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First Mercedes-Benz GLC F-CELL hybrid plug-in FCEVs delivered to German customers

Mercedes-Benz has handed over the first batch of its GLC F-CELL hybrid plug-in fuel cell electric vehicles to selected customers in Germany. The zero-emissions, all-electric premium SUV is unique in featuring both hydrogen fuel cells and a battery drive system that can be charged externally using plug-in technology.

The first German customers include various national and regional ministries as well as NOW GmbH (National Organisation Hydrogen and Fuel Cell Technology), the H_2 Mobility Deutschland GmbH infrastructure rollout joint venture, and the German railway company Deutsche Bahn. Further handovers will be made before the end of the year, to the likes of Air Liquide, Shell, Linde, and also the cities of Stuttgart and Hamburg. Other business as well as the first private customers in Germany will also be able to lease the GLC F-CELL from spring 2019 via Mercedes-Benz Rent.

The GLC F-CELL was announced two years ago [*see the News Feature in FCB, August 2016*], and a preproduction model presented at last year's IAA International Motor Show in Frankfurt [*see the News Focus in October 2017*]. The vehicle has two carbon-fibre tanks in the floor holding 4.4 kg of hydrogen, which with a hydrogen consumption of around 1 kg/100 km, gives a hydrogen-based range of about 430 km (270 miles) under the New European Driving Cycle (NEDC) test. In hybrid mode a fully charged battery can add up to 51 km (32 miles).

The innovative plug-in battery/fuel cell drivetrain combines the advantages of both zero-emission drive technologies, and uses an intelligent operating strategy – with four modes: Hybrid, F-CELL, Battery, and Charge – to continuously optimise the use of both energy sources in line with the current operating situation, alongside energy recovery during braking or coasting, for storage in the battery.

The market launch of the GLC F-CELL is taking place in selected metropolitan regions, focusing on major cities which are already comparatively well equipped with hydrogen refueling stations, such as Stuttgart, Düsseldorf, Berlin, Hamburg, Frankfurt, Munich, and Cologne. The vehicle is being offered exclusively in the form of a full-service rental business model, including all maintenance and repairs together with a comprehensive warranty package covering the entire rental period. From spring 2019, business and private customers will be able to rent the vehicle under short- and long-term rental plans from one of the seven GLC F-CELL outlets throughout Germany, via the Premium Car Rental service from Mercedes-Benz Rent.

Daimler – the parent company of Mercedes-Benz – is a founding partner in the H_2 Mobility joint venture, which expects to grow the German hydrogen refueling station network from its current level of 53 stations to about 100 locations by the end of 2019 [*November 2015, p6, and see page 8 in this issue*]; the long-term objective is up to 400 stations. Similar infrastructure projects are being promoted elsewhere in Europe, the US, and Japan [*see page 9*].

Daimler is also participating in the two-phase Hydrogen Mobility Europe (H2ME) lighthouse project [*June 2016, p1 and February 2017, p1*], supported by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), which is promoting the expansion of a large-scale hydrogen station infrastructure and the development of FCEVs such as the GLC F-CELL, and provided funding for the vehicle's development.

Mercedes-Benz GLC F-CELL announcement: https://tinyurl.com/glc-fcell-first

H_2 Mobility Deutschland: www.h2.live/en

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

Hydrogen Mobility Europe: www.h2me.eu

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ROAD VEHICLES

Ballard fuel cells for California UPS trucks in CARB-funded trial

Canadian-based Ballard Power Systems is supplying fuel cell modules to power four UPS delivery trucks as part of a project being managed by the Center for Transportation and the Environment (CTE) in Atlanta, and partially funded by the California Air Resources Board.

The Next Generation Fuel Cell Delivery Van Deployment Project will develop, validate, and deploy four Class 6 fuel cell electric hybrid delivery trucks with a view to commercialisation of the technology. Linamar Corporation will be the primary systems integrator of the vehicle, utilising its existing hybrid powertrain configuration with a next-generation eAxle, while Ballard will provide hydrogen PEM fuel cell modules for primary propulsion of each truck. The completed trucks will be operated in parcel delivery service by UPS out of its Customer Center in Ontario, California.

CARB has announced a preliminary funding award of $5.8 million for the project through its Zero and Near Zero-Emissions Freight Facilities (ZANZEFF) programme. CARB recently awarded $41 million to the Port of Los Angeles for the ZANZEFF project, under which Toyota, Kenworth, and Shell will establish a fuel cell electric technology network for zero-emissions freight transport [*FCB, October 2018, p4*]. Ballard is also providing fuel cell modules to power two port terminal yard trucks as part of a CARB-funded project at the Port of LA being managed by GTI [*see page 4*].

Current battery-powered Class 6 UPS delivery trucks have a limited range that makes them unsuitable for some routes, and often for a majority of routes in any delivery area. This suitability can be further reduced if the delivery locations face unexpected heavier loads, hilly terrain, or colder temperatures. As a result, for several months Ballard has been involved in the development of a UPS truck using a 30 kW FCveloCity®-MD fuel cell module as a range-extender, addressing the above limitations by boosting the driving range and providing certainty of completing daily delivery missions while maintaining zero-emission performance. And hydrogen refueling is much faster than long battery recharging times.

The CTE project will test the performance of UPS delivery trucks using larger fuel cell modules to provide primary vehicle propulsion. Ballard expects to ship these modules in 2019, with operation of the UPS vans planned to begin in 2020.

Center for Transportation and the Environment: www.cte.tv

Ballard Power Systems: www.ballard.com

Linamar Corporation: www.linamar.com

California Air Resources Board: www.arb.ca.gov

California Climate Investments: www.caclimateinvestments.ca.gov

German project orders 11 buses for Frankfurt, Wiesbaden and Mainz

The '0-Emissions-Project' in Germany will see 11 hydrogen fuel cell buses enter regular service in Wiesbaden, Mainz, and Frankfurt am Main next summer. The buses – including four articulated vehicles – and a new hydrogen refueling station have now been ordered.

The project kicked off in 2016, when the transit agencies in Wiesbaden (ESWE Verkehr), Mainz (Mainzer Mobilität MM), and Frankfurt (traffiQ and In-der-City-Bus ICB) committed to the project 'H2 Bus Rhein-Main – Emission-Free Public Transport in the Metropolitan Region'. The Federal Ministry of Transport and Digital Infrastructure (BMVI) is funding the project with a total of €2.5 million (US$2.8 million) under the National Innovation Programme Hydrogen and Fuel Cell Technology.

The key impetus for the latest deployment project is the EU-funded Joint Initiative for hydrogen Vehicles across Europe (JIVE), supported by the Fuel Cells and Hydrogen 2 Joint Undertaking, to support the subsidised procurement of fuel cell bus fleets. JIVE will facilitate the rollout of more than 290 fuel cell buses across Europe, in two phases [*see the News Feature in FCB, February 2017, and March 2018, p2*].

Some €2 million ($2.3 million) in subsidies from the states of Hesse and Rhineland-Palatinate will allow the construction of a shared hydrogen refueling station on the premises of ESWE Verkehr, which will be supplied with 'green' hydrogen from the Energiepark Mainz. This Power-to-Gas (P2G) plant produces hydrogen using electricity from sustainable energy sources such as neighbouring wind parks [*August 2015, p8*].

Firm orders for the Rhine-Main buses were placed in September, all supplied by ebe Europa GmbH and manufactured by Autosan in Poland. ESWE Verkehr and MM have each

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SARTA to deploy fuel cell paratransit vans for disabled in Ohio

The Stark Area Regional Transit Authority (SARTA) in Ohio is deploying a small fleet of hydrogen fuel cell powered vans in its paratransit service, which provides transport for disabled people.

SARTA, which already operates a fleet of full-size hydrogen fuel cell buses [*FCB, May 2016, p2 and November 2017, p2*], is using funding from the Ohio Department of Transportation, Federal Transit Administration, and US Environmental Protection Agency to purchase and equip the vehicles.

The vans, built on Ford's U4X platform by Tesco, will have seating for six passengers and accommodate one wheelchair. US Hybrid is supplying the fuel cell drivetrain, which provides a range of 250 miles (400 km). The vans, which feature wheelchair lifts and the latest transit technology, are fully compliant with Americans With Disabilities Act (ADA) standards for paratransit vehicles. The first vehicles joined the SARTA fleet in October.

SARTA has also announced a free initiative to lend one of its fuel cell buses to any US transit agency. The Central Midlands Transit Authority in Columbia, South Carolina will be the first agency to borrow a bus. The programme is being supported by bus manufacturer ElDorado National-California and BAE Systems [*August 2018, p2*], which makes the HybriDrive® propulsion system that drives SARTA's fuel cell buses [*see also page 4*]. The companies will provide free technical support and hydrogen fueling for the vehicles while on loan.

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US Hybrid Corporation: www.ushybrid.com

Central Midlands Transit Authority: www.catchthecomet.org

ElDorado National-California: www.eldorado-ca.com

BAE Systems, HybriDrive: www.hybridrive.com

Ohio Fuel Cell Coalition: www.fuelcellcorridor.com

MOBILE APPLICATIONS

Proton Motor partners with e.GO Mobile to develop range-extender

German electric car company e.GO Mobile and Proton Motor Fuel Cell GmbH – the fuel cell systems subsidiary of UK-based Proton Power Systems Plc – have agreed to set up a joint venture, called e.GO REX GmbH, to develop and produce fuel cell range-extenders for e.GO customers and the third-party market.

e.GO REX will develop and manufacture a compact, mass-produced hydrogen PEM fuel cell system in the 22–30 kW range as a range-extender for serial plug-in hybrid vehicles such as the e.GO Mover electric minibus. This system will be available from 2021 to other OEMs and vehicle refitters.

'The special feature of the range-extender developed by e.GO and Proton Motor is that the fuel cell is designed only to be stationary [fixed output], in line with the average energy requirement, and does not directly drive the electric motor but charges the battery,' explains Professor Günther Schuh, CEO of Aachen-based e.GO Mobile, which will hold a majority stake in the joint venture. 'This makes it much easier to industrialise the system.'

Concept studies carried out jointly by e.GO and Proton Motor indicate that the prerequisites for scalable components – bipolar plates, stacks, compressors, inverters, cooling systems, and hydrogen tanks – are now identified for significantly more cost-effective systems. In order to carry out further research on cost reduction and scaling potential, the 'Industrialisation Fuel Cell' centre is being founded on the RWTH Aachen University

EDITORIAL

Daimler has been lagging behind the likes of Hyundai, Toyota, and Honda in getting its latest-generation fuel cell electric vehicle on the road, but the recent handover of the first Mercedes-Benz GLC F-CELL premium SUVs to customers has been worth the wait, as we report on page 1 of this issue…

The GLC F-CELL was announced two years ago [*see the News Feature in FCB, August 2016*], and a preproduction model was showcased at the 2017 IAA International Motor Show in Frankfurt [*see the News Focus in October 2017*]. It is unique in featuring both hydrogen fuel cells and a battery drive system that can be charged externally using plug-in technology, making it the very first plug-in hybrid FCEV.

In early November, Mercedes-Benz handed over the keys to the first batch of these next-generation hybrid FCEVs to selected customers in Germany, representing several national and regional ministries, NOW GmbH, the H_2 Mobility Deutschland joint venture, and the German railway company Deutsche Bahn. Further deliveries will be made before the end of the year, and additional vehicles will be available for rental by businesses and the first private customers from next spring.

Daimler and General Motors (where are they now?) were the early leaders in the race to develop a 'commercially ready' FCEV, with several generations of demonstration vehicles racking up many miles in modest sized fleets around the world. For example, in April 1999 we reported on the unveiling of the DaimlerChrysler NECAR 4, based on the original Mercedes-Benz A-Class subcompact car, with the fuel cell system mounted within the sandwich floor construction. And in early 2011 three Mercedes-Benz F-CELL cars – now based on the slightly larger B-Class car – set off from Stuttgart on a five-month 'World Drive' circumnavigation, passing through 14 countries on four continents [*see the News Focus in February 2011, and June 2011, p1*].

But then it went relatively quiet, although clearly Daimler was working hard on both R&D and the challenging practicalities of manufacturing FCEVs. In the meantime, in early 2013 the first Hyundai ix35/Tucson Fuel Cell car rolled off the South Korean automaker's production line [*March 2013, p2*], then the following year Toyota launched its *Mirai* FCEV in Japan [*November 2014, p1*], and its compatriot Honda unveiled its Clarity Fuel Cell a year after that [*November 2015, p2*]. Increasing numbers of these FCEVs are being driven in a growing number of countries worldwide, so it is good to see that Daimler is now getting back in on the act.

