FuelCell Energy has announced that the Gyeonggi Green Energy fuel cell park, located in Hwasung City, South Korea, is fully operational. The largest fuel cell park in the world, the facility consists of 21 FuelCell Energy DFC3000® power plants, rated at 2.8 megawatts each, totalling 59MW. The fuel cell park provides continuous baseload electricity to the South Korean electric grid and usable high quality heat for a district heating system. Only about 5 acres of land is required for 59 megawatts of new and renewable power. POSCO Energy commenced construction on this project in November 2012 and finished in only 13 months, illustrating the ability to rapidly construct multi-megawatt fuel cell installations that enhance grid resiliency.

"The scale of this installation is contributing to the power and heating needs of an urban population and generating the electricity in a highly efficient and ultra-low emission profile that supports our National renewable portfolio standard," said Tae-Ho Lee, Chief Executive Officer at Gyeonggi Green Energy.

In order to meet the accelerating market demand in Asia, FuelCell Energy sold two 1.4 megawatt and three 300 kilowatt fuel cell modules to POSCO Energy during the first quarter of 2014. These modules are in addition to the monthly fuel cell kit shipments under an existing 122 megawatt order that was signed in October 2012. "These module purchases are giving us the ability to meet additional demand above and beyond our existing fuel cell kit orders," said Jung-Gon Kim, Senior Vice President of POSCO Energy. "We are pursuing combined heat and power opportunities with building applications as well as a demonstration project at a liquefied natural gas terminal to efficiently convert boil-off natural gas to ultra-clean power."

NEW FUEL CELL PARK UNDERWAY

Seoul City in South Korea continues to adopt new and renewable power generation to reduce dependence on nuclear power. This includes the recent groundbreaking for the 19.6 megawatt Godeok Rolling Stock Management Office fuel cell park, consisting of seven DFC3000® fuel cell power plants that each provide 2.8 megawatts of power. The ultra-clean electricity will be supplied to the electric grid and the usable high quality heat supplied to a district heating system. The fuel cell park is adjacent to a railroad depot operated by the Seoul Metropolitan Rapid Transit Corporation. In the event of an electrical grid disruption or outage, the electricity from the fuel cell park will provide power to the railroad depot. The power output is adequate to power approximately 45,000 South Korean households. The fuel cell power plants will be supplied by POSCO Energy using licensed technology and fuel cell components manufactured by FuelCell Energy. The fuel cell park is expected to be operational by the end of 2014.

"Both of these fuel cell parks illustrate how our distributed power generation solutions enhance the resiliency of the electric grid with baseload power delivered in an environmentally friendly manner," said Chip Bottone, President and Chief Executive Officer, FuelCell Energy, Inc.

US FUEL CELL PARK

The 14.9 megawatt (MW) Bridgeport fuel cell park for Dominion, a Connecticut electric utility, has been completed on schedule and power is being delivered to the electric grid under a 15 year energy purchase agreement. The installation consists of five fuel cell power plants from FuelCell Energy and an organic rankine cycle turbine for added output and further efficiency gains, with the power output adequate to power approximately 15,000 average size U.S. homes.

"Dominion is pleased to be adding 15 megawatts of additional renewable energy in Connecticut to our existing 2,100 megawatts of carbon-free power from our Millstone Power Station," said David A. Christian, Dominion Generation chief executive officer. "These stations are generating clean, reliable electricity for Connecticut."
ADVANTAGES FOR UTILITIES AND LOCAL COMMUNITIES

"The beginning of operations for the Bridgeport Fuel Cell Power Park represents an important milestone on the path toward Governor Malloy’s vision of a cheaper, cleaner, and more reliable energy future for Connecticut’s residents and businesses,” said Connecticut Department of Energy and Environmental Protection Commissioner Daniel Esty. "This project highlights Connecticut’s new approach to clean energy, which focuses on using limited ratepayer dollars to leverage private capital and to get the greatest possible ratepayer benefit per dollar of public funds expended."

"The commencement of commercial operation by delivering electricity to the electric grid is a major milestone for a Project that is bringing international recognition to the City of Bridgeport and highlighting the capability of utility-scale fuel cell parks,” said Bridgeport Connecticut Mayor Bill Finch. "This event marks the completion of a unique and successful public/private development effort, and the delivery of electricity is a key element of the City’s BGreen 2020 initiative as we work to make Bridgeport the cleanest and greenest City in the region."

"We met our commitments, delivering a turnkey multi-unit fuel cell park on schedule and in less than a year," said Chip Bottone, President & Chief Executive Officer, FuelCell Energy, Inc. "Our team developed the project, manufactured the fuel cell power plants, and now that the plants are operational, FuelCell Energy will operate and maintain the fuel cell park for Dominion during the 15 year term of the energy purchase agreement."

The project is located on a remediated brownfield site in an industrial area of Bridgeport, Connecticut, using only about 1 ½ acres of land to provide 14.9 MW of baseload renewable power. The City benefits with clean distributed power generation and is receiving tax revenue from what was a vacant lot. The community benefits with ultra-clean power generation that is created locally, enhancing power reliability. The State of Connecticut benefits with tax revenue from a variety of sources, job creation in the State, and progress towards the State’s renewable portfolio standard.

Multi-megawatt fuel cell parks solve power generation challenges for utilities as the combination of near-zero pollutants, modest land-use needs, and the quiet operating nature of fuel cell power plants facilitates their siting in urban locations. Fuel cell parks offer a multitude of advantages for both utilities and neighboring communities, including: virtually zero nitrogen oxide (NOx), sulfur dioxide (SOx) or particulate matter (PM\textsuperscript{10}), and the power is delivered with a low carbon footprint. Distributed power generation places power near where it is used, enhancing the resiliency of the grid. The highly efficient power generation process is economical; and continuous power around the clock is not reliant on weather or time of day.

Multi-megawatt fuel cells ensure clean energy and grid resiliency. They operate around the clock and can be quickly ramped up or down to meet changing demands. This 2 megawatt natural gas powered system is seen here at night.
TWO BILLION KILOWATT HOURS OF ULTRA-CLEAN ELECTRICITY

FuelCell Energy has achieved an operating milestone with the generation of two billion kilowatt hours (kWh) of ultra-clean and renewable electricity produced by Direct FuelCell® (DFC®) power plants since the first commercial installation in 2003. "This is a noteworthy achievement highlighting the growing installed base of our clean and efficient power generation solutions that provide continuous power to the electric grid or on-site for large power users that value enhanced energy security and power reliability," said Chip Bottone, President & Chief Executive Officer, FuelCell Energy, Inc.

Two billion kWh of electricity is adequate to power more than 181,000 average size U.S. homes for one year. DFC plants are fuel flexible, operating on natural gas, on-site renewable biogas from wastewater treatment and food processing, or directed biogas. This 300kW plant provides electricity for a food processor.

"We installed our first commercial fuel cell plant in 2003 and announced one billion kilowatt hours of ultra-clean power production in January 2011, which is a time span of eight years," continued Mr. Bottone. "We generated the second billion kilowatt hours in just under two years and the next billion is expected to be generated in less than one year as a 15 megawatt fuel cell park is nearing completion in Bridgeport, Connecticut and a 59 megawatt fuel cell park, the world's largest, is operating in South Korea."

Two billion kWh of fuel cell power production configured in a combined heat & power mode (CHP) benefits public health and helps customers achieve sustainability goals by virtually eliminating criteria pollutants including nitrogen oxide (NOx) that causes smog, sulfur dioxide (SOx) that contributes to acid rain and particulate matter (PM10) that aggravates asthma.

Compared to the average U.S. fossil-fuel power plant, this level of fuel cell power generation avoided the emission of approximately 16,900 tons of these criteria pollutants as well as approximately 1,068,000 tons of carbon dioxide (CO2), which is equivalent to removing about half a million passenger vehicles from the road. This 1500kW plant powers a bakery around the clock.

VIRTUALY ELIMINATING CRITERIA POLLUTANTS

With more than 110 DFC plants producing environmentally friendly power and usable high quality heat at more than 50 locations globally, they are eliminating the emission of a significant level of pollutants and substantially reducing carbon emissions compared to the average U.S. fossil-fuel power plant.
The 4 megawatt (MW) fuel cell below is powered by renewable biogas from waste water at a treatment plant.

TRI-GENERATION WITH ELECTRICITY, HEAT AND HYDROGEN (DFC-H2)

FuelCell Energy has announced further progress with developing the on-site distributed hydrogen generation market with a $2.8 million continuation of an award from the U.S. Department of Energy’s Advanced Manufacturing Office to showcase the tri-generation capabilities of a Direct FuelCell® (DFC®) power plant for industrial applications. Versatile DFC power plants can provide hydrogen at the point of use in addition to ultra-clean electricity and usable high quality heat in a solution that is cost competitive, environmentally friendly and easy to site. FuelCell Energy will install a sub-megawatt fuel cell power plant at its manufacturing facility in Torrington, Connecticut, to generate hydrogen, electricity and heat, replacing hydrogen that is currently purchased and delivered to the facility via truck, and replacing electricity purchased from the electric grid. The tri-generation DFC-H2® is expected to be operational by the end of 2014.

