

power sources, which have large moving assemblies and a significantly larger noise signature, the only moving parts in these SOFCs are the internal cooling and air-delivery fans, providing an acoustic noise signature similar to that of a battery-powered UAS platform.

‘The integration of our D245XR and D350XR fuel cells with Group 1 UAS platforms provides a significant strategic advantage to our ground forces in the field. The D245XR and D350XR rugged, lightweight portable fuel cells are the perfect power source for expeditionary UAS mission power,’ says Patrick Allison, VP of Marketing and Sales for USSI. ‘The use of clean and efficient propane fuel, which contains 10 times the energy density of advanced batteries, allows the fuel cells to be operated anywhere in the world by locally sourced propane and natural gas fuel.’

Ultra Electronics USSI’s Fuel Cell Products team designs and manufactures SOFCs for backup and portable power. The company’s microtubular ceramic cell design allows it to offer compact and rugged systems that can operate in the most austere and remote locations. Two years ago USSI won a follow-on contract for a large number of SOFC systems from strategic partner RedHawk Energy Systems in Ohio, for P250i Fuel Cell systems – developed by sister company Ultra Electronics AMI – to provide extended-run backup power for railway signals and crossings [FCB, March 2016, p6].

Ultra Electronics USSI, Fuel Cell Products:
www.ultra-fuelcells.com or www.ultra-ussi.com

PORTABLE & MICRO

Aberdeen construction site uses BOC Hymera in TCP lighting tower

In the UK, Taylor Construction Plant Ltd (TCP) has supplied its Ecolite TH200 LED Lighting Tower to help illuminate the construction site of the new Aberdeen Exhibition and Conference Centre (AECC) in Scotland. The tower, which uses BOC’s Hymera® fuel cell as a sustainable power source, provides the best possible illumination with zero emissions.

The new Aberdeen Exhibition and Conference Centre will feature a 1.4 MW Doosan Purecell® phosphoric acid fuel cell system for hybrid combined cooling, heating and power (CCHP) when it opens in 2019 [FCB, January 2017, p6]. The principal contractor on the AECC, Robertson Construction Group, and its specialist civil engineering contractor, Careys Civil

Engineering, support the use of the Ecolite LED lighting tower. Carey Civil Engineering is already familiar with the product, having used TCP lighting towers and compaction plates for several years.

The deployment of the Ecolite lighting tower has been led by Aberdeen City Council, which saw the product in action at the Shell Eco-Marathon in London. The city has invested significantly in hydrogen refueling infrastructure and transportation: it now has two hydrogen stations [March 2017, p7, and see the News Feature in March 2015], along with a fleet of hydrogen powered buses, cars and vans. The Council is also working with North East Scotland College and several European partners to develop a new accredited course for fuel cell and hydrogen technicians [June 2017, p12].

The Ecolite TH200 LED lighting tower has been developed by TCP in collaboration with industrial gases specialist BOC, to provide an alternative to traditional diesel powered off-grid lighting. The product uses BOC’s Hymera hydrogen PEM fuel cell, which is virtually silent, enabling contractors to comply with noise control regulations.

BOC – a member of The Linde Group – launched its Hymera fuel cell generator in 2010 [April 2010, p7, and see the Hymera feature in August 2011]. In 2014 it launched the second-generation Hymera II [October 2014, p5], which can support a wide range of commercial and industrial off-grid applications, such as task lighting, security cameras, environmental monitoring, and process control systems.

Last autumn TCP partnered with Intelligent Energy, to supply the latter’s air-cooled PEM fuel cell modules for integration, testing and evaluation into power products for the construction industry [October 2017, p6].

TCP and BOC have also just linked up with UK-based Bramble Energy, to develop portable LED lighting towers powered by a 20 W fuel cell [see In Brief item on page 13].

Taylor Construction Plant Ltd: www.tcp.eu.com

BOC Hymera: <http://tinyurl.com/boc-hymera>

EVERYWH2ERE project to develop fuel cell containerised ‘plug and play’ gensets

The European EVERYWH2ERE project recently got under way, to develop eight fuel cell equipped, containerised ‘plug and play’ transportable generator sets (gensets). The aim is

that these will replace traditional genset solutions, mainly based on diesel engines, to provide a zero-emission, zero-noise solution with greater operating flexibility and longer lifetime. EVERYWH2ERE prototypes will be tested at construction sites, music festivals, and urban public events across Europe.

The EU-supported Fuel Cells and Hydrogen Joint Undertaking (FCH JU) is providing nearly €5 million (US\$6.2 million) in funding towards the total €6.8 million (\$8.4 million) project cost. The five-year project is being coordinated by RINA Consulting in Italy, and also involves Genport (a spinout from the Politecnico di Milano), Environment Park and Linde Gas Italia in Italy; Aragon Hydrogen Foundation and Acciona Construction in Spain; Delta gUG (Green Music Initiative) and ICLEI European Secretariat (Local Governments for Sustainability) in Germany; VTT Technical Research Centre of Finland; PowerCell Sweden; Swiss Hydrogen in Switzerland; and Mahytec in France.

The results of the project will be exploited through three replicability studies for the use of the gensets in new contexts, such as emergency and reconstruction sites, ship ‘cold ironing’ in harbours (i.e. providing power to berthed ships [FCB, May 2013, p11]), and industrial mining sites. The project aims to define a commercial roadmap and suitable business model for the market launch of fuel cell gensets by 2025.

The crucial role of cities in promoting the wider use of fuel cell gensets, through policies and dedicated regulatory frameworks, means that local authorities will be involved in the project from the start. A strong dissemination and communication campaign will be conducted, in particular during the demonstration events (more than 25 festivals are involved), in order to increase public audience awareness about fuel cell and hydrogen technologies.

‘The systems are based on the PowerCell S2 and the PowerCell S3, and are developed for plug-and-play,’ comments Per Ekdunge, CTO at PowerCell Sweden [see also page 10]. ‘It can be used at construction sites, music festivals, and other events where there is a temporary need for electric power. Two advantages of fuel cells are that they are quiet, and that they don’t generate any emissions other than water.’