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MOBILE APPLICATIONS

Proton Motor partners with e.GO Mobile to develop range-extender

German electric car company e.GO Mobile and Proton Motor Fuel Cell GmbH – the fuel cell systems subsidiary of UK-based Proton Power Systems Plc – have agreed to set up a joint venture, called e.GO REX GmbH, to develop and produce fuel cell range-extenders for e.GO customers and the third-party market.

e.GO REX will develop and manufacture a compact, mass-produced hydrogen PEM fuel cell system in the 22–30 kW range as a range-extender for serial plug-in hybrid vehicles such as the e.GO Mover electric minibus. This system will be available from 2021 to other OEMs and vehicle refitters.

'The special feature of the range-extender developed by e.GO and Proton Motor is that the fuel cell is designed only to be stationary [fixed output], in line with the average energy requirement, and does not directly drive the electric motor but charges the battery,' explains Professor Günther Schuh, CEO of Aachen-based e.GO Mobile, which will hold a majority stake in the joint venture. 'This makes it much easier to industrialise the system.'

Concept studies carried out jointly by e.GO and Proton Motor indicate that the prerequisites for scalable components – bipolar plates, stacks, compressors, inverters, cooling systems, and hydrogen tanks – are now identified for significantly more cost-effective systems. In order to carry out further research on cost reduction and scaling potential, the 'Industrialisation Fuel Cell' centre is being founded on the RWTH Aachen University

EDITORIAL

Daimler has been lagging behind the likes of Hyundai, Toyota, and Honda in getting its latest-generation fuel cell electric vehicle on the road, but the recent handover of the first Mercedes-Benz GLC F-CELL premium SUVs to customers has been worth the wait, as we report on page 1 of this issue…

The GLC F-CELL was announced two years ago [*see the News Feature in FCB, August 2016*], and a preproduction model was showcased at the 2017 IAA International Motor Show in Frankfurt [*see the News Focus in October 2017*]. It is unique in featuring both hydrogen fuel cells and a battery drive system that can be charged externally using plug-in technology, making it the very first plug-in hybrid FCEV.

In early November, Mercedes-Benz handed over the keys to the first batch of these next-generation hybrid FCEVs to selected customers in Germany, representing several national and regional ministries, NOW GmbH, the H_2 Mobility Deutschland joint venture, and the German railway company Deutsche Bahn. Further deliveries will be made before the end of the year, and additional vehicles will be available for rental by businesses and the first private customers from next spring.

Daimler and General Motors (where are they now?) were the early leaders in the race to develop a 'commercially ready' FCEV, with several generations of demonstration vehicles racking up many miles in modest sized fleets around the world. For example, in April 1999 we reported on the unveiling of the DaimlerChrysler NECAR 4, based on the original Mercedes-Benz A-Class subcompact car, with the fuel cell system mounted within the sandwich floor construction. And in early 2011 three Mercedes-Benz F-CELL cars – now based on the slightly larger B-Class car – set off from Stuttgart on a five-month 'World Drive' circumnavigation, passing through 14 countries on four continents [*see the News Focus in February 2011, and June 2011, p1*].

But then it went relatively quiet, although clearly Daimler was working hard on both R&D and the challenging practicalities of manufacturing FCEVs. In the meantime, in early 2013 the first Hyundai ix35/Tucson Fuel Cell car rolled off the South Korean automaker's production line [*March 2013, p2*], then the following year Toyota launched its *Mirai* FCEV in Japan [*November 2014, p1*], and its compatriot Honda unveiled its Clarity Fuel Cell a year after that [*November 2015, p2*]. Increasing numbers of these FCEVs are being driven in a growing number of countries worldwide, so it is good to see that Daimler is now getting back in on the act.

Steve Barrett

campus under the direction of the Fraunhofer Institute for Production Technology IPT.

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performance is several orders of magnitude better than any battery-electric aircraft so far, opening new aerial routes between smaller towns and rural areas using an existing and dense network of small-scale airports and aerodromes. Refueling Element One will take no more than 10 minutes using an automated nacelle swap system that applies automated guided vehicles and warehouse operations.

Originally from Singapore, HES – part of H3 Dynamics – has been working with a number of fast-moving startups and small and medium-sized enterprises (SMEs) in France over the past year [*FCB, March 2018, p6*], and exploring various locations to execute its Element One vision, including 'Aerospace Valley', the aviation R&D hub in and around Toulouse and Bordeaux.

HES recently announced plans to begin associating onsite hydrogen generation with fuel cell powered unmanned aircraft across a network of hydrogen-ready airports, in preparation for larger-scale electric aircraft such as Element One [*October 2018, p6*]. HES is now in discussions with industrial-scale hydrogen producers to explore energy-efficient refueling systems using locally produced renewable solar or wind energy.

HES is targeting a first flying prototype before 2025, and is building a technical and commercial consortium involving both the aviation and hydrogen industry ecosystems. The company has aligned its zero-carbon aviation roadmap with Wingly, a French startup that offers flight sharing services for decentralised and regional air travel.

HES Energy Systems, Element One: www.hes.sg/element-one

Wingly: https://en.wingly.io

BSHARK starts up manufacturing base, grid inspection drone

BSHARK has started production at its new Chinese manufacturing base in Liaocheng, Shandong Province, which will help to meet the high demand for the company's hydrogen fuel cell powered unmanned aerial vehicles (UAVs). This includes the China Southern Power Grid Company, which has requested the services of BSHARK's fuel cell drone for a powerline inspection project.

The **Liaocheng production facility**, called Shandong BSHARK Intelligent Technology Co Ltd, has been established to assist in meeting the current high demand for the company's hydrogen fuel cell products, including the Narwhal 2 drone. The new factory is expected to manufacture at least 100 hydrogen fuel cell products per month in Q4 of 2018, with production capacity ramping up to at least 200 fuel cell products and the Narwhal series beginning in Q1 of 2019.

The 8000 m^2 (86 000 sq ft) facility will produce three categories of products: the H2 Hydrogen Fuel Cell, the Narwhal 2 Hydrogen Fuel Cell Drone, and the Orca Mobile Hydrogen Fueling Station – a mobile, fully automated hydrogen generator for up to 350 bar storage pressure.

Meanwhile, **China Southern Power Grid Company** has requested the services of BSHARK's hydrogen fuel cell drone to carry out a powerline inspection project. The state-owned utility is responsible for building and operating the power grid in the southern part of the country, and is looking at BSHARK's technology to see if it can overcome persistent deficiencies in powerline inspection projects. This particular project, which was completed in early October, checked 60 000 km (37 000 miles) of powerlines and more than 200 towers in a mountainous area.

BHSARK recommended the use of the Narwhal 2 drone, which gives 1.5 h of flight time and has a payload capacity of 1 kg (2.2 lb), allowing the powerlines to be checked in just a few days, assisted by certified drone pilots from BSHARK.

BSHARK: www.bsharktech.com

Lloyd's Register teams up on marine fuel cell tech, LOHC storage

Lloyd's Register has signed an agreement with Siemens and Viareggio Super Yachts (VSY) to develop a project for the application of hydrogen fuel cell technology on a special version of the new VSY 65 m (210 ft) Waterecho luxury motor yacht project. LR is also working with energy storage specialist H2-Industries to develop standards for all-electric vessels powered by Liquid Organic Hydrogen Carrier (LOHC) technology.

The main aim of the **project with VSY and Siemens** is to assess the specific safety and technical requirements for feeding the stern electric engine (used for manoeuvring or as auxiliary propulsor, which is standard in all VSY yachts) in a completely sustainable mode. VSY will study the technical and commercial

IN BRIEF

Korea's first fuel cell bus on regular route

The first hydrogen fuel cell bus to enter regular public service in South Korea is running on a route in the southeastern city of Ulsan, after a 12-month trial [*FCB, August 2018, p15*]. The bus's manufacturer Hyundai Motor Company [*see also page 12*] operates the world's largest integrated automobile manufacturing facility in Ulsan, including production of its NEXO fuel cell electric vehicle [*January 2018, p2*].

The bus runs twice a day on the 56 km (35 mile) round trip served by city bus line 124, from the Ulsan Public Bus Terminal to Daeangam Park. It is refueled at the hydrogen station in Ok-dong, about 5.5 km (3.5 miles) from where the bus is garaged. Hyundai introduced the third-generation fuel cell bus in February, as a sponsored vehicle at the 2018 Winter Olympics and Paralympics in Pyeongchang.

The Ministry of Trade, Industry and Energy says that 30 more buses will enter service on regular routes in major Korean cities over the coming year.

TCP hydrogen-powered rural broadband

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HES Energy Systems, Element One: www.hes.sg/element-one

Wingly: https://en.wingly.io

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BSHARK: www.bsharktech.com

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feasibility of the application of hydrogen fuel cells and their installation onboard. Siemens will provide know-how, technical solutions already developed or to be developed, and LR will carry out a preliminary assessment for certification purposes.

Siemens' SISHIP BlueDrive integrated marine energy and propulsion system offers customised, scalable energy and drive solutions that are also suitable for smaller applications such as yachts. This enables easy integration of battery systems, and has recently been consolidated through a partnership with the fuel cell module manufacturer PowerCell Sweden [*FCB, September 2018, p4*]. This will drive forward the integration of fuel cell modules in shipping, and develop a fuel cell based energy supply system for maritime vessels.

LR has also announced a **collaboration with H2-Industries** in Germany to develop safety standards for all-electric vessels based on the innovative LOHC power storage technology. The project is seeking to obtain Approval in Principle for the use of LOHC technology on ships. This covers the refueling of ships with LOHC, storage of the energy carrier onboard, and the power generation process onboard the vessel. H2-Industries' LOHC technology is compatible with existing infrastructure, as the oily substance can be stored and transported in the same way as diesel.

Lloyd's Register: www.lr.org

Siemens, Marine: https://tinyurl.com/siemens-marine

Viareggio Super Yachts: www.vsy.it

H2-Industries: www.h2-industries.com/h2-world

SMALL STATIONARY

PACE project sees fuel cell micro-CHP rapidly expanding in Belgium

More than 500 fuel cell micro-cogeneration units have already been sold in Belgium under the EU-supported PACE project, as momentum continues to build for the large-scale uptake of this efficient energy solution.

The PACE project (Pathway to A Competitive European fuel cell micro-cogeneration market) aims to unlock the large-scale European deployment of fuel cell micro-cogeneration – also known as micro combined heat and power (micro-CHP) – for private homes, with more than 2800 next-generation systems deployed in households across Europe [*FCB, June 2016, p5*]. The project, co-funded by the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2 JU), brings together European manufacturers, research institutes, and other key energy stakeholders in making the products available across 11 European countries. It builds on the success of the earlier FCH JU ene.field project, which installed more than 1000 fuel cell micro-CHP systems across 10 European countries [*November 2017, p6*].

With a complete phase-out of nuclear energy planned for 2025, Belgians are looking for more sustainable ways to generate their own heat and electricity at home or in small businesses. The PACE partners active in Belgium therefore see increasing demand for fuel cell micro-cogeneration, and are ramping up their installation capacity. Viessmann's broad network of installers has deployed these systems in more than 150 Belgian houses in less than 18 months. The Belgian energy service company Elugie – a partner of SOLIDpower [*May 2017, p4*] – says that more than 200 end-users in Belgium have switched to the hydrogen economy.

The PACE project coordinator is COGEN Europe, working alongside manufacturers BDR Thermea Group, Bosch, SOLIDpower, Sunfire and Viessmann; research partners DTU (Technical University of Denmark) and Element Energy; and utility partner EWE.

PACE project: www.pace-energy.eu

Peoples Gas installs first WATT residential unit in W Pennsylvania

Pennsylvania-based companies Peoples Gas and WATT Fuel Cell Corporation installed the first Imperium™ solid oxide fuel cell system at a residence in Westmoreland County at the end of September, kicking off the first field trial of a WATT SOFC system by Peoples Gas.

Earlier this year Peoples Gas – with more than 740 000 residential customers across western Pennsylvania, West Virginia and Kentucky – entered into a Joint Development and Commercialisation Agreement with WATT Fuel Cell [*FCB, September 2018, p13*]. The inaugural installation of WATT's product in a residential home is one of the first steps towards the ultimate goal of having a fuel cell installed in every residence within the utility's service territory.

The system installed as part of the Peoples Gas field trial is a residential Imperium SOFC system running on natural gas. It works in parallel with the electric grid, as well as other renewable resources such as solar, to generate power onsite, on-demand. The clean, compact, and quiet SOFC system can be located inside or outside the home.

'Working with Peoples has allowed us to accelerate our entrance into the residential market,' says Dr Caine Finnerty, President and Chief Operating Officer of WATT Fuel Cell. 'And with one of the world's largest natural gas shales right here, Pennsylvania couldn't be a more perfect place to launch our residential product.'