“The objective of this project is to demonstrate the technology and system that will enable market development for distributed hydrogen used for industrial purposes, delivered efficiently, cleanly and in an economically compelling manner by our existing technology,” said Chip Bottone, President and Chief Executive Officer at FuelCell Energy, Inc. “In addition to offering ultraclean electricity and usable high quality heat, this fuel cell installation will provide reliable on-site hydrogen production that has the potential to reduce costs associated with purchasing, transporting and storing hydrogen. We estimate a potential market size of $1.6 billion for our tri-generation DFC-H2 fuel cell power plants serving the industrial and mobility markets in the United States alone.”

HYDROGEN FOR INDUSTRY

The DFC-H2 installation can generate about 135 kilograms of hydrogen per day which generally meets the daily requirements of many industrial hydrogen users.

Once commercially available, the production cost of the hydrogen from DFC plants is expected to be competitively priced within a range of $5 to $7 per kilogram or even lower with increased production volumes. On-site hydrogen generation from DFC plants avoids the costs and pollutants associated with transportation while enhancing the reliability of supply. “For this installation in Torrington, hydrogen will be used as an oxidation preventative to support the company’s manufacturing process, replacing hydrogen we currently purchase and have delivered,” said Neil Aiello, Vice President of Manufacturing at FuelCell Energy, Inc. "The high quality heat will contribute to facility heating while the ultra-clean baseload electricity will support our around-the-clock production.”

HYDROGEN FOR VEHICLES

While this industrial application is the first of its kind, a DFC-H2 project has been operating for over two years, converting renewable biogas from the Orange County Sanitation District (OCSD) in Fountain Valley, California into renewable hydrogen for vehicle fueling as well as ultra-clean electricity. This installation generates 250 kilowatts of power which is enough to power about 250 average size homes and provide renewable hydrogen that can fuel approximately 25 vehicles per day.

For this project, FuelCell Energy will configure the stationary fuel cell power plant to also produce and distribute useable hydrogen, making it a tri-generation system, or CHHP. Fuel cells electrochemically convert a fuel source into electricity and heat in a highly efficient process that emits virtually no pollutants due to the absence of combustion.
SERVICE AGREEMENT WITH SWISS GRID

FuelCell Energy Solutions, GmbH has entered into a multi-year service agreement for a stationary fuel cell power plant owned by Elektrizitätswerke Zurich (ewz), an electric utility company in Switzerland. FuelCell Energy Solutions (FCES) will operate and maintain the power plant in close collaboration with ewz and will supervise the plant from a European-based operations center that is staffed 24 hours a day, seven days a week.

ewz is among the largest energy utility companies in Switzerland and is a supplier of electricity for the city of Zurich as well as parts of the canton Graubünden since 1892. As a utility, ewz pursues and is actively involved in the development of new technologies for distributed power generation. "This fuel cell power plant operating since November 2010 is the first carbonate fuel cell installation utilized in Switzerland," said Marcel Frei, Director, Elektrizitätswerke Zurich. "We want to be the leading utility in Switzerland with a clear leading position in ecology and energy efficiency. We are demonstrating our strong motivation to invest in new technologies and in new renewable energy with this fuel cell power plant. We are performing an assessment of this carbonate fuel cell power plant to evaluate the electricity and heat output, the operating costs and the integration with the gas network for the fuel supply."

The project employees of ewz are closely involved in the operation and assessment of the stationary fuel cell power plant to study the almost complete lack of emissions by the fuel cells, the high electrical efficiency, and the operational flexibility of the power plant. "We focus on customer satisfaction and our service agreements allow our customers to concentrate on what they do best while we concentrate on our core expertise of delivering ultra-clean power in an efficient and reliable manner," said Chip Bottone, President and Chief Executive Officer FuelCell Energy, Inc. and Managing Director, FuelCell Energy Solutions GmbH. "The highly efficient and environmentally friendly baseload power generation profile of our plants makes them a good solution for supporting power grids and enabling electric utilities to add power generation in cost effective increments when and where needed."

FCES will service the existing plant including the scheduled replacement of the fuel cell stack during the ten year term of the service agreement. FCES offers a comprehensive portfolio of services for stationary fuel cell power plants with multi-year service agreements. Highly trained technicians and engineers remotely operate and maintain the fuel cell power plants, 24 hours per day, 365 days per year. Field service technicians provide on-site servicing. These service offerings transfer the plant performance responsibilities to FCES, providing the customers with certainty of costs and power supply.

MULTI-MEGAWATT FUEL CELL AT HARTFORD HOSPITAL.

FuelCell Energy Inc has announced the sale of a megawatt-class fuel cell power plant for installation at Hartford Hospital in Connecticut. Hartford Steam Company purchased the fuel cell power plant and will sell the ultra-clean electricity and steam generated by the power plant to Hartford Hospital under a long term energy purchase agreement (EPA) that will result in savings to the Hospital. Excess heat not used by the hospital will be supplied to the district heating system in Hartford that is owned and operated by Hartford Steam.

"The ability of the fuel cell power plant to produce both electricity and steam from the same unit of fuel supports the attractive economics of this installation," said Derek Rudd, President, Hartford Steam Company. "We are interested in diversifying our combined heat and power generation portfolio and the low emission profile of this on-site power plant supports our sustainability and green initiatives."

Hartford Hospital, with 867 beds for patient care, is one of the largest teaching hospitals and tertiary care centers in New England. The EPA structure will allow the hospital to benefit from ultra-clean on-site power as well as recognize cost savings from the high efficiency of the fuel cell power plant. "Our power plants are easy to site due to their clean air profile, quiet operations, relatively modest space requirements, and continuous power production," said Ben Toby, Vice President Eastern Region and International Sales, FuelCell Energy.
Over one year of power production, the fuel cell power plant is expected to prevent the emission of more than 57,000 pounds of nitrogen oxide (NOx), as well as preventing the emission of more than 128,000 pounds of sulphur dioxide (SOx) and more than 3,000 pounds of particulate matter (PM) compared to conventional combustion-based power generation. The high efficiency of the fuel cell power generation process significantly reduces CO₂ emissions compared to combustion-based power generation and the combined heat and power (CHP) configuration further drives efficiency. The power plant is expected to prevent the emission of more than 6,700 tons of CO₂ over the course of one year when compared to conventional combustion-based power generation.

The 1.4 megawatt DFC1500® fuel cell power plant will be located immediately adjacent to the hospital, occupying only about 2,250 square feet, which is minimal for renewable power generation. By comparison, 1.4 MW of solar power requires approximately 200 times greater space than the fuel cell power plant.

1.4 megawatts of power production is adequate to power approximately 1,400 average Connecticut homes. Hartford Steam, is eligible to receive renewable energy credit (REC) payments for each megawatt hour of power produced under the State of Connecticut LREC program due to the high efficiency and virtual lack of pollutants from the fuel cell power plant. Connecticut has created a number of long term programs and objectives to drive deployment of clean distributed generation, including the authorization of RECs for low-emission technologies such as fuel cells.

The Hartford Hospital installation will operate on natural gas. Total efficiency of up to 90% can be achieved by a CHP-configured DFC power plant, depending on the application.

More information about Fuel Cell Energy Inc can be found at: http://youtu.be/ubGVKxDO2kg

Fuel cells are so clean and quiet that they can be sited in or near to occupied buildings. This 4 MW (4,000 kilowatt) plant is adjacent to a university.
INTERNATIONAL MEETING CALLS FOR CHANGE TO EFFICIENT, LOCAL ENERGY

MASS PRODUCTION OF FUEL CELLS

At the tenth International hydrogen and fuel Cell Conference in Birmingham, UK, Phil Caldwell of Ceres Power, called for a change in the energy infrastructure. Global energy supplies are at a tipping point: in the USA grid outages cost $80bn per year: the UK requires £150bn to replace 20% of the infrastructure by 2020: in Germany the move to renewables causes grid instability: and Korea and Japan import 97% of their energy. Volume production of fuel cells for micro CHP reduces electricity costs, utilises the reliable gas infrastructure and cuts carbon dioxide emissions.

When volume production is achieved, the cost of Ceres Steel Cell will come down to $5,000 - $7,000, giving a 5 year payback. Efficiency is 45% or up to 90% in CHP mode. It is reliable, it copes with stop/start operation and has been thoroughly tested for double its projected lifetime. It is wall hung which is particularly convenient in apartments and houses. Initial financing could be supported by the Government and the utilities/OEMs leasing the fuel cells.