Rina Consulting: www.rina.org

PowerCell Sweden: www.powercell.se

Fuel Cells and Hydrogen Joint Undertaking:
www.fch.europa.eu

generators will also enable the power output to be adjusted in line with the scale of the facilities.

Panasonic will also develop technologies for producing hydrogen from natural gas or renewable energy, and for safe and energy-dense storage of hydrogen. In particular, the company will work on small, highly efficient hydrogen production equipment that utilises the fuel processing technology it has developed for extracting hydrogen from natural gas for residential fuel cells. This initiative aims to achieve the practical use of systems that enable the stable supply of hydrogen to factories and small logistics facilities, without the need for large-scale hydrogen stations.

Panasonic, Hydrogen Energy Society:
<https://tinyurl.com/panasonic-h2-society>

LARGE STATIONARY

FuelCell Energy signs PPAs for two large projects in Connecticut

Connecticut-based FuelCell Energy has signed long-term Power Purchase Agreements (PPAs) with local distribution utilities for two large-scale molten carbonate fuel cell installations in its home state. The 20-year PPAs will cover a 14.8 MW project in Derby, and a 7.4 MW project in the state capital Hartford.

The projects were awarded in June by the Connecticut Department of Energy and Environmental Protection (DEEP) [*FCB, July 2018, p7*]. The PPAs have been forwarded to the Connecticut Public Utilities Regulatory Authority for final authorisation. They will provide infrastructure investment in their respective areas, driving local economic development and environmental improvement through state sales tax and the local property taxes generated, as well as providing high-tech manufacturing and construction jobs.

The **14.8 MW power plant in Derby** will be developed on a vacant parcel of land in a mixed industrial, commercial, and residential area north of Lake Housatonic. The system will deliver competitively priced clean energy in a compact footprint by remediating and repurposing a municipal brownfield site.

The project will employ the latest configuration of SureSource™ technology, with electrical efficiency approaching 60%. The MCFCs utilise renewable biogas, directed biogas, or clean natural gas to efficiently produce ultra-clean electricity and usable high-quality heat, providing operating cost

reductions while supporting sustainability goals and enhancing power reliability [*see the News Feature in October 2016*].

The **7.4 MW project in Hartford** will also be located on a vacant parcel of land, enabling productive use of a dormant property. Once complete, the project will serve to improve the strength of the public electric grid in an important load area that serves the city's commercial and industrial districts.

FuelCell Energy: www.fce.com

Connecticut Department of Energy & Environmental Protection: www.ct.gov/deep

Connecticut Public Utilities Regulatory Authority: www.ct.gov/pura

Toshiba, NEA agree to promote autonomous hydrogen energy systems in Philippines

Japanese company Toshiba Energy Systems & Solutions (Toshiba ESS) has concluded a Memorandum of Understanding with the National Electrification Administration (NEA) in the Philippines, for the implementation of Toshiba's H2One™ hydrogen-based autonomous energy supply system with renewable energy and the use of hydrogen for power generation in the Philippines.

The Philippines government sees renewable energy as an opportunity to improve the self-sufficiency of its energy supply, which is currently heavily dependent on coal- and oil-fired thermal power that is reliant on imports of these fuels. The country is seeking stable and low-cost energy solutions for remote islands with low electrification rates, and ways to reduce risk from typhoons and other natural disasters.

Toshiba ESS has recently been conducting a survey project to develop H2One applications for remote islands in Indonesia and the Philippines, with support from the Japanese Ministry of Economy, Trade and Industry [*FCB, October 2018, p8*]. The company has already signed an MOU with Badan Pengkajian dan Penerapan Teknologi (BPPT), an Indonesian government organisation, to deploy H2One systems throughout Indonesia. The new MOU with NEA will accelerate business considerations for solutions to energy-related challenges in the Philippines, and the partners will study installation sites, optimum system specifications, and operation of the system, including maintenance.

Toshiba launched the H2One autonomous hydrogen energy system in 2015 [*April 2015, p1*], and has commissioned systems for a variety of applications in Japan, including an H2One Multi Station in Tsuruga to supply electric power to buildings and for charging electric vehicles as well as hydrogen for refueling fuel cell electric vehicles [*August 2018, p11*].

The H2One integrated system uses a renewable energy source to electrolyse water to produce hydrogen, and stores and uses the hydrogen in fuel cells to provide stable delivery of zero-carbon electricity and hot water. One application of H2One is the 'Off-grid solution', a distributed energy system that allows the supply of clean and stable energy, unaffected by the weather, to islands currently reliant on diesel and other generating systems such as thermal power [*see also page 10*].

Toshiba, Hydrogen Energy:
www.toshiba-energy.com/en/hydrogen/index.htm

Philippines National Electrification Administration:
www.nea.gov.ph

PORTABLE & MICRO

Bramble Energy H2O prototypes in testing

UK-based Bramble Energy has taken delivery of its first run of five prototype H2O fuel cell systems, which will be built up and tested in the lab and in a range of other facilities and operating conditions.

Over the next few weeks, these 20 W units will undergo rigorous optimisation in a variety of locations and conditions, to simulate the toughest possible user applications. The company expects the product to be commercially available in early 2019. The company is inviting contact from interested parties with an application for the H2O system, or with a specific set of conditions for testing.

Bramble Energy's 20 W units offer a dynamic power source suitable for a range of applications, such as a portable or stationary unit to provide uninterrupted long-term power for sensors, lighting, CCTV or surveillance, or for more dynamic power delivery such as sailing navigation systems. These 20 W units will form part of BOC's Hymera hydrogen fuel cell generator range, and will be available directly through the BOC sales channel.

Bramble Energy is a spinout from Imperial College and University College London, utilising unique design and manufacturing approaches to hydrogen fuel cells by

leveraging the well established printed circuit board (PCB) industry. Earlier this year it announced a partnership with BOC and Taylor Construction Plant Ltd [see also the item below, and the In Brief item on page 5] to develop portable, 20 W hydrogen fuel cell powered LED lighting towers, for launch in late 2018 [FCB, March 2018, p13]. The company has also been developing a 5 kW PCBFC™ stack for automotive applications [February 2018, p11], which was recently demonstrated as a range-extender in a light commercial van [October 2018, p5].