More than 60 million homes in the US use natural gas, so a successful field trial with Peoples Gas is expected to advance WATT's commercialisation activities nationally and bring the opportunity for WATT to work with other distributed natural gas partners, as well as help pave the way into key industrial markets. WATT recently shipped Imperium systems to Erwin Hymer Group North America, for integration into recreational vehicles (RVs) [*October 2018, p5*].

WATT Fuel Cell Corporation: www.wattfuelcell.com

Peoples Gas: www.peoples-gas.com

Panasonic aims to commercialise fuel cell generator in 2021

Panasonic in Japan is accelerating initiatives to roll out sustainable hydrogen energy through the wider application of technologies it has developed for residential fuel cell systems, starting with the commercialisation of hydrogen fuel cell generators around April 2021.

In May 2009, Panasonic was the first in Japan to start selling residential fuel cells running on hydrogen extracted from natural gas [*FCB, June 2008, p5*], and by June 2018 had produced more than 140 000 units. Since 2016 the company has also been working to develop hydrogen fuel cell generators and conducting field tests, participating in projects such as the Yume Solar Kan Yamanashi in Yamanashi Prefecture [*February 2011, p9*] and Shizuoka Hydrogen Town in Shizuoka Prefecture. Panasonic plans to deliver the first hydrogen fuel cell generators to Harumi Flag, the Type 1 Urban Area Redevelopment Project being undertaken by the Tokyo Metropolitan Government in the Harumi 5-chome West District.

The hydrogen fuel cell generators to be commercialised will have a power generation output of 5 kW, and are expected to be used at locations such as hydrogen refueling stations and commercial facilities. Linking the operation of these

ordered two 12 m city buses and two 18 m articulated buses. The articulated buses will be used from summer 2019 on the Community Line 6 between Mainz and Wiesbaden, and the city buses in the rest of the network. In-der-City-Bus has ordered three buses for use in Frankfurt city traffic. The buses are expected to be delivered by the end of Q2 in 2019, and will refuel at the existing hydrogen refueling station in Industriepark Hoechst in Frankfurt. Linde has been commissioned to construct the new hydrogen station in Wiesbaden.

ESWE Verkehr: www.eswe-verkehr.de [in German]

Mainzer Mobilität MM: www.mainzer-mobilitaet.de [in German]

traffiQ: www.traffiq.de [in German]

In-der-City-Bus ICB: www.icb-ffm.de [in German]

National Innovation Programme Hydrogen and Fuel Cell Technology: http://tinyurl.com/nip-h2fc-tech

ebe Europa GmbH: www.ebe-europa.com/?lang=en

Linde, Hydrogen Energy: http://tinyurl.com/linde-hydrogen-energy-h2

Energiepark Mainz: www.energiepark-mainz.de/en

SARTA to deploy fuel cell paratransit vans for disabled in Ohio

The Stark Area Regional Transit Authority (SARTA) in Ohio is deploying a small fleet of hydrogen fuel cell powered vans in its paratransit service, which provides transport for disabled people.

SARTA, which already operates a fleet of full-size hydrogen fuel cell buses [*FCB, May 2016, p2 and November 2017, p2*], is using funding from the Ohio Department of Transportation, Federal Transit Administration, and US Environmental Protection Agency to purchase and equip the vehicles.

The vans, built on Ford's U4X platform by Tesco, will have seating for six passengers and accommodate one wheelchair. US Hybrid is supplying the fuel cell drivetrain, which provides a range of 250 miles (400 km). The vans, which feature wheelchair lifts and the latest transit technology, are fully compliant with Americans With Disabilities Act (ADA) standards for paratransit vehicles. The first vehicles joined the SARTA fleet in October.

SARTA has also announced a free initiative to lend one of its fuel cell buses to any US transit agency. The Central Midlands Transit Authority in Columbia, South Carolina will be the first agency to borrow a bus. The programme is being supported by bus manufacturer ElDorado National-California and BAE Systems [*August 2018, p2*], which makes the HybriDrive® propulsion system that drives SARTA's fuel cell buses [*see also page 4*]. The companies will provide free technical support and hydrogen fueling for the vehicles while on loan.

Stark Area Regional Transit Authority: www.sartaonline.com

US Hybrid Corporation: www.ushybrid.com

Central Midlands Transit Authority: www.catchthecomet.org

ElDorado National-California: www.eldorado-ca.com

BAE Systems, HybriDrive: www.hybridrive.com

Ohio Fuel Cell Coalition: www.fuelcellcorridor.com

MOBILE APPLICATIONS

Proton Motor partners with e.GO Mobile to develop range-extender

German electric car company e.GO Mobile and Proton Motor Fuel Cell GmbH – the fuel cell systems subsidiary of UK-based Proton Power Systems Plc – have agreed to set up a joint venture, called e.GO REX GmbH, to develop and produce fuel cell range-extenders for e.GO customers and the third-party market.

e.GO REX will develop and manufacture a compact, mass-produced hydrogen PEM fuel cell system in the 22–30 kW range as a range-extender for serial plug-in hybrid vehicles such as the e.GO Mover electric minibus. This system will be available from 2021 to other OEMs and vehicle refitters.

'The special feature of the range-extender developed by e.GO and Proton Motor is that the fuel cell is designed only to be stationary [fixed output], in line with the average energy requirement, and does not directly drive the electric motor but charges the battery,' explains Professor Günther Schuh, CEO of Aachen-based e.GO Mobile, which will hold a majority stake in the joint venture. 'This makes it much easier to industrialise the system.'

Concept studies carried out jointly by e.GO and Proton Motor indicate that the prerequisites for scalable components – bipolar plates, stacks, compressors, inverters, cooling systems, and hydrogen tanks – are now identified for significantly more cost-effective systems. In order to carry out further research on cost reduction and scaling potential, the 'Industrialisation Fuel Cell' centre is being founded on the RWTH Aachen University

EDITORIAL

Daimler has been lagging behind the likes of Hyundai, Toyota, and Honda in getting its latest-generation fuel cell electric vehicle on the road, but the recent handover of the first Mercedes-Benz GLC F-CELL premium SUVs to customers has been worth the wait, as we report on page 1 of this issue…

The GLC F-CELL was announced two years ago [*see the News Feature in FCB, August 2016*], and a preproduction model was showcased at the 2017 IAA International Motor Show in Frankfurt [*see the News Focus in October 2017*]. It is unique in featuring both hydrogen fuel cells and a battery drive system that can be charged externally using plug-in technology, making it the very first plug-in hybrid FCEV.

In early November, Mercedes-Benz handed over the keys to the first batch of these next-generation hybrid FCEVs to selected customers in Germany, representing several national and regional ministries, NOW GmbH, the H_2 Mobility Deutschland joint venture, and the German railway company Deutsche Bahn. Further deliveries will be made before the end of the year, and additional vehicles will be available for rental by businesses and the first private customers from next spring.

Daimler and General Motors (where are they now?) were the early leaders in the race to develop a 'commercially ready' FCEV, with several generations of demonstration vehicles racking up many miles in modest sized fleets around the world. For example, in April 1999 we reported on the unveiling of the DaimlerChrysler NECAR 4, based on the original Mercedes-Benz A-Class subcompact car, with the fuel cell system mounted within the sandwich floor construction. And in early 2011 three Mercedes-Benz F-CELL cars – now based on the slightly larger B-Class car – set off from Stuttgart on a five-month 'World Drive' circumnavigation, passing through 14 countries on four continents [*see the News Focus in February 2011, and June 2011, p1*].

But then it went relatively quiet, although clearly Daimler was working hard on both R&D and the challenging practicalities of manufacturing FCEVs. In the meantime, in early 2013 the first Hyundai ix35/Tucson Fuel Cell car rolled off the South Korean automaker's production line [*March 2013, p2*], then the following year Toyota launched its *Mirai* FCEV in Japan [*November 2014, p1*], and its compatriot Honda unveiled its Clarity Fuel Cell a year after that [*November 2015, p2*]. Increasing numbers of these FCEVs are being driven in a growing number of countries worldwide, so it is good to see that Daimler is now getting back in on the act.

Steve Barrett

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DOE map for hydrogen, fuel cells career

The US Department of Energy's Fuel Cell Technologies Office has launched an interactive Hydrogen and Fuel Cells Career Map (https://tinyurl.com/hfc-career-map), which allows users of all ages to discover traditional and non-traditional career opportunities in the hydrogen and fuel cells industry. The tool also promotes workforce development in the science, technology, engineering, and mathematics (STEM) field by making information about hydrogen and fuel cell technology careers, education requirements, and skills for each career easily accessible.

The tool, based on data from the US Bureau of Labor Statistics, displays more than 40 careers across the hydrogen and fuel cell sectors, such as R&D, engineering, and manufacturing; operations and management; and communications, training, and outreach. These positions are classified by levels of experience, and detail the education, skills, and profile of each career.

to forward units, and where does it make the most sense to reform it farther forward and in smaller quantities? These are the questions we're interested in answering, and we think this agreement with the Fuel Cell Technologies Office will help us get there more quickly.'

TARDEC – headquartered at the US Army Detroit Arsenal in Warren, Michigan – is a major R&D centre for the Army Materiel Command's Research, Development and Engineering Command.

TARDEC: https://tardec.army.mil

DOE Fuel Cell Technologies Office: http://tinyurl.com/doe-fcto

DOE grant for WSU to improve fuel efficiency with liquid hydrogen

Washington State University researchers have received a $2 million grant from the US Department of Energy to test a new technology for liquid hydrogen refueling facilities. The research team will work with fuel cell system manufacturer Plug Power in this WSU effort to improve hydrogen fuel efficiency.

Hydrogen is commonly cooled to very low (cryogenic) temperatures and converted to a liquid for storage and transport in insulated tanks. The WSU researchers have been developing a way to cool hydrogen that is more efficient and less expensive than current technologies. The group, led by Dr Jacob Leachman and Dr Konstantin Matveev, associate professors in the School of Mechanical & Materials Engineering, are focused on a patent-pending device, called a Heisenberg Vortex Tube, to separate the compressed gas into hot and cold streams. Leachman modified existing vortex tube technologies by adding a hydrogen catalyst as a liner inside the tube. 'The process helps cool hydrogen down more rapidly than a standard vortex tube, and is more efficient,' he says.

The grant is one of the projects recently awarded DOE funding under its H2@ Scale initiative to produce and use hydrogen across multiple energy sectors [*FCB, September 2018, p14, and see page 11 in this issue*]. The WSU researchers will work with Plug Power [*see also page 10*] to improve the efficiency of liquid hydrogen storage systems, using excess hydrogen at Plug Power facilities that is currently going to waste. 'The challenge is to make sure the technology can be implemented well, and result in cost savings for Plug Power,' says Leachman.

The researchers will work with real-world data and simulations to experimentally validate models at very cold temperatures in WSU's Hydrogen Properties for Energy Research (HYPER) Lab. With expertise in computational fluid dynamics of marine vehicles and advanced energy conversion systems, Matveev will study thermofluid processes in the hydrogen-filled vortex tube to optimise the shape of the device.

WSU, HYPER Lab: https://hydrogen.wsu.edu

Plug Power: www.plugpower.com

ARPA-E grant for Tennessee fuel cell energy storage project

The US Department of Energy has awarded a $1.5 million grant to fund the development of an energy storage system based on an innovative electrolyser/fuel cell combination, at the University of Tennessee, Knoxville.

The UT Knoxville project is one of 10 recently awarded grants by DOE's Advanced Research Projects Agency–Energy (ARPA-E), as part of its focus on research that can provide a minimum of 100 hours of power to the grid as part of its Duration Addition to electricitY Storage (DAYS) Program.

The project is led by Professor Tom Zawodzinski, the UT–Oak Ridge National Laboratory Governor's Chair for Electrical Energy Conversion and Storage. 'It has long been a goal to make a regenerative fuel cell, a single device that functions as both a fuel cell and an electrolyser,' he explains. 'However, such devices have previously suffered from poor overall efficiency. The new project uses an alternative approach, by changing one of the chemical reactions in the cell and bypassing the efficiency bottleneck.'

Fuel cell reactions typically produce water (H_2O) through the combination of hydrogen and oxygen, but the UTK Department of Chemical & Biomolecular Engineering team will instead use cells to produce hydrogen peroxide (H_2O_2), which can be easily stored as a liquid. Depending on need, the fuel cells can provide electricity to the grid while producing peroxide, which will be converted into oxygen during the charging cycle. 'In effect, the system could allow renewable electricity inputs – such as solar or wind, for example – to be leveraged over long periods,' says Zawodzinski.

The new method uses a recent catalyst discovery in Zawodzinski's lab that is being commercialised for another application by a spinoff company, Peroxygen Systems Inc, which will also participate in the project.