This already happens in other countries, the USA provides a $5000/kW subsidy, Germany has contributed $1.2bn, South Korea $590m and Japan, contributing $5000/kW, giving $1bn so far.

ACCELERATING COMMERCIALIZATION

Dr Kerry-Ann Adamson recommended that the EU Horizon 2020 Hydrogen & Fuel Cells Subsidy will continue to develop a portfolio of clean, efficient and affordable fuel cells and hydrogen technologies to the point of market introduction and help secure the future international competitiveness of this strategically important sector in Europe. It should be more market orientated than the former FP7 programme, which funded endless R & D without bringing technologies to market.

Over the past two decades fuel cell funding by the USA, Europe and Japan totalled over $8bn. To put this in context, according to the International Energy Agency (IEA), worldwide subsidies for fossil fuels in 2012 alone totalled over $554bn.

An example of how volume production can be achieved is given by the UK’s Feed-in-Tariff (FiT) for solar PV units, which reduced payback time to 5 – 10 years.
The EU should take into account that it will get a return on its €700m investment in Horizon 2020, in terms of future jobs created, emissions reduced and barrels of oil saved.

A concerted European effort will be needed to match the progress made by the USA and Japan in patents filed for fuel cell and hydrogen technologies. Europe should focus on patents generated, creating companies from the IP generated and bringing new products to market. There should be targeted support for fuel cell start-ups, with mapping of opportunities and gap analysis, with R & D showing advancement through an agreed market related framework.

LOCALISED ENERGY MARKETS (LEMS)

Paddy Thompson of CFCL outlined the advantages of Localised Energy Markets, which match supply and demand at the local level. Localised Energy Markets enable peer to peer electricity sales across the public wire network and district and communal heat and power schemes using Energy Service Companies (ESCOs). This creates local power, local jobs and a local economy. The take up and efficient use of resources will then be driven by market forces.

The early UK electricity generators supplied energy locally but the national energy system was built up during an era of cheap fuels, with significant inefficiencies, e.g. heat losses at central plants and grid losses. The connection of distributed generators was promoted by the UK Utilities Act 2000. The introduction of ROCs in 2002 kick-started the wind farm market and Feed in Tariffs in 2010 kick-started the PV market. There are high capital costs but low operating costs for non fuel based generation (wind, solar). Huge investment is required in the present UK infrastructure, up to £200bn according to Ofgem. There are political calls for change as a result of increasing fuel bills and politicians have responded with calls for “not 6 but 60,000 energy companies” by Greg Barker, Minister of State for Climate Change, and “a freeze in energy prices” by Ed Miliband.

WHAT WENT WRONG?

Over centralisation made sense when most power was used by heavy industry, services were a small part of the economy and there were few consumer devices, but the world has changed and so must the energy system. There was lack of investment as low prices disincentivised investment for the future. We can now either spend £200bn+ on refurbishing the centralised system or spend less and re-design the system.
There is lack of innovation and short termism: the internet is radically changing our economy, generally for the better. It can do the same for our energy system to make it smarter, more efficient and more responsive to our needs. The short term interest of the Big 6 and their shareholders is profit maximisation, not innovation. There is a closed shop: small scale generators (<10MW) are effectively denied access to market because they are small scale - even feed in tariffs perpetuate this.

THE CASE FOR CHANGE

New technologies offer a different approach: distributed generation is a reality and offers environmental and economic benefits. The fuel poor benefit the local economy most when they have reduced bills, as they tend to spend savings locally on essential goods and services.

Pure renewables need fuel cells, which offer high efficiency and controllability at local and community scale – perfectly complementary to wind and solar. By controlling energy flows at the local level the demands on the grid are reduced, national investment is reduced and consumers see lower bills. Localised energy markets are more efficient: by using the heat by-product from generation locally and efficiently, primary energy use reduces whilst comfort levels increase. Micro-generators should be able to sell their excess power locally and bilaterally via an aggregator – a local utility company.

BLUEGEN PROVIDES BASELOAD AND PEMs PEAK DEMAND

In a typical town of 20,000 homes, the baseload demand of homes and small businesses could all be supplied by 5,000 of our highly efficient BlueGen fuel cells and the non baseload demand can be supplied by flexible PEM fuel cells. The medium sized commercial and small industrial businesses and public sector buildings can be served by larger scale fuel cells (100kW-500kW).

Energy intensive industries would continue to buy from centralised generators as they do today, matching the scale of supply and demand.

LOCALISED ENERGY MARKETS NEED TO HAPPEN

There are several alternative scenarios to keep the lights on as below, none of which address the grid investment issue. There is no credible scenario where nuclear can bridge the gap from fossil fuelled plants, given the time it takes to bring them online. Gas is apparently the government’s preferred scenario, but the problem is that renewables take precedence on the grid, making returns uncertain and significantly increasing the cost of finance (and hence cost of power). Whilst additional pumped hydro is possible, there just are not enough sites to make a difference. The high cost and limited capacity of battery storage mean this option is not viable, at least until 2020 when Tesla’s “gigafactory” is in full swing. If there were blackouts, the cost to the economy would be far in excess of almost any other option. Future UK energy reserves could be insufficient - the projected de-rated capacity margin of 1%-6% is very uncomfortable. It would also be very costly if the Government ignored the EU’s Large Combustion Plant Directive (LCPD) and ordered utilities to keep the coal fired plants running until alternatives can be put in place.

Fuel cells provide the high efficiency, flexible, baseload power generation required. Solar PV can be integrated for daytime peaking demand where air conditioning is prevalent. PEM fuel cells can “fill in the gaps” in the demand curve. Fuel cells are either low or zero carbon and facilitate the introduction of wind and solar.

The greatest value in the electricity market is at the end of the value chain. Generating at the point of use, behind the meter, is the point of greatest value. The retail value of electricity is up to three times the wholesale value.
John Cunnington of IPower said that we can reshape the energy markets with fuel cell combined heat and power (CHP) and other new technologies. Put the customer first with deep cuts in energy bills, and in carbon emissions. Go for growth, it is already being done in Japan, bringing new manufacturing and service jobs. We need new power stations for a new energy mix. This could be spread out in customers’ premises to provide cleaner and cheaper energy. Virtual power stations will manage as one many small/medium fuel cells, PV and low carbon heat installations in or near buildings.

Benefits are that there is typically 20-35% saving on displaced energy, 8 – 13% typical project return if self-funded and 3.5 tonnes-5 tonnes CO₂ reduction per year. Two UK projects with BlueGen fuel cells have already been completed, at the Madingley Centre near Crewe and at Blandford House in Maidenhead. There are also a hundred new build houses planned with BlueGen fuel cells and heat pumps.

Prof Gavin Walker, Director of the Energy Technologies Research Institute at the University of Nottingham outlined progress with the ECOIsland project on the Isle of Wight. Creative energy homes generate energy on site with hydrogen stored to balance intermittent loads and surplus energy exported to the national grid. There is also a biomass and concentrated photovoltaic solar power system. A safe and efficient hydride system enables drivers to refuel at home. According to a 2013 report by Shell, large quantities of hydrogen are already used by industries around the world, equivalent to 10% of world electricity production.

FUEL CELL COMBINED HEAT AND POWER

CREATIVE ENERGY HOMES ON ECOISLAND
SOFC IN SOUTH KOREA

Prof Nigel Sammes of the Department of Chemical Engineering at the University of Birmingham is working with Pohang University of Science and Technology (POSTECH) in South Korea to develop micro-tubular solid oxide fuel cells (mSOFC). Their aim is to design, optimize and build a 100W/200W mSOFC stack and integrate it into an unmanned aerial vehicle platform. There are several organisations in South Korea working on various aspects of SOFC development. The Korea Institute of Energy Technology Evaluation and Planning (KETEP) is the government agency involved with energy efficiency and resources.

ENERGY SECURITY AND POLLUTION REDUCTION IN CHINA

Prof Sheng Sui of the Fuel Cell Institute in Shanghai said that China’s economic development depended upon energy use. Coal was the main fuel but they are increasing their use of solar, wind and nuclear power. Their aim is to ensure energy security and reduce air pollution. This opens up opportunities for fuel cells, for which China has ample resources of the rare earth materials needed for some fuel cells. The Orient Pearl Tower, a landmark in Shanghai, is seen here through a haze of pollution, which has affected many towns during the past year.