Bramble Energy: www.brambleenergy.com

BOC Hymera: <http://tinyurl.com/boc-hymera>

Intelligent Energy, TCP launch unit for construction industry

In the UK, Intelligent Energy and Taylor Construction Plant Ltd (TCP) unveiled the ECO GH₂, a zero-emission hydrogen fuel cell power product aimed specifically at the construction industry, at the UK Construction Week show in Birmingham in early October.

Intelligent Energy announced a strategic partnership with TCP [see also the item above, and the In Brief item on page 5] in late 2017 to integrate, test, and evaluate new products for the construction industry [FCB, October 2017, p6]. The first product from this collaboration is the ECO GH₂, which uses an Intelligent Energy FCM-801 Fuel Cell Module [July 2017, p10] to make a DC generator with a maximum output of 1 kW. The product can be used with DC power loads or with a TCP inverter power pack to produce an off-grid generator unit rated at up to 5 kW for power tools, accessories, and welfare units.

The ECO GH₂ – powered by Intelligent Energy's air-cooled PEM fuel cell – offers nearly silent operation, an advantage for night-time work and for operating in urban areas, particularly where noisy diesel generators would disturb residents and businesses. The product is lightweight, easy to carry and operate, can be used in enclosed ventilated spaces, and does not use a liquid fuel. Intelligent Energy's FCMs provide further benefits that make them a versatile solution for the construction industry, including compact and robust design, lower life-cycle cost than standby diesel generators, and minimal service requirements (simple air filter replacement).

In other news, Intelligent Energy has appointed **David Woolhouse as its new**

CEO, marking continued investment from business owner Meditor to drive the business forward [November 2017, p11]. He was previously Managing Director of Wabtec Rail, and has held MD positions at Alstom and the Brush engineering group.

Intelligent Energy: www.intelligent-energy.com

Taylor Construction Plant Ltd: www.tcp.eu.com

myFC demos prototype smartphone charged by integrated fuel cell

Swedish company myFC has showcased a fully functional prototype of a commercial Android smartphone with its integrated Lamina™ thin-film PEM fuel cell. myFC has also developed a way to securely identify its patented PowerCard fuel supply card, so that only PowerCards will be accepted at the start of energy generation for a smartphone or other device.

myFC is intensifying its efforts to integrate fuel cells into smartphones, reaching an important milestone by **demonstrating a fully functional smartphone** with an integrated Lamina fuel cell. 'Using this prototype, we can intensify discussions with leading smartphone manufacturers to show the potential of our technology,' says Sebastian Weber, who joined myFC as Chief Technology Integration Officer in the spring [FCB, April 2018, p7].

The integration team at myFC developed the prototype based on a commercial smartphone model that provides built-in support for adding new hardware and software. The prototype has been developed without collaboration with the smartphone manufacturer, and will be used as a reference design when promoting myFC's technology to smartphone manufacturers. The next steps include improved mechanical integration, system performance, and end-user interaction, as well as further developing the fuel ecosystem.

myFC is also developing a system and technologies to **protect the unique certified fuel chemistry in its PowerCard**, so that only PowerCards will be accepted when starting power generation for a smartphone or other device. Specifically, the pending patent covers the technology that allows the device to immediately recognise if a fuel supply card is in fact a myFC PowerCard, safe for the intended use, and ensuring the device does not accept any uncertified or counterfeit versions. The company sees sales of fuel cards as a significant source of recurring revenue – with users buying

one or two PowerCards a month, the potential annual revenues from fuel cards could be 5–10 times higher than from fuel cell revenues.

myFC: www.myfcpower.com

FUELING

H₂ Mobility opens new German stations in Weiterstadt, Leipzig

H₂ Mobility Deutschland GmbH has added two more hydrogen refueling stations to the German network, with a Shell station at Weiterstadt in Hesse and a Total station in Leipzig, Saxony, making it a total of **53 operational stations nationwide**.

The new station in **Weiterstadt**, the seventh in Hesse, closes a large gap in the network between the Main and Neckar rivers. The Shell service station is located on the Weiterstadt motorway exit, a few km from the Darmstädter Kreuz junction in the Darmstadt and Gross-Gerau catchment areas, where the Bundesautobahn BAB 5, 67, and 672 motorways meet. This means that drivers of fuel cell electric vehicles now have an additional fueling option on the important north–south axis between Frankfurt, Mannheim, and Karlsruhe. The station features Air Liquide hydrogen dispensing technology, and has a capacity of around 200 kg/day of hydrogen, enough to refuel 40–50 vehicles.

The European Commission is funding a total of 17 facilities in the Trans-European Transport Network (TEN-T CEF), including the Weiterstadt station, with a total of €11 million (US\$12.4 million), through its Connecting Hydrogen Refuelling Stations (COHRS) project.

H₂ Mobility, Linde, and Total have also inaugurated the first hydrogen station in the **Leipzig** region, at the Total truck stop in Poststrasse, closing another major gap in the network. This station uses Linde technology, and can refuel up to 40 vehicles per day. It has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU), under the Hydrogen Mobility Europe (H2ME) project. The first station in Saxony was recently opened in Dresden [FCB, October 2018, p9]. More stations in the region are under construction and/or at the planning stage, e.g. at Total service stations in Magdeburg, Erfurt and Neuruppin, and Linde will open another station shortly in Halle.

The H₂ Mobility joint venture was created in 2015 by Air Liquide, Daimler, Linde, OMV,

This enhanced stack and cartridge has also demonstrated it can meet multiple power cycling steps without loss of performance.

In addition, the latest electrode pairings, developed in collaboration with Industrie De Nora and tested during December [*FCB, January 2018, p10*], exhibit significantly extended electrode operational life, and well exceed the longevity targets AFC had set for 2017. AFC and De Nora now plan ongoing testing for delivery of an electrode pairing that will achieve a four-year operational life with associated performance warranties, and at a cost which should see AFC's Levelised Cost of Electricity at below US\$0.10 per kWh (excluding the cost of hydrogen, which varies from project to project, and consistent with previous calculations).