UT Knoxville, Department of Chemical & Biomolecular Engineering: http://news.engr.utk.edu/cbe

Peroxygen Systems Inc: www.peroxygensystems.com

ARPA-E, DAYS Program: https://arpa-e.energy.gov/?q=arpa-e-programs/days

IN BRIEF

Nel joins German consortium for rollout of Alstom hydrogen fuel cell train fleet

Norwegian hydrogen company Nel (www.nelhydrogen.com) is participating in the H2-Consortium Westküste in Germany, which has been selected as a preferred partner of Alstom for the deployment of a 20 MW electrolyser and associated fueling equipment. This will have sufficient capacity to refuel a complete fleet of Alstom hydrogen fuel cell powered passenger trains that is anticipated to enter service in Schleswig-Holstein from 2021. The consortium is currently working with Alstom on a tender for the trains, which will be decided at the beginning of 2019 [*see also page 4*].

The H2-Consortium Westküste includes regional development agency Entwicklungsagentur Region Heide, renewable energy specialist GP Joule [*see also page 11*], engineering company IPP Projects, and French electric utility EDF. The consortium also plans to install hydrogen refueling stations at train stations, bus depots, or truck distribution centres to serve other heavy-duty vehicles in the region.

The Alstom Coradia iLint is the world's first hydrogen fuel cell powered passenger train [*FCB, September 2016, p1, and see the News Feature in March 2017*]. Two trains entered commercial service to a fixed timetable in Lower Saxony in September [*FCB, September 2018, p1*], while Schleswig-Holstein saw a demonstration run between Neumünster and Kiel on 1 October.

ITM Power factory under construction

UK-based ITM Power (www.itm-power.com) reports good progress towards its planned move to a new 11 610 m^2 (125 000 sq ft) factory, which will be commissioned and run in parallel with the existing factory until the lease runs out at the existing Atlas Way site in Sheffield in 2021. The company says that the project manufacturing capacity ramp-up across the old and new factories is more than adequate to support its substantial projected sales growth in the next three years. Product testing is currently a constraint at the old Atlas Way factory, as the company delivers larger products, so the power supply at the new factory will be commissioned early in the fit-out process.

ITM has designed a new manufacturing process (including introducing new automated technical processes), designed a new factory layout (to optimise product flow-through), completed all of the detailed drawings of the factory, the technology centre and the offices, and applied for planning consent. The consenting process includes a traffic survey and full environmental impact survey. Terms are expected to be signed in Q1 of 2019.

Patents

Microfluidic fuel cell with flow-through porous electrodes for use with liquid reactants (formic acid)

Assignee: **UVic Industry Partnerships Inc, Canada [University of Victoria]**
Inventors: E. Kjeang et al.
Patent number: US 10079391
Published: 18 Sep. 2018 (Filed: 9 Oct. 2007)

Fabrication of SOFC interconnect with protective layer formed by powder pressing pre-alloyed metal particles and annealing

Assignee: **Bloom Energy Corporation, USA**
Inventors: A. Verma et al.
Patent number: US 10079393
Published: 18 Sep. 2018 (Filed: 8 Jan. 2015)

Method of welding porous body flow path for seal shield plate in automotive PEMFC stack

Assignee: **Toyota Motor Corporation, Japan**
Inventors: H. Okabe et al.
Patent number: US 10079394
Published: 18 Sep. 2018 (Filed: 30 Sep. 2015)

Simultaneous control of liquid fuel concentration and temperature in DMFC by sensor-less, temperature control-based feedback

Assignee: **Korea Institute of Science & Technology, Korea**
Inventors: H.Y. Ha et al.
Patent number: US 10079395
Published: 18 Sep. 2018 (Filed: 2 Dec. 2013)

Method of stopping SOFC system while improving durability

Assignees: **Panasonic, Japan** *and* **Toto Ltd, Japan**
Inventors: S. Onuma et al.
Patent number: US 10079396
Published: 18 Sep. 2018 (Filed: 9 Feb. 2015)

Prompt detection of hydrogen leaks in automotive PEMFC system, based on pressure in low-pressure zone of anode gas channel at startup

Assignee: **Toyota Motor Corporation, Japan**
Inventors: H. Imanishi et al.
Patent number: US 10079397
Published: 18 Sep. 2018 (Filed: 22 Oct. 2015)

Startup transition process for SOFC operation, minimising number of components and system complexity for startup/shutdown

Assignee: **Convion, Finland**
Inventors: K. Åström et al.
Patent number: US 10079398
Published: 18 Sep. 2018 (Filed: 25 Oct. 2016)

MCFC power generation system using anaerobic digestion gas as renewable biogas, with gas-purification membrane separation

Assignee: **Doosan Heavy Industries & Construction Co Ltd, Korea**
Inventors: C.M. Yun et al.
Patent number: US 10079399
Published: 18 Sep. 2018 (Filed: 22 July 2014)

Automotive PEMFC module with low-cost, secure stack fastening

Assignee: **Toyota Motor Corporation, Japan**
Inventor: M. Takeyama
Patent number: US 10079402
Published: 18 Sep. 2018 (Filed: 14 Oct. 2015)

Compact thermally integrated catalytic reformer and purifier, use with fuel cell system

Assignee: **Horizon Fuel Cell Technologies, Singapore**
Inventor: P.D. DeVries
Patent number: US 10081543
Published: 25 Sep. 2018 (Filed: 23 Oct. 2015)

Sintered ceramic SOFC manifolds, fabrication with minimal impurities

Assignees: **Saint-Gobain Ceramics & Plastics Inc, USA** *and* **Saint-Gobain Centre de Recherche et d'Etudes Européen, France**
Inventors: G. Lin et al.
Patent number: US 10081575
Published: 25 Sep. 2018 (Filed: 22 Mar. 2017)

Robust solid electrolyte laminate to supply large amount of gas to SOFC anode, manufacturing

Assignee: **Sumitomo Electric Industries Ltd, Japan**
Inventors: C. Hiraiwa et al.
Patent number: US 10084191
Published: 25 Sep. 2018 (Filed: 26 Apr. 2013)

Cathode contact layer design to prevent Cr contamination in SOFC, with Cr-getter material comprising La_2O_3, $La_2(CO_3)_3$ and/or $CaCO_3$

Assignee: **Versa Power Systems, USA [FuelCell Energy]**
Inventors: A. Wood et al.
Patent number: US 10084192
Published: 25 Sep. 2018 (Filed: 20 Mar. 2014)

Device to prevent overpressure of cooling system in automotive fuel cell system, monitors temperature of coolant discharged from stack

Assignee: **Hyundai Motor Company, Korea**
Inventors: S.D. Han et al.
Patent number: US 10084193
Published: 25 Sep. 2018 (Filed: 7 Dec. 2014)

Aircraft onboard power unit with cooled reformer/HT-PEMFC module including absorption heat engine for heat-exchange

Assignee: **Safran Aircraft Engines, France**
Inventors: F. Boudjemaa et al.
Patent number: US 10084194
Published: 25 Sep. 2018 (Filed: 6 Nov. 2013)

Fabrication of water transfer material with thermoplastic protection layer, for humidification of process gases for PEMFCs

Assignee: **Reinz-Dichtungs GmbH, Germany**
Inventors: J. Scherer et al.
Patent number: US 10084195
Published: 25 Sep. 2018 (Filed: 5 Oct. 2015)

System and method for controlling PEMFC module, responding to changes in density or humidity of gases in hydrogen recirculation loop

Assignee: **Hydrogenics, Canada**
Inventor: P. Forte
Patent number: US 10084196
Published: 25 Sep. 2018 (Filed: 3 May 2013)

Automotive fuel cell stack enclosure with reduced volume and reliable stack rigidity

Assignees: **Hyundai Motor Company, Korea** *and* **Kia Motors Corporation, Korea**

Inventors: D.W. Kim et al.
Patent number: US 10084199
Published: 25 Sep. 2018 (Filed: 26 Aug. 2014)

Conditioning/cooling of oxygen depleted air (ODA) exhaust from PEMFC APU onboard an aircraft

Assignee: **Airbus Operations Ltd, UK**
Inventors: F. Tichborne et al.
Patent number: US 10086222
Published: 2 Oct. 2018 (Filed: 19 Mar. 2013)

Method to prepare shape-controlled Pt-based alloys, improved catalyst performance in fuel cells with reduced Pt loading

Assignee: **Nissan North America, USA**
Inventors: Y. Liu et al.
Patent number: US 10086434
Published: 2 Oct. 2018 (Filed: 30 Mar. 2016)

Glass ceramic seal compositions comprising alkaline earth metal oxides, methods, and structures for planar SOFCs

Assignee: **Bloom Energy Corporation, USA**
Inventors: A.H. Kumar et al.
Patent number: US 10087103
Published: 2 Oct. 2018 (Filed: 21 Nov. 2016)

Method for producing dimethyl polyvinylphosphonate and polyvinylphosphonic acid, for PEM with higher molecular weight and lower dispersion

Assignee: **Maruzen Petrochemical Co Ltd, Japan**
Inventors: T. Takahashi et al.
Patent number: US 10087265
Published: 2 Oct. 2018 (Filed: 1 June 2015)

Pd plate coated material for corrosion-resistant fuel cell separator formed with gas flow channels, production method

Assignee: **Toyo Kohan Co Ltd, Japan**
Inventor: N. Mukai
Patent number: US 10087528
Published: 2 Oct. 2018 (Filed: 21 Apr. 2014)

Impregnation process using biotemplating for incorporating nanocatalyst into SOFC electrodes

Assignee: **West Virginia University, USA**
Inventors: E.M. Sabolsky et al.
Patent number: US 10087531
Published: 2 Oct. 2018 (Filed: 9 Dec. 2015)

Electrochemical compression of working fluid (water) in vapour compression system utilising electrolyser coupled with PEMFC

Assignee: **Xergy Ltd, UK**
Inventors: B. Bahar et al.
Patent number: US 10087532
Published: 2 Oct. 2018 (Filed: 14 May 2015)

Mesh-shaped, porous electric current density distributor for electrode in PEMFC or electrolyser

Assignee: **VITO NV, Belgium**
Inventors: D. Pant et al.
Patent number: US 10087537
Published: 2 Oct. 2018 (Filed: 26 Feb. 2014)

Liquid metal electrodes for gas separation, SOFC cathode with liquid silver and current collector

Assignee: **Infinium Inc, USA**
Inventors: A.C. Powell et al.
Patent number: US 10087539
Published: 2 Oct. 2018 (Filed: 12 June 2014)

Non-carbon mixed-metal oxide electrocatalysts, in particular with TiO_2-RuO_2 composite support, for automotive PEMFC systems [*and see US 10090533 below*]

Assignee: **Nissan North America, USA**
Inventors: N. Dale et al.
Patent number: US 10090530
Published: 2 Oct. 2018 (Filed: 31 Jan. 2014)

Vertically aligned TiO_2 nanotubes for automotive PEMFC electrodes with increased electrochemical and structural stability

Assignee: **Toyota Motor Europe, Belgium**
Inventors: I. Cerri et al.
Patent number: US 10090531
Published: 2 Oct. 2018 (Filed: 26 Feb. 2013)

Fabrication of PEMFC electrode capable of stable power generation under varying external humidity

Assignee: **Toyota Motor Corporation, Japan**
Inventors: T. Arai et al.
Patent number: US 10090532
Published: 2 Oct. 2018 (Filed: 11 Apr. 2016)

Non-carbon mixed-metal oxide support comprising TiO_2 and RuO_2, for electrocatalysts in automotive PEMFC systems [*and see US 10090530 above*]

Assignees: **Nissan North America, USA** *and* **V.K. Ramani, USA**
Inventors: V.K. Ramani et al.
Patent number: US 10090533
Published: 2 Oct. 2018 (Filed: 21 Dec. 2016)

Embossed contacting plate in (PEM) fuel cell system, improved electrical connection between stack and external components

Assignee: **Reinz-Dichtungs-GmbH, Germany**
Inventors: A. Speidel et al.
Patent number: US 10090534
Published: 2 Oct. 2018 (Filed: 29 Sep. 2015)

Automotive PEMFC with active surface layer(s) to provide crossflow-fields with only two external manifolds, for lower cost

Assignee: **BMW, Germany**
Inventors: S. Haase et al.
Patent number: US 10090535
Published: 2 Oct. 2018 (Filed: 6 July 2015)

PEMFC seal plate to reduce or adjust pressure drop in stack cooling flow channels

Assignee: **Nissan Motor Co, Japan**
Inventors: Y. Numao et al.
Patent number: US 10090537
Published: 2 Oct. 2018 (Filed: 6 Mar. 2013)

PEMFC MEA manufacturing with suppressed positional misalignment between GDL and frame

Assignee: **Toyota Motor Corporation, Japan**
Inventors: N. Kanai et al.
Patent number: US 10090538
Published: 2 Oct. 2018 (Filed: 19 Dec. 2014)

Method to purge automotive PEMFC system with appropriate timing, enhanced purging capacity

Assignee: **Toyota Motor Corporation, Japan**
Inventors: T. Maruo et al.