STANDARDS FOR HYDROGEN AND FUEL CELLS

Chinese universities and research organisations are working on several projects with cost effective production of hydrogen from fossil and renewable energy, as well as storage and distribution. They are developing key fuel cell components with integration into stationary and mobile applications. Their national committee, SAC 342, has already published 23 standards for hydrogen and fuel cells. Fuel cell and hydrogen R & D in China is mainly focusing on PEM, DMFC and SOFC.

New materials are being developed for fuel cells. The first markets are back-up power for telecommunications and for electric vehicles. At the Shanghai 2010 World Expo six fuel cell buses were used, with ninety fuel cell vehicles for official use and a hundred cars for sightseers. There is a large gap in terms of R & D investment between China and the developed countries, lack of enough finance support!

It is urgent to develop a hydrogen and fuel cell roadmap on the national level. Considering China’s potential market and huge energy consumption, it is an optimal opportunity for fuel cell development and commercialization.
FUEL CELLS IN A SMART ENERGY WORLD

Ecuity Consulting plc is helping to develop an effective policy framework for small scale stationary fuel cells in their report entitled ‘The role of micro CHP in a smart energy world.’ The UK Government has not considered the long-term strategic role for fuel cells or developed a tailored policy framework for commercialisation. Japan and Germany have driven the global market with a solid framework of support, which has enabled prices in Japan to fall by 25% in 2012 from 2010 levels. Cost reductions can also be achieved in the UK, where fuel cell micro CHP will contribute to the low carbon economy, enable energy bill reductions, create manufacturing and service jobs and contribute to key strategic and security objectives.

Greg Barker, Minister of State for Climate Change, is quoted as saying “From individual consumers to community groups, entrepreneurs, SMEs and FTSE giants, I want them all to consider generating their own energy at real scale, as well as starting to sell their excess energy on a commercial basis. A decentralised power to the people energy revolution – not just a few exemplars but tens of thousands of them.” The reduced cost of fuel cell micro CHP at a scale of one million units is estimated at 6.5p/kWh, based upon reduced transmission and distribution losses, reduced cost of holding centralised electricity, reduced energy cost and avoided emissions value.

The chart compares micro CHP resource costs from the present, at 50,000 units and 1 million units per annum.

The existing UK support framework for fuel cells provides feed-in-tariffs for micro CHP up to 2kWe. Current support schemes focus on R & D, there is at present no tailored support for fuel cells in real world commercial applications. Viable support for fuel cells makes economic sense as production increases.

UK AND EU BACKING FOR ENERGY EFFICIENCY

Helen Fairclough, of the UK Department of Energy and Climate Change, said that EU Energy Focus has been set up to assist with the implementation of projects with hydrogen and fuel cells in the Horizon 2020 programme. The EU’s Fuel Cell and Hydrogen Joint Technology Partnership (FCH JTI) was set up as a public/private partnership in 2008, with the objective of expediting development of hydrogen and fuel cell technologies. Financial and resource commitments made by industry were matched by EU funding. FCH2 is expected to start in 2014 with a budget of €1.4bn, half of which will come from the Horizon 2020 budget.

Horizon 2020’s priorities include energy efficiency, renewables, smart grids, energy storage and smart cities. Projects are generally collaborative, with shared costs and cover all aspects from R & D and innovation to market transformation. EU Energy Focus Meetings will be arranged to advise new participants and a monthly bulletin will be issued.

Full papers at the meeting are available from www.climate-change-solutions.co.uk
DISTRIBUTED POWER FOR INDIA

Intelligent Energy and India’s Microqual Techno Limited have signed an exclusive 15-year agreement to provide Intelligent Energy’s innovative and efficient power solutions to Microqual-installed mobile telecom base station equipment on existing electricity transmission towers. The collaboration, the first of its kind in India, will significantly reduce the cost of rolling out mobile phone telephony across parts of India’s hinterland. It also enables the use of electricity towers for last-mile mobile phone coverage by providing an independent source of energy from the existing high voltage lines which cannot be relied upon to power localised equipment due to access and maintenance restrictions.

Around one-third of India’s population of 1.2 billion are denied access to mobile phone services, mainly in the country’s rural areas. By installing equipment on the existing transmission infrastructure, coupled with an efficiently managed power source, Microqual, as installer, and Intelligent Energy, as managed energy supplier, are able to deliver to India’s Mobile Network Operators their infrastructure and its continued operation to high levels of availability more cheaply than conventional alternatives. Coupled with reduced set-up times and avoiding environmental issues surrounding the construction of new telecom towers, this represents a compelling and scalable proposition to the market. Microqual has exclusive rights to some 85,000 towers owned by the Power Grid Corporation of India Limited, India’s largest electricity transmission company, and other state power transmission companies. Under the agreement, Intelligent Energy, through its wholly owned subsidiary, Essential Energy (Operations) India Pvt Limited, will provide energy generation and management services to the Microqual transmission tower estate across India.

Essential Energy has been formed to address the growing gap between supply and demand of energy in countries like India. Essential Energy partners with customers allowing them to meet their energy requirements in a responsible and economical manner. Based in Bangalore, Essential Energy has a team of experienced professionals with backgrounds in energy, finance and power systems engineering.

SINGAPORE’S SOVEREIGN WEALTH FUND INVESTS

Intelligent Energy Holdings plc and GIC, Singapore’s sovereign wealth fund, have jointly announced that GIC has invested approximately $63 million in the Company. Whilst good progress has been made on the Company’s recent strategic priorities of the commercial launches of the consumer electronics division and of the stationary power division, initially in India, the Board very much welcomes the additional strategic and financing options that are anticipated to be available to the Company as a result of GIC’s investment. Paul Heiden, Chairman of Intelligent Energy, said: “GIC’s long-term investment perspective and global presence, with particular domain knowledge of the Asian market in which the Company’s Distributed Power & Generation division has launched, means that the Board was pleased to recommend to shareholders this investment from a new cornerstone investor.”

INNOVATION CAPITAL OF THE UNITED STATES

Intelligent Energy has strengthened its longstanding U.S. presence by establishing a commercial facility in San Jose, California, at the heart of Silicon Valley on the U.S. West Coast. With the objective of working more closely with the company’s Silicon Valley based partners, Intelligent Energy’s local operations will be led by Julian Hughes, Group Corporate Development Director and executive team member of Intelligent Energy. Highly flexible and with the ability to cover a broad power range from less than a watt to 200 kilowatts, Intelligent Energy’s high performance proprietary fuel cell systems are designed for easy integration to speed up time-to-market for companies looking to offer innovative products to their customers for automotive, consumer electronics and distributed power and generation applications. Dr. Henri Winand, CEO of Intelligent Energy said: “We are excited to have a base in the heart of the innovation capital of the United States. We are keen to expand our network of partners and establish collaborations that will enable the accelerated commercialisation of our fuel cell technology.”

www.intelligent-energy.com
Hydro Industries, based in Llangennech, South West Wales, has entered into a collaboration with Intelligent Energy to support the commercialisation of Hydro’s water purification technology across India.

The partnership, which could result in Hydro’s technology being powered by Intelligent Energy and deployed at thousands of sites over the next five years, was announced in the presence of First Minister of Wales, Carwyn Jones. (Left to right Wayne Preece, Hydro, Carwyn Jones, Dr Henri Winand, David Pickering)

Hydro Industries focuses on the design, manufacture and operation of electro-based water treatment products. Intelligent Energy is an international power technology company specialising in the development of cost-effective, efficient fuel cell systems for its business partners and their global mass markets. This collaboration follows the announcement that Intelligent Energy, through its wholly owned Indian operating business, Essential Energy, will deliver power management solutions for telecom towers across India. Essential Energy’s power management solutions will facilitate keeping India’s mobile phone networks working, with Intelligent Energy’s proprietary fuel cell systems replacing - over time - the more expensive diesel generators currently used. The collaboration will see Hydro’s technology powered by Essential Energy’s power portfolio, offering Essential Energy an additional customer for its power.

PROVIDING CLEAN WATER

Hydro’s proprietary technology uses electricity to treat water, removing the need for bulk liquid chemicals or large volumes of biomass. With no moving parts and adaptive software, system maintenance is straightforward and supervisory control can be carried out remotely. India has one of the world’s fastest growing economies and its rapid urbanisation is expected to lead to a 40% increase in domestic demand for water over the next decade. It is estimated that around 720 million of India’s 1.25 billion population lack access to clean drinking water. Around 100,000 people die of water-related illnesses annually and, according to UNICEF, waterborne diseases cost the Indian economy $600m in lost production and medical treatment.

Wayne Preece, CEO of Hydro Industries, said: “This is an extremely significant relationship for our company, further enhancing Hydro’s global reputation to deliver resourceful, innovative products to regions in real need of accessible, clean drinking water. The positive humanitarian impact is of vast importance to us, and we are delighted that technologies and products developed in Wales will provide a source of clean water for communities across India, improving their quality of life and giving them access to what is an essential requisite for a healthy life: clean water.” Hydro Industries Chairman and Principal Scientist, Phil Morgan, was clearly delighted, “This collaboration follows a series of successful river and bore-hole water purification trials already conducted on various sources in India. The positive implications are enormous and we are delighted to have the opportunity to work with Intelligent Energy to meet this challenge.”