In December, AFC compiled its first stack featuring several new system design characteristics. These include a new design of hydrogen, electrolyte and air plates, following significant computational fluid dynamics (CFD) simulation, resulting in improved gas, liquid, temperature and pressure regulation within the system, and also addressing underlying legacy design observations which have previously led to premature stack failure. The new electrode pairings have also been integrated within a new flow plate design, removing the need for expensive nickel substrates while enlarging the size of the electrode active area, improving cell output and performance. The cartridge system has been fully redesigned with fewer nozzles and simplified orientation for the gas and liquid inlet and outlet nozzles, based on the revised flow plate design, and the balance-of-plant (BOP) has been reconfigured to facilitate the above changes and address legacy design inefficiencies observed in the earlier KORE system [*e.g. August 2015, p5*].

In parallel with these activities, significant progress has been achieved in collaboration with De Nora in further iterations of the electrode pairings (cathode–anode). While AFC froze its electrode design to validate its enhanced stack design in Q3 of 2017, progress has continued with De Nora, via testing of smaller-scale electrode samples, to further optimise performance. The results after two months of operation suggest this electrode pairing has the potential to exceed the targeted one-year operational life objective set for 2017 – and is likely to have the capacity to operate for more than 24 months. The latest electrode design, suitable for industrial scale applications, is on test at AFC's facilities in Surrey.

AFC Energy: www.afcenergy.com

Industrie De Nora: www.denora.com

Ballard narrows focus, cuts costs at Protonex, SOFC tech to Upstart

Canadian-based Ballard Power Systems has implemented several changes at its Protonex subsidiary in Southborough, Massachusetts, including sharpening the focus of its business by divesting certain non-core assets. Protonex's solid oxide fuel cell assets were transferred at the end of 2017 to a private startup company, Upstart Power Inc, for a nominal consideration.

Ballard acquired Protonex Technology in mid-2015 [*FCB, July 2015, p1*], and retained its focus on both PEM and SOFC technologies. Last year Ballard carried out a strategic review of the subsidiary, and took steps in August to reduce and align the cost base. The latest actions are expected to yield annualised cost savings of US\$2.6 million, and put Protonex in a better position to deliver future profitability. The SOFC divestiture is expected to yield annualised cost savings of \$1.4 million.

The Protonex subsidiary had three businesses: Power Manager, Unmanned Aerial Vehicles (UAVs), and Solid Oxide Fuel Cells. Ballard's strategic review of each of these activities aimed to determine the most effective strategic course for each business.

The **Power Manager business** has underperformed against expectations, primarily due to unexpected delays in achieving a certain procurement milestone in the US Army's Program of Record, which was not achieved until September 2017. Ballard now expects growth in the Power Manager business to begin this year. Protonex has subsequently announced the receipt of a \$1.6 million purchase order for the supply of Squad Power Manager SPM-622 Special Operations Kits for end customer US Special Operations Command.

Protonex has made significant progress in the **UAV business**, in both the military and commercial markets, including key business planning, field trials, and business development activities [*e.g. July 2017, p4 and January 2018, p4*]. Ballard plans to rebrand the commercial UAV business with the Ballard brand under the leadership of Phil Robinson, previously VP Defense Power Systems at Protonex, who has now been appointed as Vice President, UAV.

With respect to the **SOFC business**, Protonex had been engaged in certain product development and commercialisation programmes for small-scale SOFC stationary power products.

In 2017 it was determined that these assets were not core to Ballard's PEM fuel cell business, and the company decided to divest these non-core assets. As a result, certain SOFC assets were transferred to Upstart Power Inc, with Ballard having no associated ownership interest or liabilities. Initially, 10 Protonex employees have moved to Upstart Power, with an additional six employees expected to transfer later this year on completion of certain Technology Solutions contracts. As part of this transfer of employees, Dr Paul Osenar, previously President of Protonex, has moved to Upstart Power as CEO. This action has enabled Ballard to significantly reduce the cost structure at Protonex.

Ballard Power Systems: www.ballard.com

Protonex Technology: www.protonex.com

Upstart Power: www.upstartpower.com

Bramble Energy makes progress on 5 kW air-cooled PCBFC stack

UK-based Bramble Energy reports excellent progress in its project to develop a 5 kW air-cooled printed circuit board (PCB) fuel cell stack, and has also announced the kickoff of its new Investment Accelerator Pilot project, funded by IP Group and Innovate UK.

Bramble Energy – founded in 2016 as a spinout from University College London (UCL) and Imperial College London – has used innovative fuel cell design and manufacturing techniques to develop its unique printed circuit board (PCB) fuel cell. Its patent-protected PCBFC™ utilises cost-effective production methods and materials from the PCB industry to reduce the cost and complexity of manufacturing proton-exchange membrane (PEM) fuel cells. The PCBFC technology was originally conceived after a joint flexi-planar fuel cell project between UCL and Imperial College won the Carbon Trust Polymer Fuel Cell Challenge [*FCB, March 2012, p10*]. After spinning out of both universities, the team has quickly established rapid prototyping and laboratory testing facilities, which have enabled the development and production of evaluation prototypes for industrial application.

The company has been busy for several months developing a range of different sized systems and products, in particular making progress in its IDP13, Innovate UK-funded **project to produce a 5 kW air-cooled stack**. (IDP13 was a 2016 government supported funding competition for low-emission vehicle systems.)

The system is made up entirely of manufactured modules, unlocking a key element of Bramble Energy's business approach. Through extensive design and iteration, the company has optimised module design and performance, working with its PCB manufacturer, ZOT Engineering in Scotland, to completely standardise the module manufacturing. Standardising this process reduces the risk of errors and manufacturing defects and cuts down on waste, which in turn helps the company to produce stacks more efficiently and more quickly.