Patent number: US 10090539
Published: 2 Oct. 2018 (Filed: 17 June 2016)

Method for controlling startup of automotive (PEM) fuel cell system, to prevent carbon erosion of cathode during startup

Assignee: **Hyundai Motor Company, Korea**
Inventors: S.U. Kwon et al.
Patent number: US 10090540
Published: 2 Oct. 2018 (Filed: 17 June 2016)

Preventing reactant flooding in PEMFC by selectively shielding reaction and cooling spaces which connect with each manifold in stack

Assignee: **Hyundai Motor Company, Korea**
Inventor: J.I. Kim
Patent number: US 10090543
Published: 2 Oct. 2018 (Filed: 24 May 2016)

PEMFC system control method, adjusting fuel and/or oxidant gas supply/exhaust to mitigate localised power generation in MEA by nonuniform water distribution

Assignee: **Toyota Motor Corporation, Japan**
Inventor: M. Matsusue
Patent number: US 10090544
Published: 2 Oct. 2018 (Filed: 27 July 2011)

Structure and control method for stable driving of compressor with air foil bearing in automotive fuel cell system, to limit and recirculate excess air supply

Assignee: **Hyundai Motor Company, Korea**
Inventors: H.R. Kwon et al.
Patent number: US 10090545
Published: 2 Oct. 2018 (Filed: 9 June 2015)

Method for activating sealed and stored automotive PEMFC stack without using electric load, by chemically adsorbing hydrogen into cathode catalyst

Assignee: **Hyundai Motor Company, Korea**
Inventors: H.S. Choo et al.
Patent number: US 10090546
Published: 2 Oct. 2018 (Filed: 23 Sep. 2015)

Fuel supply for micro fuel cell (e.g. DMFC) with (encrypted) information storage capability relevant to fuel contained in supply

Assignee: **Intelligent Energy, UK**
Inventors: P. Adams et al. [BiC, USA]
Patent number: US 10090547
Published: 2 Oct. 2018 (Filed: 5 Feb. 2016)

SOFC system with desulfurisation unit, purifier to remove CO in exhaust, and heat-exchanger, for improved efficiency and reliability

Assignee: **Panasonic, Japan**
Inventors: H. Kita et al.
Patent number: US 10090548
Published: 2 Oct. 2018 (Filed: 27 Oct. 2015)

Method of fabricating metallic interconnect for improved electrical contact in SOFC or SOEC high-temperature electrolyser

Assignee: **CEA, France**
Inventors: S. Di Iorio et al.
Patent number: US 10090549
Published: 2 Oct. 2018 (Filed: 24 June 2013)

Structure for mounting automotive PEMFC stack, without needing structural modification when stack length is changed

Assignee: **Hyundai Motor Company, Korea**
Inventor: J.D. Suh
Patent number: US 10090551
Published: 2 Oct. 2018 (Filed: 5 Nov. 2015)

Autothermal reforming catalytic structures for generating low-cost, pure hydrogen from liquid hydrocarbons, for fueling FCEVs

Assignees: **Saudi Arabian Oil Company, Saudi Arabia** *and* **University of Queensland, Australia**
Inventors: J.N. Beltramini et al.
Patent number: US 10093542
Published: 9 Oct. 2018 (Filed: 1 Apr. 2016)

Integration of MCFCs in iron and steel processing, for increased efficiency, reduced or simplified capture of carbon emissions

Assignee: **ExxonMobil Research and Engineering Company, USA**
Inventors: P.J. Berlowitz et al.
Patent number: US 10093997
Published: 9 Oct. 2018 (Filed: 4 Jan. 2016)

Carbon support for metal catalyst, minimises drop in PEMFC power generation resulting from repeated load fluctuations during operation

Assignees: **Nippon Steel & Sumitomo Metal Corporation, Japan** *and* **Nippon Steel & Sumikin Chemical Co Ltd, Japan**
Inventors: T. Iijima et al.
Patent number: US 10096837
Published: 9 Oct. 2018 (Filed: 19 Mar. 2015)

Chemical bonding for catalyst/membrane surface adherence in alkaline membrane fuel cells

Assignee: **POCell Tech Ltd, Israel**
Inventor: D. Dekel
Patent number: US 10096838
Published: 9 Oct. 2018 (Filed: 6 June 2011)

Preparation of advanced CCMs for alkaline membrane fuel cells by amination and crosslinking of ionomer precursor

Assignee: **POCell Tech Ltd, Israel**
Inventors: D. Dekel et al.
Patent number: US 10096839
Published: 9 Oct. 2018 (Filed: 11 Mar. 2014)

High-temperature air purge of SOFC anodes

Assignee: **Bloom Energy Corporation, USA**
Inventors: S. Venkataraman et al.
Patent number: US 10096840
Published: 9 Oct. 2018 (Filed: 14 Dec. 2015)

Catalyst carrier comprising Ti compound-carbon composite particles, for durable PEM or DMFC electrocatalysts with minimal low-humidity degradation

Assignee: **Showa Denko KK, Japan**
Inventors: K. Lee et al.
Patent number: US 10096841
Published: 9 Oct. 2018 (Filed: 24 Dec. 2015)

IT-SOFC interconnect, comprising stainless-steel substrate with metal (e.g. cobalt) oxide coated chromium oxide (Cr_2O_3) layer

Assignee: **Ceres Power, UK**
Inventors: R. Leah et al.
Patent number: US 10096843
Published: 9 Oct. 2018 (Filed: 9 Mar. 2015)

Common manifold for multiple (PEM) fuel cell stacks, fabrication

Assignee: **Hamilton Sundstrand, USA**
Inventors: J.D. O'Neill et al.
Patent number: US 10096844
Published: 9 Oct. 2018 (Filed: 4 Feb. 2014)

Methods of forming fuel cell layers as electrically conductive paths in substrates for planar micro fuel cell arrays

Assignee: **Intelligent Energy, UK**
Inventors: O.R. Vanderleeden et al.
[Angstrom Power/BiC, Canada]
Patent number: US 10096845
Published: 9 Oct. 2018 (Filed: 16 Nov. 2012)

Multilayer monolithic SOFC Stick™ with rectangular ceramic substrate, in which thermal expansion occurs primarily along length, manufacturing methods

Applicants/Inventors: **A. Devoe** *and* **L. Devoe, USA**
Patent number: US 10096846
Published: 9 Oct. 2018 (Filed: 6 June 2017)

FCEV air intake structure with water separation passage, prevents intrusion of water and snow

Assignee: **Honda Motor Co, Japan**
Inventors: T. Mito et al.
Patent number: US 10096847
Published: 9 Oct. 2018 (Filed: 18 Oct. 2016)

Compact air cutoff valve module mounted in automotive PEMFC stack, with bypass flow path to dilute stack exhaust gas, reducing hydrogen concentration

Assignee: **Hyundai Kefico Corporation, Korea**
Inventors: M.J. Kim et al.
Patent number: US 10096848
Published: 9 Oct. 2018 (Filed: 14 Dec. 2017)

SOFC system with increased safety during ignition process in startup phases until power is generated

Assignee: **Panasonic, Japan**
Inventors: O. Sakai et al.
Patent number: US 10096849
Published: 9 Oct. 2018 (Filed: 9 Feb. 2015)

Startup method for automotive (PEM) fuel cell system, transducer absorbs power generated when reactant(s) supply is interrupted

Assignee: **Daimler, Germany**
Inventor: S. Schmalzriedt
Patent number: US 10096850
Published: 9 Oct. 2018 (Filed: 24 Mar. 2015)

Method of stopping SOFC system, by combusting mix of anode and cathode off-gases, better durability

Assignees: **Panasonic, Japan** *and* **Toto Ltd, Japan**
Inventors: Y. Kaneko et al.
Patent number: US 10096851
Published: 9 Oct. 2018 (Filed: 9 Feb. 2015)

Gas purge control for coolant in (PEM) fuel cell system, using water transport plate with water flow-field to permit flow of water with entrained gas

Assignee: **Audi, Germany**
Inventor: R.M. Darling [UTC Power, USA]
Patent number: US 10096852
Published: 9 Oct. 2018 (Filed: 11 Aug. 2015)

Method of detecting abnormality in pressure sensors in automotive PEMFC system

Assignee: **Toyota Motor Corporation, Japan**
Inventor: H. Saito
Patent number: US 10096853
Published: 9 Oct. 2018 (Filed: 23 Feb. 2017)

Monitoring and controlling resonance in automotive PEMFC stack, changing natural frequency of stack to minimise vibration

Assignee: **Toyota Motor Corporation, Japan**
Inventor: R. Nanba
Patent number: US 10096854
Published: 9 Oct. 2018 (Filed: 17 Dec. 2015)

Multimetallic core/interlayer/shell (e.g. Ni/Ag/PtNi) nanoparticles for PEMFC cathode catalysts

Assignee: **UChicago Argonne LLC, USA [Argonne National Lab]**
Inventors: V. Stamenkovic et al.
Patent number: US 10099207
Published: 16 Oct. 2018 (Filed: 2 Apr. 2015)

Production of nano-organised electrodes on porous substrate, e.g. fabricating nanowires for fuel cell electrodes

Assignees: **CEA, France** *and* **King Saud University, Saudi Arabia**
Inventors: N. Guillet et al.
Patent number: US 10100419
Published: 16 Oct. 2018 (Filed: 25 Nov. 2009)

Method for producing PEMFC catalyst layer, allowing sufficient ionomer penetration to inside of fine pores in support

Assignee: **Toyota Motor Corporation, Japan**
Inventors: T. Arai et al.
Patent number: US 10103387
Published: 16 Oct. 2018 (Filed: 12 Jan. 2017)

Method for producing fine catalyst particles comprising Pd-Pt core and Pt outer layer, use in PEMFC

Assignee: **Toyota Motor Corporation, Japan**
Inventors: K. Kaneko et al.
Patent number: US 10103388
Published: 16 Oct. 2018 (Filed: 13 May 2013)

EVENTS CALENDAR

27–28 November 2018
2018 European Zero Emission Bus Conference
Cologne, Germany
More information: Sabrine Skiker, Email: s.skiker@hydrogeneurope.eu

4–7 December 2018
30th Steering Committee Meeting of the International Partnership for Hydrogen & Fuel Cells in the Economy
South Africa
More information: www.iphe.net

6 December 2018
HyLAW EU Workshop (Hydrogen Europe)
Brussels, Belgium
More information: www.eventbrite.com/e/hylaw-eu-workshop-tickets-50965612519

2019

5–10 January 2019
2019 International Coalition for Energy Storage and Innovation and Pacific Power Source Symposium, ICESI-PPSS 2019
Waikoloa, Hawaii, USA
More information: www.icesi.site

23–24 January 2019
9th Energy Storage 2019 Conference
Brussels, Belgium
More information: www.wplgroup.com/aci/event/energy-storage-conference

6 February 2019
2nd Flying Electric Vehicle Summit, FEVS 2019
Geneva, Switzerland
More information: www.fevs.mobi

6–7 February 2019
Hydrogen & Fuel Cells Energy Summit
Madrid, Spain
More information: www.wplgroup.com/aci/event/hydrogen-and-fuel-cells-energy-summit

12 February 2019
HPEM2GAS Project Workshop: High Performance PEM Electrolyzer for Cost-effective Grid Balancing Applications
Emden, Germany
More information: http://hpem2gas.eu/hpem2gas-final-event-save-date

12–14 February 2019
8th International Conference on Fundamentals & Development of Fuel Cells, FDFC 2019
Nantes, France
More information: https://fdfc2019.sciencesconf.org

19–21 February 2019
SAE 2019 Hybrid & Electric Vehicle Technologies Symposium, HVTS
Anaheim, California, USA
More information: www.sae.org/attend/hybrid

26 February 2019
7th International Fuel Cell Meeting, Fuel Cell Development Information Center (FCDIC) [before FC EXPO]
Tokyo, Japan
More information: www.fcdic.com/infometion

27 February–1 March 2019
FC EXPO 2019, 15th International Hydrogen & Fuel Cell Expo
Tokyo, Japan
More information: www.fcexpo.jp/en

6–8 March 2019
BIT's 5th Annual World Congress of Smart Materials 2019, WCSM-2019 (including Forum 5: Smart Materials for Energy & Environment)
Rome, Italy
More information: www.bitcongress.com/wcsm2019

11–15 March 2019
Sixth International Conference on Multifunctional, Hybrid & Nanomaterials
Sitges, Spain
More information: www.elsevier.com/events/conferences/international-conference-on-multifunctional-hybrid-and-nanomaterials

12–13 March 2019
ModVal 2019, 16th Symposium on Modeling and Experimental Validation of Electrochemical Energy Technologies
Technische Universität Braunschweig, Germany
More information: www.modval-2019.de