Congratulating Hydro Industries and Intelligent Energy, First Minister Carwyn Jones said: “This is great news and a very clever collaboration that will benefit everyone. I am proud that products developed by a Welsh company will help improve the lives of, potentially, millions of people in India who currently have no access to clean water.” Dr Henri Winand, Intelligent Energy’s CEO, said: “We are very excited about our relationship with Hydro. The combination of Hydro’s leadership in water treatment technology, coupled with Intelligent Energy’s expertise in providing efficient power management solutions, will enable the delivery of clean water where it is needed most across India.” www.intelligent-energy.com
As business and industry strive to improve their green identity, many are finding that cleaner, more efficient, and more reliable power generation technologies, like fuel cells, are an important component of their energy portfolio. Many are also finding that such corporate sustainability efforts not only save energy and reduce pollution, but deliver both higher productivity and greater profits.

ClearEdge PureCell™ fuel cells produce near-zero, ultra-low air emissions, because electricity is generated in a highly efficient electrochemical process without combustion. PureCells work steadily around the clock, seven days a week providing reliable base load power. They can operate independently, or in parallel with the electric grid, or in a micro-grid with solar and wind renewables to provide 100% grid independent capability.

AIR POLLUTION AND CLIMATE CHANGE

Big cities around the world are well known for their pollution and unhealthy air. In the USA over 40% of the population lives where pollution levels are often dangerous to breathe, contributing to respiratory illnesses, asthma, heart diseases and cancer. Children may have to be kept indoors and sporting activities cancelled. The electrochemical process results in near zero emissions of the common air pollutants, (NOx, SO2, carbon monoxide, volatile organic compounds and particulate matter.)

Climate change is another significant effect of air pollution, bringing with it more frequent wildfires, longer periods of drought in some regions and an increase in the number, duration and intensity of tropical storms. According to the US Department of Energy, fuel cell combined heat and power systems can reduce greenhouse gas emissions by 60% and virtually eliminate air pollutants. A report by McKinsey suggests that a 50 gigawatt expansion of cogeneration capacity in the U.S. would save 100 million metric tonnes per year of carbon dioxide emissions by 2020.

EFFICIENT COMBINED HEAT AND POWER (CHP)

PureCell fuel cell systems convert waste heat into useable energy, supplying baseload electric power, as well as heating and cooling. They come in two sizes: the Model 5 generating 5kW of base load power plus 21,000 btu/hour of heat output; and the Model 400, generating 400kW of continuous base load power plus 1,500,000 btu/hour of thermal energy for space heating, hot water and cooling applications. Both models can achieve up to 90% efficiency when all the by-product heat is utilized. By contrast, data from the U.S. Environmental Protection Agency show a conventional power plant delivered efficiency of 33%.

IDEAL WITH INTERMITTENT SOLAR AND WIND ENERGY

PureCell fuel cells can work with solar and wind installations to create a clean energy microgrid that can operate either in parallel with the electric utility grid or independent from it. The fuel cells provide active balancing when the sun is not shining or wind is not available. For example when a cloud rolls by fuel cell output can be increased so that the grid is not impacted. This contrasts sharply with today’s utility infrastructure, which was not designed to handle the intermittency requirements of renewables.

A one megawatt (MW) installation of solar PV panels with overall utilization of 15% will require the owner to purchase the balance of their energy requirements from the local utility. This will reduce emissions by 15%, compared with a 1MW fuel cell operating at 95% capacity saving 4 times more CO2 emissions. Likewise, compared with wind energy generated at 30% capacity, the PureCell operating at 95% capacity, will save double the CO2 emissions.
SMALL FOOTPRINT

Fuel cells can be installed in a small space. Due to their clean and quiet operation they can also be operated inside residential buildings.

The PureCell requires only 0.01 acres of land per gigawatt hour (GWh) of energy per year, enough to power around 90 average U.S. homes.

WATER SAVING

PureCell fuel cell systems operate in water balance, which means that there is no consumption or discharge of water in normal operations. This saves millions of gallons of water every year, compared with central power generation, for which substantial fresh water is required to cool the turbine generators.

BENEFITS FOR USERS

San Diego’s historic Lafayette Hotel generates 45% of its electricity from a 40kW PureCell fuel cell system comprised of eight 5kW units.

By-product heat keeps the temperature of the hotel’s Olympic sized swimming pool at 76-79°F year-round. In addition the system eliminates 100 tons of greenhouse gas emissions annually and saves $30,000 per year in energy costs. The compact design of the ClearEdge system and its clean operation are key advantages; the scalable system was installed neatly in the basement of the hotel with no effect on the building’s exterior appearance.

In the U.S., Verizon is using nineteen PureCell 400 units at nine sites with solar PV to generate over 70 million kilowatt hours (kWh) of electricity and save approximately 10,000 metric tons of CO₂ every year. This is part of Verizon’s effort to cut its carbon intensity in half by 2020.

The PureCell is the basis of a clean, safe energy infrastructure providing electricity and heat from the same unit of energy. Replacing combustion with electrochemical energy conversion, it helps to solve the severe problems of air pollution in cities and climate change. The PureCell also encourages the widespread introduction of intermittent renewable energy from sun and wind. It instantly fills the gap when the sun is not shining or the wind drops.

The PureCell is so clean, quiet and safe that it is operating indoors or outdoors, in schools, shops, hospitals, hotels and commercial and government offices. At present the external costs of energy generation are often not taken into account, but the PureCell enables operators to “go green” and at the same time improve their bottom line. More details are given in the white paper entitled “The Green Edge of Fuel Cells”. Financial plans including total cost of ownership and return on investment are also available at www.clearedgepower.com
Logan Energy, the world’s market leader in providing fuel cell solutions, has announced a restructure of the business to create a team of experts suited to managing the company’s increasingly global customer base. As the focus on European and international markets develops, the business is now recruiting a new global operations manager to drive existing and new projects across these markets. Current Managing Director Bill Ireland will take on the role of Chief Executive and Chairman, with Gordon Watt expanding his remit to become European Business Development Manager.

Commenting on the restructure Bill Ireland said: ‘As Logan Energy continues to win new contracts and develop projects in Europe and around the world, our business must reflect this demand with a globally focused team. Our new Global Operations position is a crucial part of this process and we are now actively seeking someone with the suitable sector and market experience to fill the role. We would also like to thank John Lidderdale for the important role he has played in developing Logan Energy and in helping us to achieve the success that we enjoy today. We wish him the very best for the future.’

Edinburgh based Logan Energy Ltd is the world market leader in providing fuel cell solutions that target customers’ demand for clean energy systems. Specialising in large scale energy efficient generation and storage solutions, the company uses conventional or proven alternative technologies to provide the customer with their desired solution.

**BRITAIN’S LARGEST FUEL CELL SYSTEM**

Logan Energy successfully installed Britain’s largest fuel cell system in London, at Quadrant 3, the landmark Regent Street redevelopment project. The installation, which was designed and integrated by Logan Energy, has been undertaken at The Crown Estate’s £400m, 270,000 sq ft mixed use Quadrant 3 scheme. The fuel cell forms part of one of the world’s most sophisticated central energy systems which serves over 500,000 sq ft of offices, retail, residential, restaurant and hotel space in the Regent Street Quadrant area.

The fuel cell is the UK’s first molten carbonate fuel cell and the most efficient fuel cell installation in Europe, emitting 38 per cent less carbon dioxide than using electricity from the grid and heat from efficient gas fired boilers. Fuel cell power provides the most efficient combined cooling heat and power distributed energy schemes, and was chosen to help the project meet their clean air and carbon reduction targets. The 300kW fuel cell CHP installation uses similar technology to that used to power space shuttles, and works by converting natural gas into electricity via an electrochemical process. As a result, no products of combustion are emitted such as NOx, SOx and particulates, with a projected carbon dioxide emission saving of 350 tons per annum.

The heat from this fuel cell installation will be used for facility heating and cooling, resulting in maximum efficiency and cost savings for The Crown Estate’s customers. The overall efficiency of the installation is estimated at 83% but with a higher electrical contribution than other types of distributed generation. The Crown Estate’s Head of Development Alastair Smart said: “Occupiers are increasingly looking to operate more sustainably and this includes factoring in the green credentials of their premises. The fuel cell is a real flag in the sand, demonstrating what is possible in terms of energy efficiency and carbon reduction, and it will only enhance the building’s reputation as a world leading example of sustainable development.”