Bramble Energy has also announced the launch of the **Investment Accelerator Pilot (IAP)** project, funded by technology intellectual property investor IP Group and the government-supported Innovate UK. This programme will advance and demonstrate improved protective layers within the fuel cell, to enhance durability for the most intensive applications, such as micro combined heat and power (mCHP). Fuel cells offer an ideal technology for commercial and residential mCHP units, but current hydrogen fuel cell mCHP units are limited by long-term durability and high costs to customers. Bramble Energy will use its PCBFC technology and unique manufacturing routes to combat these inherent industry issues through the development a new 500 W stack.

Bramble Energy: www.brambleenergy.com

ZOT Engineering: www.zot.co.uk

Innovate UK: www.innovateuk.gov.uk

Engie buys controlling stake in Electro Power Systems, global rollout

French multinational electric utility Engie has signed a share purchase agreement with the main shareholders in Electro Power Systems SA, the Paris/Milan-based technology pioneer in energy storage systems and microgrids, to acquire a majority stake in EPS, slightly above 50% of the share capital and voting rights.

Paris-based Engie [see also pages 3/4 and 7] – formerly known as GDF Suez – is one the largest global utilities, active in some 70 countries, and is committed to taking on the major challenges of moving towards a more decarbonised, decentralised and digitalised world. It has bought out the stakes held by 360 Capital Partners, Ersel and Prima Industrie, and the agreement also involves the members of the Board of Directors and the management team. A new retention and long-term incentive plan has been set up, to secure and strengthen the full commitment of

the management team until 2021, linked to the development of the company.

EPS and Engie see the transaction as a broad industrial partnership to scale up globally, with both aiming to further accelerate their vision to be at the forefront of the energy transition, with special focus on decentralised energy solutions. The transaction is expected to be completed during Q1 of 2018.

'EPS is a recognised technology provider in the microgrid market, with a differentiating control technology and already significant microgrid installed base, in particular in Africa and Asia Pacific [FCB, February 2017, p7],' says Shankar Krishnamoorthy, Executive VP of Engie. 'Together, we will achieve a major step to become a decentralised energy leader, and confirm that energy transition is at the core of the strategy and transformation of Engie.'

'This is a transformational step for EPS. We share Engie's strategic vision of a paradigm shift in the energy system towards decentralised energy solutions: in advanced economies, renewables are displacing conventional centralised power plants, calling for distributed energy storage to secure flexibility and capacity; thus, value-added migrates from traditional energy supply to the delivery of advanced services,' says Carlalberto Guglielminotti, CEO and General Manager of EPS. 'EPS has been delivering one of the largest installed bases of commercial microgrids and utility-scale systems globally: today, our unique technological platform, combined with Engie's global reach, establishes a driving force of the energy transition.'

In 2016 Engie bought a stake in French fuel cell range-extender specialist Symbio FCell, as part of its drive to encourage hydrogen electric mobility [October 2016, p10]. The company was also a founding member of the Hydrogen Council a year ago [January 2017, p1].

Electro Power Systems: www.electropowersystems.com

Engie: www.engie.com/en

Ceres Power signs fifth major partner for joint development activities

UK-based Ceres Power, which is developing the low-cost SteelCell® intermediate-temperature solid oxide fuel cell technology, has signed a new Joint Development Agreement (JDA) with a significant European-based global OEM. Ceres and the new, unnamed partner will work together to develop prototype multi-kW power systems for several potential applications.

This strategic relationship, the fifth agreement that Ceres has signed in less than two years, is the first step in considering a potential collaboration which could include joint system development, SOFC stack development, and manufacturing. It maintains the company's development momentum, and highlights increasing global backing for the SteelCell technology.

Ceres Power already has strategic JDA partnerships with Honda [FCB, January 2016, p1], Nissan [July 2016, p4], Cummins [April 2014, p10], and a further, unidentified global OEM [June 2017, p5]. Ceres is working with these world-class companies to embed the SteelCell technology into power systems for the residential, business, data centre, and electric vehicle markets.

'We set ourselves the target of securing five major development partners within two years, and we've now achieved that by signing an agreement with another global player,' says Phil Caldwell, CEO of Ceres Power. 'We are continuing to attract some of the biggest names in the power systems and energy sectors, an endorsement not just of our technology and engineering expertise, but also of the significant potential of the SteelCell.'

Ceres Power's unique, patented SteelCell IT-SOFC technology operates on grid natural gas and is manufactured using standard fabrication processes and conventional materials such as steel. This means that it can be mass-produced at an affordable price for domestic and business applications. Last autumn Ceres completed a successful year-long field trial of SteelCell residential combined heat and power (CHP) systems in the UK [October 2017, p4], and recently reported that it is on track to begin field trials this year with its first go-to-market product utilising its low-cost, next-generation SteelCell technology [January 2018, p11]. The company also announced a new Technology Assessment Agreement with a leading global OEM.

Ceres Power: www.cerespower.com

FuelCon ships fuel cell test stations for major German project

German company FuelCon recently despatched four of its high-performance fuel cell system test stations to an unnamed customer in Germany, which will use the stations in the development of automotive drivetrain systems.

Seven trucks were needed to ship the four Evaluator S200-LT and SX200-LT test

transportation, both long-haul goods delivery and long-distance or intercity passenger transport. Hydrogen, stored in high-pressure carbon fibre tanks, is used in the fuel cell system to generate electricity that powers a 400 kW electric engine.

FPT Industrial (formerly Fiat Powertrain Technologies) is dedicated to the design, production, and sale of powertrains for on- and off-road vehicles, marine, and power generation applications. The company's extensive range of diesel and natural gas engines, and its close focus on R&D, make it a world leader in industrial powertrains. FPT Industrial and Iveco are brands of CNH Industrial, one of the leading players worldwide in the agricultural and construction equipment sectors. Last year CNH partnered with H2U in Melbourne, Australia to develop and test a fleet of pre-production hydrogen fuel cell powered waste trucks for use in the local council's operations [*FCB, September 2017, p6*].