12–14 March 2019
Energy Storage Europe 2019 Expo & Conference
Düsseldorf, Germany
More information: www.energy-storage-online.com

19 March 2019
15th International Hydrogen & Fuel Cell Conference, Hydrogen & Fuel Cells – Powering the Future, CCSHFC2019
NEC, Birmingham, UK
More information: www.climate-change-solutions.co.uk/events/hydrogen-fuel-cells-powering-future

31 March–4 April 2019
AIChE 2019 Spring Meeting and 15th Global Congress on Process Safety, including Topical 5: Emerging Technologies in Clean Energy
New Orleans, Louisiana, USA
More information: www.aiche.org/conferences/aiche-spring-meeting-and-global-congress-on-process-safety/2019

1–5 April 2019
Hydrogen + Fuel Cells Europe Exhibition, within Hannover Messe [formerly Group Exhibit]
Hannover, Germany
More information: www.h2fc-fair.com

9–11 April 2019
SAE 2019 WCX World Congress Experience
Detroit, Michigan, USA
More information: www.sae.org/attend/wcx

16–18 April 2019
Nikola World [Invitation-only on 16–17 April, Public on 18 April]
Phoenix, Arizona, USA
More information: https://nikolamotor.com/press_releases/nikola-world-launches-in-phoenix-april-16-18-51

24–26 April 2019
14th HYdrogen POwer THeoretical and Engineering Solutions International Symposium, HYPOTHESIS XIV
Foz do Iguaçu, Brazil
More information: www.hypothesis.ws

29 April–1 May 2019
US DOE Hydrogen and Fuel Cells Program 2019 Annual Merit Review and Peer Evaluation Meeting
Crystal City, Virginia, USA
More information: www.annualmeritreview.energy.gov

5–8 May 2019
4th Green and Sustainable Chemistry Conference
Dresden, Germany
More information: www.elsevier.com/events/conferences/green-and-sustainable-chemistry-conference
Abstract deadline: 30 November 2018

15–16 May 2019
All-Energy Exhibition & Conference 2019
Glasgow, Scotland, UK
More information: www.all-energy.co.uk
Abstract deadline: 20 December 2018

19–22 May 2019
32nd Edition of the International Electric Vehicle Symposium & Exhibition, EVS32
Lyon, France
More information: www.evs32.org

22–23 May 2019
f-cell + HFC, The Impulse Summit for Hydrogen & Fuel Cells [and see 10–11 September in Stuttgart]
Vancouver, BC, Canada
More information: www.hyfcell.com

23–24 May 2019
26th Fuel Cell Development Information Center (FCDIC) Fuel Cell Symposium
Tokyo, Japan
More information: www.fcdic.com/infometion

26–31 May 2019
235th ECS Meeting, including Symposium I: Fuel Cells, Electrolyzers & Energy Conversion
Dallas, Texas, USA
More information: www.electrochem.org/235
Abstract deadline: 14 December 2018

2–7 June 2019
WHTC 2019, World Hydrogen Technologies Convention
Tokyo, Japan
More information: www.whtc2019.jp
Abstract deadline: 23 November 2018

2–5 July 2019
EFCF 2019, Low-Temperature Fuel Cells, Electrolysers & H_2 Processing: Fundamentals and Engineering Design [including FCH Tutorial and EIS Tutorial on 2 July]
Lucerne, Switzerland
More information: www.efcf.com
Abstract deadline: 30 November 2018

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PACE project: www.pace-energy.eu

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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 H20 prototypes in testing

UK-based Bramble Energy has taken delivery of its first run of five prototype H20 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 H20 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

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

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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 H20 prototypes in testing

UK-based Bramble Energy has taken delivery of its first run of five prototype H20 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 H20 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

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

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FUELING

H_2 Mobility opens new German stations in Weiterstadt, Leipzig

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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.

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myFC: www.myfcpower.com

FUELING

H_2 Mobility opens new German stations in Weiterstadt, Leipzig

H_2 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.

H_2 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 H_2 Mobility joint venture was created in 2015 by Air Liquide, Daimler, Linde, OMV,

Shell, and Total [*November 2015, p6*], and was recently joined by Chinese automaker Great Wall Motor [*October 2018, p1*]. Its primary goal is 100 stations by the end of 2019 in seven metropolitan areas (Hamburg, Berlin, Rhine-Ruhr, Frankfurt, Nuremberg, Stuttgart, and Munich) and along motorways and highways, with a further 300 stations added as vehicle numbers are ramped up.

H_2 Mobility Deutschland: www.h2.live/en

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HTEC is designing and building hydrogen fuel supply solutions to support the deployment of FCEVs, partnering with government, industrial gas companies, key equipment suppliers, automotive companies, and energy companies to deliver safe, reliable, convenient, sustainable, and low-cost hydrogen to customers and consumers. The company is currently running a crowdfunding campaign to support the rollout of hydrogen stations across Canada [*October 2018, p5*].

HTEC: www.htec.ca

Harnois Groupe pétrolier: www.harnoisgroupepetrolier.com

Toyota Industries to utilise Toshiba green hydrogen supply unit

In Japan, Toyota Industries Corporation will adopt a Toshiba Energy Systems & Solutions (Toshiba ESS) facility to produce and supply hydrogen generated using renewable energy for fuel cell powered forklifts at Toyota Industries' Takahama Plant in Aichi Prefecture.

The system will control the production quantity and compression of hydrogen using Toshiba ESS's groundbreaking hydrogen energy management system, which includes a hydrogen demand prediction function that forecasts supply requirements for each fuel cell forklift, allowing energy-efficient use.

Since November 2016, Toyota Industries has supplied nearly 80 fuel cell powered forklifts to factories and airports where it is difficult to find time to charge batteries for long run-times, whereas fuel cell forklifts can be refueled in as little as three minutes [*see, for example, the News Feature in FCB, April 2016, and April 2018, p4*]. Six trucks are in operation at the Takahama Plant, and Toyota Industries plans to increase this fleet to 12 trucks by next spring.

In mid-2017 Toshiba ESS opened its Hydrogen Application Center in Tokyo, which showcases the business facility model of its H2One™ autonomous hydrogen energy system, producing renewable energy based hydrogen to supply fuel cell forklifts [*August 2017, p7, and see also page 7 in this issue*]. Toshiba ESS's hydrogen-related projects and the usability of the facility, in which both the quantities of hydrogen produced and stored can be confirmed in real time through a monitor screen, have led to the Toyota Industries order.

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

Toyota Industries Corporation: www.toyota-industries.com

Plug Power customers meet demand peaks with hybrid station

New York-based Plug Power has deployed its third hybrid GenFuel hydrogen refueling station, in Cocoa, Florida. These stations combine the advantages of onsite hydrogen generation with cryogenic liquid hydrogen storage.

The GenFuel hybrid fueling station includes a natural gas-fed reformer and liquid hydrogen storage [*see also page 15*]. The onsite generation solution reliably produces hydrogen via the modular reformer, and utilises stored liquid hydrogen to manage demand peaks. With rising demand for hydrogen, these stations enable customers to respond quickly and easily to hydrogen demand peaks. Plug Power has already installed hybrid GenFuel stations in Texas and California [*FCB, April 2018, p9*].

Plug Power customers using the hybrid system benefit from lower hydrogen fuel costs, and the flexibility to easily respond to seasonal business dynamics, such as those seen within the retail industry. In addition, the onsite hydrogen generation capability provides operational continuity throughout logistical emergencies, during which hydrogen fuel delivery may be interrupted. This attribute is critical in states like Florida, where the hurricane season can have a significant impact on businesses and their customers.

'Plug Power solutions are designed to keep customer fleets up and running, significantly improving productivity, efficiency, and the bottom line,' says CEO Andy Marsh. 'With this deployment, we're expanding the availability of economical hydrogen solutions for electric vehicle operating fleets in North America.'

Earlier this year Plug Power reported that its customers had achieved 10 million hydrogen refueling operations using GenFuel dispensers to refuel GenDrive-powered forklifts, representing a daily average of 15 000 refills [*see the Plug Power feature in December 2011*].

Plug Power: www.plugpower.com

COSMHYC project targets compression for hydrogen refueling

In its first 18 months, the European COSMHYC project has consolidated the design of a new hybrid compression solution, which combines mechanical and metal hydride compressors. The three-year project, with five European partners from industry and research, has a total budget of €2.5 million (US$2.8 million).

The COSMHYC project, funded by the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2 JU) [*FCB, February 2017, p10*], aims to develop a cost-effective, low-noise system for hydrogen compression, in particular for hydrogen refueling stations. The team will focus on developing and testing a combined compression solution based on a mechanical compressor and a metal hydride compressor. The developments will significantly improve the fueling process, and lead to cost reductions of up to 25% for hydrogen at the dispenser.

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HTEC is designing and building hydrogen fuel supply solutions to support the deployment of FCEVs, partnering with government, industrial gas companies, key equipment suppliers, automotive companies, and energy companies to deliver safe, reliable, convenient, sustainable, and low-cost hydrogen to customers and consumers. The company is currently running a crowdfunding campaign to support the rollout of hydrogen stations across Canada [*October 2018, p5*].

HTEC: www.htec.ca

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The system will control the production quantity and compression of hydrogen using Toshiba ESS's groundbreaking hydrogen energy management system, which includes a hydrogen demand prediction function that forecasts supply requirements for each fuel cell forklift, allowing energy-efficient use.

Since November 2016, Toyota Industries has supplied nearly 80 fuel cell powered forklifts to factories and airports where it is difficult to find time to charge batteries for long run-times, whereas fuel cell forklifts can be refueled in as little as three minutes [*see, for example, the News Feature in FCB, April 2016, and April 2018, p4*]. Six trucks are in operation at the Takahama Plant, and Toyota Industries plans to increase this fleet to 12 trucks by next spring.

In mid-2017 Toshiba ESS opened its Hydrogen Application Center in Tokyo, which showcases the business facility model of its H2One™ autonomous hydrogen energy system, producing renewable energy based hydrogen to supply fuel cell forklifts [*August 2017, p7, and see also page 7 in this issue*]. Toshiba ESS's hydrogen-related projects and the usability of the facility, in which both the quantities of hydrogen produced and stored can be confirmed in real time through a monitor screen, have led to the Toyota Industries order.

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

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New York-based Plug Power has deployed its third hybrid GenFuel hydrogen refueling station, in Cocoa, Florida. These stations combine the advantages of onsite hydrogen generation with cryogenic liquid hydrogen storage.

The GenFuel hybrid fueling station includes a natural gas-fed reformer and liquid hydrogen storage [*see also page 15*]. The onsite generation solution reliably produces hydrogen via the modular reformer, and utilises stored liquid hydrogen to manage demand peaks. With rising demand for hydrogen, these stations enable customers to respond quickly and easily to hydrogen demand peaks. Plug Power has already installed hybrid GenFuel stations in Texas and California [*FCB, April 2018, p9*].

Plug Power customers using the hybrid system benefit from lower hydrogen fuel costs, and the flexibility to easily respond to seasonal business dynamics, such as those seen within the retail industry. In addition, the onsite hydrogen generation capability provides operational continuity throughout logistical emergencies, during which hydrogen fuel delivery may be interrupted. This attribute is critical in states like Florida, where the hurricane season can have a significant impact on businesses and their customers.

'Plug Power solutions are designed to keep customer fleets up and running, significantly improving productivity, efficiency, and the bottom line,' says CEO Andy Marsh. 'With this deployment, we're expanding the availability of economical hydrogen solutions for electric vehicle operating fleets in North America.'

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Sandia, FirstElement Fuel model safe liquid hydrogen fuel stations

Sandia National Laboratories in New Mexico is working with California-based FirstElement Fuel, the largest hydrogen retailer in the US, to model and design the next generation of safe, cryogenic liquid hydrogen refueling stations.

Sandia helped design the first generation of hydrogen stations, under the H_2FIRST project [*FCB, May 2014, p7*], but the accelerating rollout of these facilities requires switching from gaseous to liquid hydrogen, because the denser liquid form enables retailers to store more in the same volume.

A new Cooperative Research and Development Agreement (CRADA) between Sandia and FirstElement Fuel will allow the retailer to build more liquid hydrogen stations. It will also help modernise the decades-old National Fire Protection Association (NFPA) safety codes for liquid hydrogen safety distances. The updated codes will in turn benefit hydrogen retailers and fire marshals in designing and permitting new, safer stations.

Using its Hydrogen Risk Assessment Model (HyRAM) software [*May 2016, p9*], Sandia's hydrogen safety modeling team – risk analyst Dr Brian Ehrhart, and project co-leaders Dr Chris LaFleur and Alice Muna – is quantifying the effect of hydrogen leaks from various system designs, and the safety measures used to detect and protect against the effects of leaks. 'This way, we can enable hydrogen fueling of fuel cell vehicles in places it's never been able to go before, like the busy downtowns of big, densely packed cities,' says LaFleur.