Logan Energy’s past projects include Transport for London’s prestigious Palestra Building, which has been operating successfully since its commissioning in February 2009. Bill Ireland, Chief Executive and Chairman at Logan Energy Ltd, said: ‘We are really pleased to play our part in the on-going regeneration of Regent Street. This project demonstrates that fuel cell based energy centres are able to compete with all other forms of distributed generation even without government subsidy and will play an increasingly significant role in the reduction of carbon emissions and electrical power resilience in the UK. We are presently negotiating several megawatt scale projects which make commercial sense as companies strive for control over rising utility prices, lifecycle cost and carbon reduction, and security of supply.’ The global market for stationary fuel cells is projected to increase from the present $1.2 billion to $14.3 billion in 2020.

www.logan-energy.com
The latest report from the International Panel on Climate Change Working Group III (IPCCWGIIIAR5) shows that the rate of increase in atmospheric CO₂ is accelerating, mainly due to growing GDP per capita. The carbon intensity of energy is also now contributing to the acceleration. According to a review by the UK Royal Society, if emissions continue on their present trajectory then warming of 2.6 to 4.8°C, in addition to that which has already occurred, would be expected by the end of the 21st century. If unchecked, this level of warming will be increasing ten times faster than previously occurred at the end of ice ages, the fastest known natural sustained changes on a global scale.

Over the same period, from 1970 to 2010, the UK Department of Energy and Climate Change (DECC) finds that UK final energy consumption is beginning to fall. Government policies are beginning to have an effect, as well as the transfer of manufacturing overseas and the change from coal to natural gas for electricity generation. DECC’s ‘Energy Consumption in the UK [2013]’ states that in 2011, 45% of final energy consumption was consumed for heating purposes, 54% by the domestic sector, 19% by services and 27% by industry.

There is clearly a need for combined heat and power systems. Fuel cells providing both electricity and heat have efficiency up to 90% compared with electricity from the grid up to 40%. Fuel cell systems, whether gas or hydrogen powered, will also be part of a ‘Smart Grid’. Utilised alongside intermittent renewable energy sources they will meet peak demands as they can be quickly ramped up or down.

**TRILLION TONNES OF CARBON**

Governments must put policies in place to prevent the cumulative emission of more than a trillion tonnes of carbon, according to a statement from leading global businesses. Failure to limit the stock of carbon in the atmosphere would risk increasingly serious climate impacts. The Trillion Tonne Communiqué, coordinated by The Prince of Wales’ Corporate Leaders Group, has so far been signed by 70 companies from 5 continents. This follows the report by the Intergovernmental Panel on Climate Change (IPCC) on the actions scientists believe are necessary to mitigate climate change. It also looks to the UN climate change talks in Paris in 2015 as a major opportunity to secure global agreement on a net zero emissions goal. The Communiqué will remain open for companies to sign until the Paris meeting commences.

www.climatecommuniques.com
This paper provides a detailed analysis of the data used in Integrated Assessment Models (IAMs) to estimate the long-term economic costs and benefits of mitigating climate change. Most governments accept the climate mitigation target which would limit the increase in global temperature due to greenhouse gas emissions derived from human-related activities to 2°C relative to pre-industrial times, by 2100. Due to the lack of information about technological change, especially for energy efficiency technologies, policymakers should not base climate change mitigation policy on the estimated net economic impacts computed by IAMs. Almost all the recent assessments of the economics of climate change have relied on IAMs and this paper addresses the question of whether IAMs can adequately model the economics of future energy efficiency enhancements, since increasing the efficiency of energy end-use technologies (the demand side of the energy economy) over the long run is a crucial policy option for mitigating climate change, if not the crucial option.

IAMs FOCUS ON COSTS NOT BENEFITS

Most IAMs focus upon the net costs of mitigation. They have hundreds of input parameters, each of which is highly uncertain in the long run. Claiming that climate change targets can be based on projections of incremental changes undervalues the importance of radical changes. Mitigation scenarios are not small perturbations but represent major transformations of the economy and highly non-linear changes that will strongly impact the development of new energy technologies on both the supply and demand sides. However, falsely claiming to know that a 100-year analysis of the economics of mitigating climate change shows “net costs” only serves to scare off policymakers from doing much to mitigate climate change. “Net economic benefits” are rarely reported, so decisions to mitigate climate change are not popular and politicians try to avoid the topic in election campaigns. The global mitigation pathway pursued should be adjusted every few years as we learn more about the short-to-medium term science, technology and economics. Businesses use just such a procedure when applying the technique of scenario-planning.

Surprisingly, most IAMs do not include any estimates of the likely future damage due to climate change at all, although Dr Stern has stressed recently that the damages caused by climate change could be very large and the longer mitigation is delayed the more costly it will become. Because no reasonable damage estimates have been incorporated into most IAM results, it is very hard to estimate the net benefits of mitigating climate change in the long run. Not only is it impossible to forecast the future of the energy economy for the next 50 to 100 years, but this approach does not take into account potential major economic crises caused by climate change or the depletion of fossil fuels. The risk of climate feedbacks is generally not included, despite the fact that the impact of feedbacks on GDP could be large.

Most models are restricted to estimating the cost of altered fossil-fuel combustion applied to carbon, as this reduces model complexity. Although fossil-fuel combustion accounts for three-quarters of developed economies’ carbon emissions, this simplifying assumption will tend to over-estimate costs, as many low-cost mitigation opportunities in other sectors are left out (for example, energy efficiency, non-CO₂ emissions in general and less deforestation.)

ENERGY EFFICIENCY

The capital costs and operating parameters of new low-carbon electricity generators and other technologies are generally not included. Many IAMs have only one equation for representing energy use in the residential building, commercial building, industrial and transportation sectors. Changes in the future technologies cannot be identified, for example one cannot tell the difference between a trend
towards the use of more efficient gasoline engines in cars and switching from gasoline engines to electric vehicles. An exception to this void in the literature is a study which focuses on the United States entitled “Energy Efficiency and Climate Change”. This project involved IAM modellers from around the world and one of the main conclusions was that “improvements are required to make the models more useful for policymakers” on energy efficiency.

Energy efficiency is often very cost-effective for investors, reflecting the fact that the energy system is not currently close to a state of economic equilibrium, in part because the world has substantially under-invested in enhanced energy efficiency in the past. Thus the more they are available, and the cheaper new energy efficient technologies become, the more likely the net costs of mitigating climate change as a whole will be negative, i.e., there will be net benefits. New lifestyle patterns can accentuate these effects.

**MITIGATION IN EACH SECTOR**

Humanity would be wise to mitigate climate change as quickly as possible without being constrained by existing economic systems and institutions, or risk making the world uninhabitable. This conclusion is clear from a strictly physical and ecological perspective, independent of previously projected economic trade-offs over the long run, and it is well documented in the climate change literature. Going forward, the key economic issue on which policymakers (and IAM research teams) should focus is how to implement as cost-effective and stringent a mitigation policy as possible in the short to medium term, with periodic adjustments to such a plan.

Making realistic plans to mitigate climate change decade by decade requires much more specialized and detailed sectoral planning models than the current IAMs to carry out least cost/maximum benefit planning in each sector of the economy in order to create hopeful, normative mitigation scenarios.


---

**NEWS**

**CAPPING GREENHOUSE GAS EMISSIONS**

Media outlets have reported that China plans to introduce an absolute carbon cap. This follows the US announced plans to reduce greenhouse gas emissions. The EU is currently discussing its climate targets for 2030. On this issue, Hans Joachim Schellnhuber, director of the Potsdam Institute for Climate Impact Research said: “If China would indeed set an absolute national cap on greenhouse gas emissions, this would mean a boost for finding global solutions to tackle the climate challenge. It is most remarkable that now both China and the US seem to be ready to show renewed leadership. Science keeps on demonstrating that the world is about to reach more and more tipping points in the climate system, such as the recently detected and probably irreversible ice-melt in the western Antarctic, eventually causing substantial sea level rise. So the big question is how stringent China’s cap of emissions will be. For Europe, host of the 2015 climate summit, it might be about time to wake up from its recent climate fatigue. The example it set with its cap-and-trade system (ETS) finally finds followers, so the EU could pioneer further by setting more ambitious climate targets. Research shows that it would make sense to include the transport and heat sectors into the cap-and-trade system. The science is clear that the later we act, the more costly it gets in the economic system, and the more risky in the climate system.”