FPT Industrial: www.fptindustrial.com

MOBILE APPLICATIONS

Revolve unveils van range-extender with Bramble PCB fuel cell

In the UK, Revolve Technologies has completed a project to develop fuel cell technology created by Bramble Energy using a printed circuit board (PCB) construction, which has been shown in a fuel cell range-extender. The project aims to support the development of the UK's low-carbon propulsion supply chain through the upscaling and streamlining of an innovative 5 kW PCB-based fuel cell and light commercial electric vehicle with a hydrogen range-extender.

Revolve displayed a Renault Kangoo ZE van with the PCB fuel cell range-extender at the recent Cenex Low Carbon Vehicle Event at Millbrook Proving Ground. The 5 kW PCBFC™ utilises cost-effective production methods and materials from the PCB electronics industry to reduce the cost and complexity of manufacturing PEM fuel cells.

This is the first time that a PCB-based fuel cell has been developed for use in an automotive environment. Compared with conventional systems, the PCBFC stack offers dramatically reduced system costs, while delivering reduced weight for a given power output and providing a more flexible form-factor. With the PCBFC fitted, an additional range of around 80 miles (130 km) can be expected on the NEDC (New European

Driving Cycle) with 1.7 kg of hydrogen on board; the range can be further extended simply by fitting additional hydrogen storage capacity.

The demonstration vehicle has the fuel cell, control system, and electronics integrated in an enclosed roof-rack. The hydrogen storage tank is currently in the van's load bay, although future development could see the tank relocated to the roof. The vehicle integration is part of an IDP13 Innovate UK funded project, which has taken just over a year to bring to fruition, with the majority of the work completed in July.

Revolve Technologies carried out system integration, benchmarking and testing, while Bramble Energy – a spinout from Imperial College and University College London (UCL) – was responsible for fuel cell development and manufacture [*FCB, February 2018, p11*]. UCL provided fuel cell testing and manufacturing support, STI developed the electronics, and manufacturing consultancy HSSMI worked on scaling-up manufacturing.

While the demonstration was shown on a Renault Kangoo small van, the fuel cell range-extender module is designed as an aftermarket kit for all commercial electric vehicles, and the technology can also be adopted by OEMs in other EV segments.

Revolve Technologies: www.revolve.co.uk

Bramble Energy: www.brambleenergy.com

WATT fulfills first Imperium order for Hymer North America

Pennsylvania-based WATT Fuel Cell has made multiple commercial shipments of its Imperium™ solid oxide fuel cell system to Erwin Hymer Group North America (EHGNA) in Cambridge, Ontario, Canada. These shipments mark the first deliveries of WATT's Imperium SOFC system for integration into a consumer product.

EHGNA – one of the leading manufacturers of Class B (semi-integrated) motorhomes in North America – placed its first order with WATT after a successful pilot of the Imperium on board its E-Trek autonomous recreational vehicle (RV) earlier this year [*FCB, December 2017, p4*]. The Imperium provides clean power on demand, allowing users to automatically create, access, and manage power for all their onboard appliances and devices.

The initial Imperium shipments are part of a larger purchase agreement from EHGNA [*April 2018, p4*], and signal WATT's official entrance into the RV market. Additional shipments to

IN BRIEF

HTEC launches equity crowdfunding to support Canada hydrogen station rollout

Canadian company Hydrogen Technology & Energy Corporation (HTEC, www.htec.ca) has launched a direct-equity campaign on Vancouver-based crowdfunding platform, FrontFundr. HTEC hopes to raise at least C\$1 million (US\$760 000) to support the deployment of retail hydrogen refueling networks across Canada.

In June, HTEC opened Canada's first retail hydrogen station, in Vancouver [*FCB, July 2018, p8*]. This is the first in a six-station network HTEC is building in Greater Vancouver and Victoria, scheduled for completion in 2020, to enable the deployment of the first 1000 fuel cell electric vehicles in the province. The majority of contracts are already in place for the six stations, including three that HTEC is building in partnership with Shell.

IRENA on hydrogen in energy transition

A new report from the International Renewable Energy Agency (IRENA, www.irena.org) says that hydrogen is the missing link in the global energy system transition by 2050, as required by the targets in the Paris Agreement. The report, *Hydrogen from Renewable Power: Technology Outlook for the Energy Transition* (<https://tinyurl.com/irena-h2-report>), is co-authored by sustainable energy consultancy Hincio (www.hincio.com), and builds on the Hydrogen Council's global roadmap published last year [*FCB, November 2017, p1, and see page 14 in this issue*].

The report shows how hydrogen is a key enabler to integrate more renewables into the energy system, funneling them towards sectors that are otherwise difficult to decarbonise such as industry, buildings, and mobility. The report emphasises that although key hydrogen technologies are still maturing, scale-up can yield the necessary technology cost reductions.

Swiss H₂ Mobility association is growing

The H₂ Mobility Switzerland Association (www.h2mobilitaet.ch/en), which was founded in May [*FCB, June 2018, p5*], has welcomed its newest member, filling station operator SOCAR Energy Switzerland (www.socarenergy.ch/en), providing additional support to promote and accelerate the establishment of hydrogen mobility in Switzerland.

Things are starting to accelerate in Switzerland since the Swiss Hydrogen Association published its *Hydrogen Report Switzerland: 2016–2017* last autumn [*October 2017, p11*]. H₂ Energy recently partnered with Empa and the Paul Scherrer Institute to further develop fuel cell technology and prepare for market entry [*August 2018, p14*], and has just joined with South Korean automaker Hyundai to deploy 1000 fuel cell trucks in Switzerland by 2023 [*see page 3*].

The proposed fuel cell powered train [see also *the next item*] will feature PEM fuel cells coupled with lithium-ion batteries and supercapacitors. A fuel cell powered switcher (shunter) locomotive will be developed in parallel with a passenger train with two coaches, each capable of carrying 65 passengers, operating at up to 75 km/h (47 mph). Each fuel cell will operate at a maximum output power of approximately 30 kW for the switcher, providing a total of 1 MW peak power and 650 kW continuous power as a prime mover. Additional required transient power will be stored in the lithium-ion batteries and supercapacitors, to cater for the electrical requirements of the coaches. The supercapacitors will be used to initiate traction for the fuel cell train, because of their high and fast discharge capacity. The switcher may not need supercapacitors.