FirstElement currently operates 19 hydrogen refueling stations in California, under the True Zero brand, each with only one pump and one hose. One result of this modeling process is that the company will have rigorous, science-based evidence to help it obtain permits for the 12 new stations it plans to build in California in 2019.

The Sandia team will benefit from being able to demonstrate its models on real-life system designs. Furthermore, the data will be used to inform and update liquid hydrogen safety codes in collaboration with the NFPA, which will allow future hydrogen refueling stations to be evaluated from a performance-based standard, rather than a prescriptive one.

Sandia's modeling work also supports the Department of Energy's H2@ Scale initiative, which focuses on large-scale production of hydrogen from diverse domestic resources [*see also page 15*]. The project also considers the use of hydrogen across multiple sectors such as steel manufacturing, fertiliser production, petroleum refining, and transportation.

Sandia National Labs, Hydrogen & Fuel Cells Program: http://tinyurl.com/sandia-h2

FirstElement Fuel: www.firstelementfuel.com

True Zero: www.truezero.com

ENERGY STORAGE & P2G

German wind park deploys H-TEC PEM electrolyser for fueling

The Citizen Wind Park Ellhöft (Bürgerwindpark Ellhöft) in northern Germany has taken delivery of H-TEC Systems' first commercial ME 100/350 PEM electrolyser, and will use it to convert wind energy into 'green' hydrogen for sale to the transport sector at a regional hydrogen refueling station, close to the border with Denmark.

'Our ME 100/350 PEM electrolyser is a key component for converting renewable energies into electricity, thereby opening up new and attractive markets above all for wind park operators outside the EEG (German Renewable Energies Act),' says Frank Zimmermann, Chief Operating Officer at H-TEC Systems. 'It produces up to 100 kg of hydrogen per day nominally, at an electric load of 225 kW – this is sufficient for fueling up to 20 hydrogen cars per day, which will satisfy the current demand.'

He adds that the compact design of the electrolyser, in a standard 20 ft (6 m) container, allows great flexibility in its placement; Wind Park Ellhöft has decided to site it directly at the hydrogen station. It is planned to have the electrolyser installed and operational by spring 2019, and a new hydrogen refueling station west of Flensburg will sell it to fuel cell electric vehicle users. The ME 100/350 electrolyser – launched at this year's Hannover Messe [*FCB, May 2018, p11*] – can convert 5.4 MWh of energy into 4 MWh of hydrogen and 1.4 MWh of heat, achieving 95% efficiency.

The H-TEC electrolyser will be integrated into a grid, making it possible to generate green hydrogen onsite in Ellhöft, exclusively for the hydrogen station in Westre. 'If the demand for hydrogen increases, it is no problem to add further electrolysers to the grid,' says Zimmermann. The ME 100/350 electrolyser can automatically adapt to changing load profiles, for example due to fluctuating (wind) energy or a change in hydrogen demand.

GP Joule itself [*see also the In Brief item on page 15*] will integrate five H-TEC PEM electrolysers into its public transport hydrogen mobility project, which is being implemented with a number of partners. This will also see regional wind energy converted into green hydrogen as an affordable and climate-friendly fuel for buses and other FCEVs. Two hydrogen stations are planned in the region, at Niebüll and Husum.

H-TEC Systems: www.h-tec-systems.com/en

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COMMERCIALISATION

Blue World to produce methanol fuel cells for the mobility market

Blue World Technologies has been founded in Denmark, to develop and manufacture methanol fuel cell components and systems for use in zero-emissions automotive and mobility applications worldwide.

Blue World's products are centred on proven high-temperature PEM fuel cell (HT-PEMFC) technology combined with integrated methanol reforming. Through advanced manufacturing and significant technology innovations, the company says that the 4th-generation technology will be more economical than combustion engines in purchase, operation, and maintenance.

The company points out that methanol is clean, cheap, simple to store and distribute, and has a superior energy density to fossil fuels. When made from renewables it has a very low well-to-wheel carbon footprint, and can enable a global trade of renewable energy using existing infrastructure.

Blue World Technologies has been founded by an executive team with decades of experience and a significant track record, who have left SerEnergy – while retaining their respective roles – to focus on bringing products to the market within a few years. Anders Korsgaard is the CEO, Mads Bang is the Chief Technology Officer, and Mads Friis Jensen is the Chief Commercial Officer. Blue World and SerEnergy are both located in Aalborg, in northern Denmark, and are both focused on HT-PEMFC technology [*e.g. FCB, May 2018, p2, and see the SerEnergy News Focus in September 2017*].

Blue World's complete system consists of a BlueBOX, holding the stack and methanol reformer, plus customised balance-of-plant. Close

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Sandia helped design the first generation of hydrogen stations, under the H_2FIRST project [*FCB, May 2014, p7*], but the accelerating rollout of these facilities requires switching from gaseous to liquid hydrogen, because the denser liquid form enables retailers to store more in the same volume.

A new Cooperative Research and Development Agreement (CRADA) between Sandia and FirstElement Fuel will allow the retailer to build more liquid hydrogen stations. It will also help modernise the decades-old National Fire Protection Association (NFPA) safety codes for liquid hydrogen safety distances. The updated codes will in turn benefit hydrogen retailers and fire marshals in designing and permitting new, safer stations.

Using its Hydrogen Risk Assessment Model (HyRAM) software [*May 2016, p9*], Sandia's hydrogen safety modeling team – risk analyst Dr Brian Ehrhart, and project co-leaders Dr Chris LaFleur and Alice Muna – is quantifying the effect of hydrogen leaks from various system designs, and the safety measures used to detect and protect against the effects of leaks. 'This way, we can enable hydrogen fueling of fuel cell vehicles in places it's never been able to go before, like the busy downtowns of big, densely packed cities,' says LaFleur.

FirstElement currently operates 19 hydrogen refueling stations in California, under the True Zero brand, each with only one pump and one hose. One result of this modeling process is that the company will have rigorous, science-based evidence to help it obtain permits for the 12 new stations it plans to build in California in 2019.

The Sandia team will benefit from being able to demonstrate its models on real-life system designs. Furthermore, the data will be used to inform and update liquid hydrogen safety codes in collaboration with the NFPA, which will allow future hydrogen refueling stations to be evaluated from a performance-based standard, rather than a prescriptive one.

Sandia's modeling work also supports the Department of Energy's H2@ Scale initiative, which focuses on large-scale production of hydrogen from diverse domestic resources [*see also page 15*]. The project also considers the use of hydrogen across multiple sectors such as steel manufacturing, fertiliser production, petroleum refining, and transportation.

Sandia National Labs, Hydrogen & Fuel Cells Program: http://tinyurl.com/sandia-h2

FirstElement Fuel: www.firstelementfuel.com

True Zero: www.truezero.com

ENERGY STORAGE & P2G

German wind park deploys H-TEC PEM electrolyser for fueling

The Citizen Wind Park Ellhöft (Bürgerwindpark Ellhöft) in northern Germany has taken delivery of H-TEC Systems' first commercial ME 100/350 PEM electrolyser, and will use it to convert wind energy into 'green' hydrogen for sale to the transport sector at a regional hydrogen refueling station, close to the border with Denmark.

'Our ME 100/350 PEM electrolyser is a key component for converting renewable energies into electricity, thereby opening up new and attractive markets above all for wind park operators outside the EEG (German Renewable Energies Act),' says Frank Zimmermann, Chief Operating Officer at H-TEC Systems. 'It produces up to 100 kg of hydrogen per day nominally, at an electric load of 225 kW – this is sufficient for fueling up to 20 hydrogen cars per day, which will satisfy the current demand.'

He adds that the compact design of the electrolyser, in a standard 20 ft (6 m) container, allows great flexibility in its placement; Wind Park Ellhöft has decided to site it directly at the hydrogen station. It is planned to have the electrolyser installed and operational by spring 2019, and a new hydrogen refueling station west of Flensburg will sell it to fuel cell electric vehicle users. The ME 100/350 electrolyser – launched at this year's Hannover Messe [*FCB, May 2018, p11*] – can convert 5.4 MWh of energy into 4 MWh of hydrogen and 1.4 MWh of heat, achieving 95% efficiency.

The H-TEC electrolyser will be integrated into a grid, making it possible to generate green hydrogen onsite in Ellhöft, exclusively for the hydrogen station in Westre. 'If the demand for hydrogen increases, it is no problem to add further electrolysers to the grid,' says Zimmermann. The ME 100/350 electrolyser can automatically adapt to changing load profiles, for example due to fluctuating (wind) energy or a change in hydrogen demand.

GP Joule itself [*see also the In Brief item on page 15*] will integrate five H-TEC PEM electrolysers into its public transport hydrogen mobility project, which is being implemented with a number of partners. This will also see regional wind energy converted into green hydrogen as an affordable and climate-friendly fuel for buses and other FCEVs. Two hydrogen stations are planned in the region, at Niebüll and Husum.

H-TEC Systems: www.h-tec-systems.com/en

GP Joule: www.gp-joule.com

Bürgerwindpark Ellhöft: www.windpark-ellhoeft.de [in German]

COMMERCIALISATION

Blue World to produce methanol fuel cells for the mobility market

Blue World Technologies has been founded in Denmark, to develop and manufacture methanol fuel cell components and systems for use in zero-emissions automotive and mobility applications worldwide.

Blue World's products are centred on proven high-temperature PEM fuel cell (HT-PEMFC) technology combined with integrated methanol reforming. Through advanced manufacturing and significant technology innovations, the company says that the 4th-generation technology will be more economical than combustion engines in purchase, operation, and maintenance.

The company points out that methanol is clean, cheap, simple to store and distribute, and has a superior energy density to fossil fuels. When made from renewables it has a very low well-to-wheel carbon footprint, and can enable a global trade of renewable energy using existing infrastructure.

Blue World Technologies has been founded by an executive team with decades of experience and a significant track record, who have left SerEnergy – while retaining their respective roles – to focus on bringing products to the market within a few years. Anders Korsgaard is the CEO, Mads Bang is the Chief Technology Officer, and Mads Friis Jensen is the Chief Commercial Officer. Blue World and SerEnergy are both located in Aalborg, in northern Denmark, and are both focused on HT-PEMFC technology [*e.g. FCB, May 2018, p2, and see the SerEnergy News Focus in September 2017*].

Blue World's complete system consists of a BlueBOX, holding the stack and methanol reformer, plus customised balance-of-plant. Close

thermal integration enables reuse of fuel cell 'waste' heat to evaporate the fuel, significantly increasing efficiency. The fuel cell system is applied in a plug-in battery hybrid configuration, to balance the vehicle's power/acceleration and energy/range needs, and waste heat can be utilised for cabin and battery heating.

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'While we've had sales and service staff committed to California and the broader US markets for over a decade, we've come to recognise – with the state ranked as the world's fifth-largest economy – the importance of having a dedicated presence to support the needs of our customers there and strengthen our business development activities,' says Rob Del Core, Managing Director of Hydrogenics USA.

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The Hydrogen Energy Fund will be jointly operated by Hyundai Motor and Yield Capital, BTIRDI's investment firm, with the aim of raising a total of US$100 million. The fund aims to attract investments from leading venture capital firms in China, Europe, and the US. The fund's contributions will not be limited to equity investments, but will involve active and systematic support based on each member's incubating programmes and Corporate Venture Capital (CVC) strategies.

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development and serial production to be in the range US$50–70 million.

Hexagon says that the long life-cycle properties of all-composite pressure cylinders, with plastic liners and carbon fibre structure, make them more suitable for hydrogen storage than metal-lined alternatives.

Hexagon Composites: www.hexagon.no

New Flyer: www.newflyer.com

Ceres Power to build SOFC manufacturing facility near UK base

UK-based Ceres Power has announced a £7 million (US$9.2 million) investment in a new, state-of-the-art manufacturing facility. The company is investing in manufacturing capacity to meet near-term demand from its partners for its low-cost, next-generation SteelCell® solid oxide fuel cell technology.

The new facility will be built in Redhill, Surrey over the next two years, funded from existing cash resources, and will create 60 new jobs. It will expand Ceres' manufacturing capacity significantly, giving the company a manufacturing capacity of ~2 MW per annum by the end of 2019, with the capacity to expand to 10 MW per annum to meet anticipated growing customer demand.

Ceres' new facility will therefore meet significant existing SteelCell demand from customers in the development phase, and also provide capacity for the early stages of commercial product launch, while also serving as a proof-of-concept facility to demonstrate rapid scale-up and low-cost manufacturing. The nearby Horsham facility will remain as the company's headquarters and technical centre.