**100 COUNTRIES PLAN NATIONAL LEGISLATION**

At the 2nd World Summit of Legislators, hosted by the Mexican Congress and organised by the Global Legislators Organisation, senior legislators politically tested a new model for an international climate change agreement that has national legislation at its heart. This was the biggest ever engagement of legislators on climate change, with delegations from over 100 countries, many attending at the level of President or Speaker of Congress/Parliament. The outcome of the Summit will detail actions that legislators can take now in their domestic legislatures. The outcome will also focus on what enabling mechanisms parliaments need from the UN climate process to further support the advancement of national climate change laws. www.globeinternational.org
COST EFFECTIVE FUEL CELLS

Most governments receive their knowledge of energy and fuel systems through energy companies, universities and other "knowledge centres". As the data is generally supplied by existing industries there is little awareness of innovation. It is a rare politician who will venture away from the established energy elite and seek the innovative technologies required for a changing world. Cygnus Atratus Ltd is bringing to market alkaline fuel cell technology developed and evaluated over a number of years. Initial projects will be in the region of 50kW.

WHO ARE POLITICIANS NOT LISTENING TO?

Governments are listening to experts from part of the solution, the waste industry, who point out the advantages of burning waste to power turbines and are buying up contracts for waste disposal. What they have not been telling the politicians is that the seeming benefits of waste disposal by this manner are inefficient and polluting. What they do not tell politicians is that they are really in the transport and storage, not the energy business and that adds up to greater cost and increased global warming. Most important is the inefficiency. The burning of waste is subject to basic science, but understanding of the physical laws does not enter the lexicon of energy efficiency. The experts the politicians will not listen to are those who point out that Anaerobic Digestion and Gasification will provide methane more efficiently than removing the carbon content of organic waste for combustion. Further, the combination of the two will reduce organic waste to a number of energy products, methane, fertiliser, heat and carbon neutral carbon dioxide. The next step is what to do with it.

RELIANCE ON EXPENSIVE NUCLEAR POWER

The reliance of Governments on nuclear energy, clean gas and coal to reduce global warming has two looming problems that will slow introduction and application. The first is funding the second, public acceptability. The growth of the nuclear industry in Europe and the United States lies in a few hands producing expensive and financially inefficient systems that cannot be economically realistic either in their building, or more importantly their de-commissioning. France, which is Europe’s nuclear base, believes it will cost 40 billion euro to de-commission the seven nuclear power stations that are now well beyond their service design. France allows the continued operation of the facilities rather than de-commission them and pay the price. This is replicated in the UK and no doubt the US. The net result is the continued use of dangerous facilities beyond their design life.

FIVE TIMES MORE ENERGY FROM WASTE

A gasified anaerobic digester has been developed which produces from waste biogas rich in hydrogen and conversion gases. A modular steam reformer then produces high quantities of hydrogen. It combines oxygen in water with carbon, so that the resulting yield provides greater hydrogen than resident in the gas produced by the anaerobic system. Reformation of CH4 (methane) produces 2.8 times its quantity in hydrogen. If that is used in a fuel cell at 60% efficiency (Alkaline) the net result is 1.62 total methane value. If the methane was used in a turbine, electrical efficiency may optimistically be considered 30%, resulting in 0.3 methane value.

$2,000/KW INSTALLED

The real cost of this total waste to energy fuel cell package is about $2,000 per kW installed. Accordingly, if taken on a reasonable return on investment, the base cost of electricity should be about $0.022 per kWh. Enquiries from those wishing to launch Collaborative Manufacturing Enterprises (CMEs) would be welcome. info@cygatgp.com

COAL, GAS, WIND AND SOLAR ENERGY

The coal and gas industry make claims about advanced technology keeping energy clean, meeting strategic needs and how both gas and coal systems are cheap, keeping costs to consumers reduced. In both cases the reality is that the cost of energy is excessively high, likely to get higher and if no action is taken, will damage life on Earth. Wind and solar energy are possibilities if the intermittent energy loads are balanced with more flexible systems, like fuel cells, which can be easily ramped up and down to meet demands.
The first housing project undertaken by Ceramic Fuel Cells Limited and Energy Services Company, iPower Energy Limited (iPower), provides combined heat and power (CHP) with natural gas powered fuel cells. This involves participating tenants of a housing association located in Maidenhead, England. In the initial phase 10 BlueGen units will be deployed with each unit serving, on average, five flats. The tenants will benefit from cheaper, lower carbon electricity and will be guaranteed a minimum discount of 10% against the best locally available standard electricity tariff. Using ceramic fuel cells, BlueGen® electrochemically converts natural gas into electricity at up to 60% electrical efficiency. The electricity is consumed locally, with unused power being exported to the grid. When the integrated heat recovery system is connected, the waste heat from BlueGen can be used to produce hot water - which improves the total efficiency to approximately 85%. BlueGen can also be monitored and controlled remotely via the internet.

**FUEL CELL CHP IN SWITZERLAND**

Ceramic Fuel Cells have set up a distribution partnership with Novogaz SA, in which the two partners will join forces in distributing the highly efficient BlueGen technology to the growing market for micro CHP’s in the French-speaking part of Switzerland. This move intensifies the cooperation between the two partners that started in 2010 when BlueGen units and integrated systems were installed in a field testing exercise. Pascal Favre, director of Novogaz SA, confirmed: “We have tested the BlueGen in-depth and we are extremely impressed with the efficiency and reliability of the technology. Now is the right time to take the next step.

**BLUEGEN RECEIVES SUBSTANTIAL STATE SUBSIDY**

The state of North Rhine-Westfalia (NRW) has started to implement its recently announced mCHP subsidy policy. Depending on the size of the business applicant, the regional government of Germany’s most populous state is set to promote the BlueGen technology by subsidising each generator with between 45% and 65% of its fundable purchase price. The first applicant, a local bakery, was granted an amount of 13,000 Euros for the purchase of one BlueGen unit, which equals 65% of the fundable investment costs. Following this first approval, BlueGen generators are now officially part of the 250 million Euro CHP incentive programme ‘progress.nrw’, which is designed to accelerate the market breakthrough of highly efficient CHP systems. The CHP Act aims to increase the proportion of electricity generated by CHP plants to 25% of the state’s total production by 2020. By 2020, NRW’s government wants small and medium-sized enterprises to contribute a large part of their CHP potential, which is estimated at 75 terawatt hours per year. CFCL’s fuel cell technology perfectly meets the objectives of the state’s government, as BlueGen units are specifically designed for decentralized, on-site use in small and medium-sized enterprises. Providing up to 13,000 kWh a year, BlueGen can cut running electricity costs by up to 50%. Due to high and rising electricity prices in Germany, one in four companies is considering generating electricity themselves, the latest survey of the German Chamber of Commerce says. With this new subsidy, BlueGen units have become an attractive investment proposition for more than 600,000 small and medium-sized enterprises in NRW.
DECENTRALISED ENERGY IN GERMANY

Ceramic Fuel Cells Limited has also signed a letter of intent for a strategic partnership with Alliander AG, a distribution grid operator. As a first step, up to 600 BlueGen systems are to be installed across Alliander's regional grids in Germany by 2015. “We were impressed with BlueGen’s almost 100% operational availability”, said Ton Doesburg, CEO of Alliander AG. “After three years of positive experience, we will now move to the next level and actively support the deployment of this innovative and environmentally friendly technology across our grids.”

Alliander will make an important contribution to advancing decentralised energy provision and to introducing this innovative fuel cell technology to the German market. Alliander was an early adopter of the BlueGen product and will initially focus on North-Rhine Westphalia before moving to the national level in a second phase of deployment. To achieve this objective, Alliander plans to top up national and regional subsidy schemes to make the installation of BlueGen systems financially more attractive to clients connected to Alliander’s grids. This novel, value-added offering creates a link between clients and their grid operator. Alliander views decentralised electricity production as an important challenge and opportunity for the “energy transition” towards a greater share of renewables in the energy mix. In that, the BlueGen technology can play a major role: contrary to solar, wind and hydroelectric power, BlueGen are consistently available, independent of weather conditions and can balance electricity grid volatility. As a result, their deployment improves the stability of decentralised grids. Central control of the individual units allows an optimal use of the energy generated, as well as its integration in regional structures. Production of BlueGen is underway. The fuel cells are built up into stacks. www.cfcl.com.au

NEWS

2.6 MW BLOOM FUEL CELL FOR SANTA CLARA COUNTY

WGL Holdings, Inc. through its subsidiary, Washington Gas Energy Systems (WGESystems), has announced a 2.6 megawatt Bloom Energy project in Santa Clara County, California. WGESystems will finance, build, own and operate the 2.6 MW Bloom Energy project and sell all energy generated to Santa Clara County under a 20-year power purchase agreement. The Bloom Energy Servers will generate clean and reliable power using natural gas and biogas, reducing the County’s carbon emissions by nearly 5 million pounds each year. “WGL is committed to providing clean and efficient energy answers while remaining a responsible steward of our resources,” said WGL Chairman and CEO, Terry D. McCallister. “We are proud to partner with Bloom Energy, and to service Santa Clara County, as we continue to invest in clean energy solutions as part of our expanding diversified energy portfolio.”