The fuel cells will be stacked in one of the coaches, to avoid electrical wiring and mechanical design complications, while the lithium-ion batteries and supercapacitors will be located underneath the coach. Six compressed hydrogen storage tanks, each 0.4 m in diameter and 4 m long, and storing 60 kg of hydrogen at 350 bar, will be employed for the proposed train. The hydrogen tanks, with all necessary safeguards, will be installed under the roof of the passenger train, or inside the locomotive itself in the case of the switcher.

The switcher project is expected to be complete by March/April 2019, while the fuel cell powered passenger train is expected to enter public service by December 2019.

Indian Railways, Integral Coach Factory:
www.icf.indianrailways.gov.in

SRM Institute of Science and Technology:
www.srmuniv.ac.in

SRM University: www.srmap.edu.in

Siemens wins BMVI funding to develop fuel cell train with Ballard

German engineering giant Siemens has received some €12 million (US\$14.8 million) in project funding from the Federal Ministry of Transport and Digital Infrastructure (BMVI), for a project to develop a fuel cell drive system for trains, in collaboration with RWTH Aachen University and Canadian-based Ballard Power Systems.

Siemens and Ballard will jointly develop a fuel cell drive system for the Siemens Mireo train platform, producing a new generation of hydrogen PEM fuel cells with an especially

long lifecycle, high power density, and improved efficiency. The Mireo regional and commuter train platform will be the reference vehicle, aiming for zero-emission operation without the need for overhead lines. Ballard announced last November that it had signed a multi-year, \$9 million Development Agreement with Siemens to develop a 200 kW fuel cell engine to power the Mireo light rail train [FCB, December 2017, p5].

Siemens and RWTH Aachen are funded under the programme by BMVI through the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP) [see also pages 2/3], which is coordinated by the NOW GmbH National Organisation Hydrogen and Fuel Cell Technology in Berlin.

‘Our cooperation with Ballard marks a decisive step being taken to replace diesel-powered rail vehicles with emission-free vehicles, in order to provide sustainable and climate-friendly mobility over the long term,’ says Sabrina Soussan, CEO of Siemens Mobility Division. ‘We want to be able to offer our customers flexible train solutions – that vary depending on regional conditions and technical possibilities – for different types of local rail routes.’

The Mireo is a modular commuter train platform designed for speeds of up to 160 km/h (100 mph). Its lightweight design, energy-efficient components, and intelligent onboard network management mean that it will consume up to 25% less energy than trains with similar passenger capacity. In addition, hydrogen-powered trains such as the Mireo offer advantages over traditional electrification solutions, including reduced infrastructure costs and minimal environmental impact, through the ability to operate on routes without overhead lines. Initial deployments of the fuel cell powered Mireo train are planned for 2021, and integration of the fuel cell technology will follow in additional vehicle platforms.

Siemens and Ballard don’t have this field to themselves. Alstom is building a fleet of 14 Coradia iLint fuel cell powered trains for the Local Transport Authority of Lower Saxony in Germany, with options for 33 more [December 2017, p4, and see the News Feature in March 2017]. The regional train fleet will be supplied with hydrogen from a dedicated refueling station to be built by Linde. And an Indian consortium has announced the joint development of a fuel cell-based train prototype [see the item above].

Ballard Power Systems: www.ballard.com

Siemens Mobility, Rail Solutions:
<http://tinyurl.com/siemens-rail-solutions>

IN BRIEF

California opens 32nd hydrogen refueling station, a Linde facility in Mountain View

The California Fuel Cell Partnership (www.cafcp.org/stationmap) has announced that the 32nd retail hydrogen refueling station in California opened for business at the end of February, in Mountain View in the heart of Silicon Valley [see also page 9]. The station, at 830 Leong Drive, will be open daily 6am to 10pm in accordance with restrictions set by the City of Mountain View. The facility was developed by Linde North America (<http://tinyurl.com/linde-us-h2energy>), which also operates the stations in San Ramon [FCB, August 2017, p5], San Juan Capistrano [November 2015, p8], and the state’s first retail station, in West Sacramento [November 2014, p9].

The Linde Group is a leading manufacturer of hydrogen dispensing technology [see the feature in September 2014], and has long experience across the entire hydrogen value chain, equipping more than 100 hydrogen stations around the world. Linde is also collaborating to explore new pathways in the sustainable production of hydrogen using renewable energy sources.

China hydrogen, fuel cell alliance created

The China National Alliance of Hydrogen and Fuel Cell was recently officially unveiled in Beijing, as an interdisciplinary, multi-industry, trans-government department initiative to promote Chinese hydrogen and fuel cell collaborative innovation, resource integration, commercialisation and application. The alliance will help the country’s hydrogen and fuel cell technologies to reach market maturity and international competitiveness. It is led by National Energy Group in Beijing, and includes 17 key industrial partners in the energy, equipment manufacturing, transportation, metallurgy and materials industries, alongside major universities and research institutions.

German NIP2 funding for emergency power units with fuel cell systems

The German Federal Ministry of Transport and Digital Infrastructure (BMVI) is now offering funding for the use of fuel cell systems in independent energy supplies for critical or off-grid infrastructure. Equipment in the power class up to 20 kW will be funded for digital radio communications for security authorities and organisations, and for traffic control systems. The funding rate is a maximum 40% of the additional investment costs compared to conventional technology. The funding call has a budget of €5 million (US\$6.2 million), sufficient to subsidise 500–600 fuel cell-based emergency power units.

Applications can be made until 31 May 2018: <https://foerderportal.bund.de/easyonline>

increase during certain operations, such as maintenance of the fuel system or powertrain. The hazards associated with hydrogen in these types of operations are minimised through appropriate facility designs, including the use of sensors, to alert personnel to the presence of hydrogen in the facility.

The NREL-KPA collaboration has facilitated the adaptation of repair facilities for FCEVs by ensuring a safe repair environment. The collaboration provides local authorities with critical performance data that enable a faster permitting process to accommodate hydrogen FCEVs in repair facilities.

KPA – which joined the California Fuel Cell Partnership [see also the *In Brief* item on page 5] a year ago – has developed a modular approach to adapt existing repair facilities to accommodate FCEVs. Individual service bays are upgraded to be compatible with overall safety requirements for FCEV maintenance activity – and hydrogen sensors are a key element in this design.

In the first phase of the collaboration, NREL and KPA identified sensor requirements based in part on the requirements within the International Fire Code and National Fire Protection Association (NFPA 2) standards. Several sensors were then identified for extended field deployment and monitoring for long-term stability.

Following testing and validation at NREL, one sensor was selected by KPA for use in its repair facility design, was readily accepted by local ‘authorities having jurisdiction’, and has been deployed in at least nine Toyota repair facilities to date. Toyota and KPA plan additional adaptation of dealership repair facilities, notably in the Northeast corridor between Boston and New York City.

NREL, Safety Sensor Testing Laboratory:
www.nrel.gov/hydrogen/sensor-laboratory.html

KPA Services: www.kpaonline.com

Toyota, Fuel Cell Vehicle:
<http://tinyurl.com/toyota-fcevs>

Toyota Motor Sales USA: www.toyota.com

Impact Coatings fuel cell coatings for Michelin, China deal

Swedish-based Impact Coatings, which develops and sells advanced technology for physical vapour deposition (PVD) coatings of fuel cell plates and vehicle reflectors, has received its first production order for Ceramic MaxPhase™ coatings from

Michelin. Impact Coatings has also signed a cooperation agreement with Telos Auto Power Systems in China, to develop advanced fuel cell systems utilising Impact Coatings’ bipolar plate coating technology.

Michelin produces fuel cell systems for trucks, buses and cars, and has chosen coatings from Impact Coatings for its production process. The French tyre and automotive components company is currently building up its fuel cell manufacturing initiative. A first order for Ceramic MaxPhase coatings has been received, worth SEK200 000 (US\$25 000); the coating service will take place at Impact Coatings’ facilities in Linköping.

Impact Coatings has previously delivered coatings for Michelin’s fuel cell development activities. Demand and delivered volumes are now expected to increase gradually during 2018 and 2019 as fuel cell production increases.

‘The cooperation with Michelin is very positive, and an important sign that the European fuel cell market is ramping up,’ says Henrik Ljungcrantz, CEO of Impact Coatings. ‘Michelin has approved and qualified our coating, and is of the view that it has the best performance to increase fuel cell system efficiency.’

Impact Coatings has previously provided Ceramic MaxPhase coatings for PowerCell Sweden [FCB, June 2013, p4] and for French fuel cell integrator Symbio FCell [FCB, October 2015, p10]; Michelin has a significant minority stake in the latter [June 2014, p9].

Impact Coatings has also signed a cooperation agreement with Chinese fuel cell manufacturer **Guangdong Telos Auto Power Systems**, based in the city of Foshan, and with the city’s administrative management. The companies will develop world-leading fuel cell systems with the support of the local city council. Foshan, in Guangdong Province, is one of the major centres for the development of fuel cells and hydrogen vehicles in China [e.g. October 2016, p2, and March 2017, p1].

Telos Auto is focused on becoming a leader in China for the development and manufacturing of fuel cell systems for metro buses and trucks. The company has manufactured its first fuel cell systems, which have been installed in buses rolled out to the market. Technology and production are now being scaled up to cope with volume production, since Telos has agreements to deliver fuel cell systems to additional bus manufacturers.

Impact Coatings: www.impactcoatings.com

Michelin Group: www.michelin.com

IN BRIEF

Bramble Energy deal with BOC and TCP for hydrogen fuel cell lighting towers

In the UK, Bramble Energy (www.brambleenergy.com) has announced a new partnership with BOC and Taylor Construction Plant Ltd (TCP, www.tcp.eu.com), to develop portable, hydrogen fuel cell powered LED lighting towers. The 20 W light towers will be launched in late 2018. Bramble Energy will also launch a PCBFC™ REX hydrogen fuel cell range-extender later this year.

Bramble Energy is a spinout from Imperial College and University College London (UCL), utilising unique design and manufacturing approaches to hydrogen fuel cells by leveraging the well established printed circuit board (PCB) industry. It recently reported progress in its project to develop a 5 kW air-cooled PCB fuel cell stack [FCB, February 2018, p11].

TCP recently supplied its Ecolite TH200 LED Lighting Tower, featuring BOC’s Hymera® fuel cell (<http://tinyurl.com/boc-hymera>), to help illuminate the construction site of the new Aberdeen Exhibition and Conference Centre in Scotland [see page 7].

FuelCon fulfils TISAX data, info security

German fuel cell testing station manufacturer FuelCon (www.fuelcon.com/en) is now TISAX certified, fulfilling the requirements for the Trusted Information Security Assessment Exchange (<http://enx.com/tisax/tisax-en.html>), part of a restricted network for automotive industry manufacturers and suppliers.

FuelCon ensures data security for collected test data, as well as sensitive and confidential customer information. The conditions were recently assessed by an independent testing service provider in a TISAX audit. FuelCon is now authorised to exchange sensitive and confidential information, such as prototypes and testing results, within the closed network.

Yuchai, King Long strategic product deal

Chinese companies Guangxi Yuchai Machinery Co Ltd (<http://en.yuchai.com>) and Xiamen King Long Motor Group (www.king-long.com) have announced a strategic partnership for new energy products. This cooperation will develop a new generation of hybrid power systems, fuel cells, electrical drive systems, and other high-end equipment, with the first new products expected to be released in 2019. The products will combine Yuchai’s sophisticated power technologies with King Long’s capabilities in complete vehicle development and production management, and be supported by Yuchai’s marketing and service networks. In 2015 King Long signed a strategic cooperation deal for fuel cell buses with Canadian-based Ballard Power Systems [FCB, December 2015, p2].