“Santa Clara County has been a strong proponent of clean energy, and we are looking forward to having another project right here in our backyard,” said KR Sridhar, Principal Co-Founder and CEO of Bloom Energy. “Energy industry partners that are willing to invest in technology projects are key to the development of a clean energy economy, and our partnership with Washington Gas Energy Systems continues to strengthen our ability to provide attractive projects for our growing customer base.” Bloom Energy was founded in 2001 with a mission to make clean, reliable energy affordable for everyone in the world. Bloom Energy Servers are currently producing power for several Fortune 500 companies including Google, Walmart, AT&T, eBay, Staples, The Coca-Cola Company, as well as notable non-profit organizations such as Caltech and Kaiser Permanente.

The Department of Defense (DOD) is one of the largest single consumers of energy in the world. It has a stated mission to reduce energy costs, decrease reliance on foreign oil, ensure energy security, and achieve sustainability goals. In an effort to deliver on that mission, the DOD has deployed a 1.6 megawatt Bloom Energy installation at the NSA Campus, Maryland. Bloom Energy has also recently installed a fuel cell at Macy’s online fulfilment centre in Cheshire, CT. www.bloomenergy.com
BUSINESS OPPORTUNITIES IN HEAT, POWER AND TRANSPORT

The knowledge Transfer Network (KTN) in collaboration with the UK Hydrogen Fuel Cell Association are hosting a free to attend event entitled “New Business opportunities in heat, power and transport through hydrogen and fuel cells” on Thursday 17th July in Liverpool, UK. The event will form part of the Low Carbon Week at the International Festival of Business and is aimed at those who are interested in engaging with the sector as, for example, suppliers, users, partners, investors, etc. It will provide a showcase for the latest commercial markets for hydrogen and fuel cells and the current value generation opportunities they offer across a diverse range of real world applications. The event will explore investment and other opportunities that fuel cells and hydrogen can deliver for energy storage and distributed power generation solutions. The benefits of using fuel cells and hydrogen in marine and road transport will be highlighted, as well as how this is being taken forward across the world. It will also consider the value of hydrogen and fuel cells in the low carbon heating and cooling technology portfolio, and how markets are developing. Further information can be obtained at:

AFC ENERGY ORDER FROM POWERHOUSE

AFC Energy has landed a first order for a hydrogen powered fuel cell system from waste-to-energy group Powerhouse. The Beta+ fuel cell test system should be delivered by the end of 2014 and will use hydrogen produced by Powerhouse’s gasification technology, which converts organic matter into syngas, to generate clean energy. AFC Energy will be paid £150,000 by Powerhouse for the system, which will contain two fuel cell cartridges. Further cartridges, additional maintenance or potential increases in capacity can be provided for an additional fee under the contract. It will be the first integration of AFC’s fuel cell systems with hydrogen derived from the gasification of waste, with the deal negotiated through the Waste2Tricity licensing agreement. “The system will form a key test bed for larger industrial applications in the waste-to-energy sector as the benefits of AFC’s fuel cells and the significant increase in efficiencies become clear,” AFC said. Ian Williamson, AFC’s chief executive, added: “It is good to see our relationship with Waste2Tricity beginning to bear fruit. We have been working together on a number of opportunities around the globe and this is likely to be an important milestone for us in waste-to-energy.” www.afcenergy.com

MASSIVE POTENTIAL MARKET FOR HYDROGEN AND FUEL CELLS

ITM Power has received confirmation of a £0.31m grant award to work with a consortium to demonstrate energy efficient technologies and energy storage solutions for non-residential buildings. The programme, known as the CommONEnergy project and funded under the EU Seventh Framework Programme, addresses the need to redesign and refurbish existing non-residential buildings to become more energy efficient and reduce energy demand. The incorporation of peak shaving technologies such as energy storage will allow an increased use of intermittent renewable energy sources. ITM Power’s main role in the project is the integration of hydrogen energy systems in multiple-use non-residential buildings and demonstrating the potential of hydrogen energy storage as an effective means of integrating renewable energy sources in the built environment. Specifically, an energy storage system will be installed in a shopping centre to match the supply and demand profiles required to integrate a renewable power system. There is also potential for a further installation of a refuelling system. ITM Power CEO, Graham Cooley, commented: “Energy storage solutions for the built environment are a key market for electrolysers and fuel cells. This project brings together a very significant European consortium to overcome some of the logistical and legislative hurdles to unlocking this potentially massive market in Europe.” www.itm-power.com

CERES AGREEMENT WITH CUMMINS POWER GENERATION

Ceres Power Holdings plc has signed a joint development agreement with Cummins Power Generation Inc., a global provider of power generation systems, which range from small generators for residential use to larger power systems for markets such as critical protection and back-up power. In the first stage of this agreement, Cummins and Ceres will work together on a non-exclusive basis, combining their complementary technical capabilities and market know-how, with Ceres assuming responsibility for the Steel Cell fuel cell system
technology and Cummins providing system integration expertise, focusing on the assessment of applications for Cummins’ core markets of larger scale back-up power and prime power applications. Further stages of the agreement could include Cummins and Ceres working together on system feasibility and the evaluation of potential development programmes with major end users and utilities, who are already expressing interest in using power systems incorporating Ceres’ Steel Cell technology. Robert Lee, Executive Director, Power Generation Strategy for Cummins Power Generation, commented: “As a global leader in power generation, we are pleased to undertake this investigation with Ceres into Solid Oxide Fuel Cell technology as a potential new vehicle to provide our customers with the clean and efficient power they’ve come to expect from Cummins.”

**EVENTS**

30th June-2nd July 2014
ASME 12th Fuel Cell Science, Engineering & Technology Conference.
Boston, USA.
www.asmeconferences.org/esfuelcell2014

1st—4th July 2014,
11th European SOFC (solid oxide fuel cell) & SOE (solid oxide electrolyser) Forum,
Lucerne, Switzerland. www.efcf.com

15-16th October 2014
Hydrogen and Fuel Cell Summit,
Sacramento, California
www.californiahasconventioncenter.com

1st—3rd December 2014
Carisma 2014,
Developing fuel cell materials for transport and stationary applications, Cape Town,
South Africa. www.carisma2014.com

17th March 2015
The 11th International Conference, Exhibition and Partnering Event will be held in Birmingham, UK. www.climate-change-solutions.co.uk

13th—17th April 2015,
Group Exhibit Hydrogen + Fuel Cells
Hannover Fair, Germany. Includes Europe’s largest hydrogen and fuel cells exhibition. www.h2fc-fair.com

27th—28th April 2015,
Hydrogen + Fuel Cells 2015,
Vancouver Hydrogen & Fuel Cells Summit,
Canada. www.hfc2015.com

6th-7th May 2015,
All Energy 2015,
The largest UK renewable energy event includes sessions on hydrogen and fuel cells.
Glasgow, Scotland. www.all-energy.co.uk

---

**CERES EVALUATION IN JAPAN**

Ceres Power has also announced a further evaluation agreement with a global Japanese Original Equipment Manufacturer (OEM) and the opening of a Company office in Japan. Following successful customer technology trials of its unique Steel Cell technology in the UK, Ceres has signed an evaluation agreement to cover further testing at 1kW level at the OEM partner’s site in Japan. In addition, trialling of the Steel Cell technology is already underway in Japan with another Japanese OEM. Phil Caldwell, Chief Executive of Ceres Power, commented: Japan is a key market for Ceres as it is recognised as the leader in commercialisation of fuel cell technology with an estimated 50,000 residential micro-CHP units sold domestically there in 2013.

www.cerespower.com

---

Fuel Cell Power’s Blog covers all types of fuel cells and their applications in distributed power generation, portable power, CHP and transport. For millennia, energy has been obtained by burning fuels, which is changing the chemistry of the atmosphere and the oceans. Cleanly, quietly and efficiently the electrochemical conversion of fuels is now becoming a practical alternative to combustion. Fuel cells utilize fossil fuels or energy from waste efficiently. They can equally be powered by hydrogen which can be generated from intermittent renewable energy sources. Articles and features in Fuel Cell Power will help individuals, businesses and communities to plan for long term energy efficiency, price stability and cuts in harmful emissions.

www.fuelcellpower.org.uk

Fuel Cell Power provides information on the practical application of fuel cells.
It is produced by the family and friends of the late Dr F T Bacon OBE, FRS, who dedicated his life to the development of fuel cell technology.
Information can be obtained from: Jean Aldous, Editor, Fuel Cell Power,
The Gallery, The Street, Woolpit, Suffolk, IP30 9QG.