Ceres' strategy is to generate revenues through licensing its intermediate-temperature SOFC technology to its partners in the development phase, and generate royalties through manufacturing partners when full-scale commercialisation is achieved, rather than become a large-scale manufacturer itself. The need for additional interim capacity has been driven by increasing demand from its partner network of major OEMs. Ceres is currently working on several applications with its partners, including a range-extender for electric buses with Weichai Power [*FCB, June 2018, p10*], small power stations with Bosch [*September 2018, p11*], electric vehicle range-extenders with Nissan [*July 2016, p4 and August 2018, p4*], and data centre power with Cummins [*April 2014, p10*].

Ceres Power: www.cerespower.com

Green Science starts custom synthesis of PEM, SOFC materials

Japanese materials chemistry research specialist Green Science Alliance Co Ltd has started custom synthesis and basic electrochemical measurements of electrodes and electrolytes for both PEM and solid oxide fuel cells, and has also started developing carbon-alloy-type catalysts and a metal organic framework (MOF)-derived catalytic electrode material for PEMFCs.

Green Science Alliance has so far been conducting research on rechargeable aluminium-air batteries, lithium-ion batteries, and solid oxide fuel cells. The company has now also begun to accept customer requests for custom synthesis and measurements of basic electrochemical properties of **PEMFC electrodes and electrolytes**, and reducing the cost by replacing conventional platinum-based catalyst materials using materials such as carbon alloy catalysts doped with nitrogen. The company will also develop **MOF-derived catalytic materials** by choosing appropriate additives and optimising heat treatment procedures to control the structure of electrode materials at the atomic and molecular levels. Green Science is already manufacturing and supplying MOFs, which has accelerated its in-house development of MOF-derived catalysts.

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The new facility will be built in Redhill, Surrey over the next two years, funded from existing cash resources, and will create 60 new jobs. It will expand Ceres' manufacturing capacity significantly, giving the company a manufacturing capacity of ~2 MW per annum by the end of 2019, with the capacity to expand to 10 MW per annum to meet anticipated growing customer demand.

Ceres' new facility will therefore meet significant existing SteelCell demand from customers in the development phase, and also provide capacity for the early stages of commercial product launch, while also serving as a proof-of-concept facility to demonstrate rapid scale-up and low-cost manufacturing. The nearby Horsham facility will remain as the company's headquarters and technical centre.

Ceres' strategy is to generate revenues through licensing its intermediate-temperature SOFC technology to its partners in the development phase, and generate royalties through manufacturing partners when full-scale commercialisation is achieved, rather than become a large-scale manufacturer itself. The need for additional interim capacity has been driven by increasing demand from its partner network of major OEMs. Ceres is currently working on several applications with its partners, including a range-extender for electric buses with Weichai Power [*FCB, June 2018, p10*], small power stations with Bosch [*September 2018, p11*], electric vehicle range-extenders with Nissan [*July 2016, p4 and August 2018, p4*], and data centre power with Cummins [*April 2014, p10*].

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The 5th-generation CVM modules can be used at ambient temperatures up to 105°C, and the power supply range has also been extended. This used to be a fixed 5 V, but the company's new IntelliProbe modules are equipped with a wide range input for supply voltages between 4.5 and 32 V, which means they can run directly on a 12 or 24 V system.

The software in the fuel cell monitoring systems has also been improved, including the addition of a new, parameterisable algorithm to make cable break detection even more reliable. The cable break detection sensitivity can be set as required, enabling the system to be adapted to the ambient conditions of the customer's application. Averaging is also configurable in the new module. And a software upgrade makes the extended software functionality available to 4th-generation CVM customers.

The next-gen CVM system also features a web-based user interface, which allows massively parallel visualisation and recording of several hundred channels, enabling users to observe fuel cell stacks in real time, for example.

Smart Testsolutions GmbH: www.smart-testsolutions.de

UQM launches fully integrated fuel cell compressor system

US-based UQM Technologies has unveiled its new PowerPhase® FCS fuel cell compressor system, which features an integrated high-efficiency motor and controller that result in a low-cost, space-optimised design that can be adapted to different compressor options.

The fully integrated fuel cell motor-inverter-compressor has been customised for a wide range of fuel cell applications. It provides a number of benefits to fuel cell suppliers, including improved packaging, the elimination of several components – such as cables and connectors between the motor and inverter – and overall optimised performance.

UQM's PowerPhase FCS product portfolio aims to cover most market needs for fuel cell electric vehicles, supporting fuel cell stacks from 30 to 150 kW and 270–800 V_{dc} voltage range, a pressure ratio range from 1 to 2.2, and airflow from 100 to 500 kg/h.

'We'll be introducing this product in China – the largest market for fuel cell technology globally, particularly in heavy-duty applications,' says Joseph Mitchell, CEO of UQM. 'Initial feedback from potential customers has been very positive, and we look forward to launching the system in early 2019.'

The company showcased the new integrated fuel cell compressor system at the recent International Hydrogen Energy and Fuel Cell Technology Expo in Foshan, China, and is now taking orders in advance of the product rollout in 2019.

UQM manufactures power-dense, high-efficiency electric motors, generators, power electronic controllers, and fuel cell compressors for the commercial truck, bus, automotive, marine, and industrial markets. The company recently received new fuel cell compressor system purchase orders from several new and existing Chinese customers, including its major Chinese OEM client [*FCB, September 2018, p13*]. It has also signed a lease agreement to open a customer service centre in Shanghai, for both its fuel cell compressor systems and propulsion systems.

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FCH JU report on fuel cells and hydrogen in European cities, regions

Fuel cells and hydrogen are a viable solution for reducing emissions and realising a 'green' energy transition in European regions and cities, according to new study from the Fuel Cells and Hydrogen Joint Undertaking.

In 2017 the FCH JU launched an initiative to support regions and cities, and now 89 regions and cities are participating, representing about one-quarter of Europe's population, surface area, and gross domestic product (GDP). These regions are pursuing ambitious plans to deploy fuel cell and hydrogen (FCH) technology, with investments totaling about €1.8 billion (US$2 billion) planned for these regions in the next five years.

The new study, *Fuel Cells and Hydrogen for Green Energy in European Cities and Regions*, provides a detailed insight into the FCH investment plans of the participating regions and cities, and highlights the next steps to be taken for realising a European FCH roadmap with a view to commercialising the technology. In particular, the study shows that:

- European regions and cities need to take action now to realise their ambitious emissions reduction targets and improve local air quality.
- Investing in FCH technology pays off for cities and regions, as it provides a mature, safe, and competitive zero-emissions solution for all their energy needs.
- Regions and cities can benefit from investing in hydrogen and fuel cells not only in environmental terms, but also by stimulating local economic growth and creating attractive places to live, work, and visit.
- The initiative provides a unique opportunity to benefit from existing knowledge, and draw on project development support and financing assistance to realise their own FCH deployment projects.
- To enable the realisation of the envisaged FCH deployment plans of the regions and cities, continued support will be required for individual projects as well as the wider coalition.

FCH JU, Cities and Regions report [PDF]: https://tinyurl.com/fchju-regions-cities

RESEARCH

US Army TARDEC, DOE to collaborate on hydrogen and fuel cells R&D for military use

The US Army Tank Automotive Research, Development and Engineering Center (TARDEC) and the Department of Energy's Fuel Cell Technology Office (FCTO) have signed a formal Memorandum of Understanding to work more closely on technologies that can meet both organisations' goals, in particular the development of hydrogen fuel cell technology for military applications.

The signing date was chosen specifically to honor October 8, National Hydrogen and Fuel Cell Day (10.08 in US date notation), and comes a year after TARDEC and FCTO agreed to work on jointly funded projects to advance progress in hydrogen and fuel cell technologies [*FCB, November 2017, p12*]. TARDEC and FCTO both conduct R&D efforts to advance technologies that enable hydrogen to be used as a fuel source for vehicles, generators, and other applications typically served by combustion engines.

TARDEC Director Paul Rogers says the US Army's most intriguing question with hydrogen is in the infrastructure required to get hydrogen as a fuel source to and around the battlefield. 'We know how to make the hydrogen, small-scale and large-scale,' he says. 'The question is, where does it make the most sense to reform the hydrogen in large quantities to transport

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The software in the fuel cell monitoring systems has also been improved, including the addition of a new, parameterisable algorithm to make cable break detection even more reliable. The cable break detection sensitivity can be set as required, enabling the system to be adapted to the ambient conditions of the customer's application. Averaging is also configurable in the new module. And a software upgrade makes the extended software functionality available to 4th-generation CVM customers.

The next-gen CVM system also features a web-based user interface, which allows massively parallel visualisation and recording of several hundred channels, enabling users to observe fuel cell stacks in real time, for example.

Smart Testsolutions GmbH: www.smart-testsolutions.de

UQM launches fully integrated fuel cell compressor system

US-based UQM Technologies has unveiled its new PowerPhase® FCS fuel cell compressor system, which features an integrated high-efficiency motor and controller that result in a low-cost, space-optimised design that can be adapted to different compressor options.

The fully integrated fuel cell motor-inverter-compressor has been customised for a wide range of fuel cell applications. It provides a number of benefits to fuel cell suppliers, including improved packaging, the elimination of several components – such as cables and connectors between the motor and inverter – and overall optimised performance.

UQM's PowerPhase FCS product portfolio aims to cover most market needs for fuel cell electric vehicles, supporting fuel cell stacks from 30 to 150 kW and 270–800 V_{dc} voltage range, a pressure ratio range from 1 to 2.2, and airflow from 100 to 500 kg/h.

'We'll be introducing this product in China – the largest market for fuel cell technology globally, particularly in heavy-duty applications,' says Joseph Mitchell, CEO of UQM. 'Initial feedback from potential customers has been very positive, and we look forward to launching the system in early 2019.'

The company showcased the new integrated fuel cell compressor system at the recent International Hydrogen Energy and Fuel Cell Technology Expo in Foshan, China, and is now taking orders in advance of the product rollout in 2019.

UQM manufactures power-dense, high-efficiency electric motors, generators, power electronic controllers, and fuel cell compressors for the commercial truck, bus, automotive, marine, and industrial markets. The company recently received new fuel cell compressor system purchase orders from several new and existing Chinese customers, including its major Chinese OEM client [*FCB, September 2018, p13*]. It has also signed a lease agreement to open a customer service centre in Shanghai, for both its fuel cell compressor systems and propulsion systems.

UQM Technologies: www.uqm.com

FCH JU report on fuel cells and hydrogen in European cities, regions

Fuel cells and hydrogen are a viable solution for reducing emissions and realising a 'green' energy transition in European regions and cities, according to new study from the Fuel Cells and Hydrogen Joint Undertaking.

In 2017 the FCH JU launched an initiative to support regions and cities, and now 89 regions and cities are participating, representing about one-quarter of Europe's population, surface area, and gross domestic product (GDP). These regions are pursuing ambitious plans to deploy fuel cell and hydrogen (FCH) technology, with investments totaling about €1.8 billion (US$2 billion) planned for these regions in the next five years.

The new study, *Fuel Cells and Hydrogen for Green Energy in European Cities and Regions*, provides a detailed insight into the FCH investment plans of the participating regions and cities, and highlights the next steps to be taken for realising a European FCH roadmap with a view to commercialising the technology. In particular, the study shows that:

- European regions and cities need to take action now to realise their ambitious emissions reduction targets and improve local air quality.
- Investing in FCH technology pays off for cities and regions, as it provides a mature, safe, and competitive zero-emissions solution for all their energy needs.
- Regions and cities can benefit from investing in hydrogen and fuel cells not only in environmental terms, but also by stimulating local economic growth and creating attractive places to live, work, and visit.
- The initiative provides a unique opportunity to benefit from existing knowledge, and draw on project development support and financing assistance to realise their own FCH deployment projects.
- To enable the realisation of the envisaged FCH deployment plans of the regions and cities, continued support will be required for individual projects as well as the wider coalition.

FCH JU, Cities and Regions report [PDF]: https://tinyurl.com/fchju-regions-cities

RESEARCH

US Army TARDEC, DOE to collaborate on hydrogen and fuel cells R&D for military use

The US Army Tank Automotive Research, Development and Engineering Center (TARDEC) and the Department of Energy's Fuel Cell Technology Office (FCTO) have signed a formal Memorandum of Understanding to work more closely on technologies that can meet both organisations' goals, in particular the development of hydrogen fuel cell technology for military applications.

The signing date was chosen specifically to honor October 8, National Hydrogen and Fuel Cell Day (10.08 in US date notation), and comes a year after TARDEC and FCTO agreed to work on jointly funded projects to advance progress in hydrogen and fuel cell technologies [*FCB, November 2017, p12*]. TARDEC and FCTO both conduct R&D efforts to advance technologies that enable hydrogen to be used as a fuel source for vehicles, generators, and other applications typically served by combustion engines.

TARDEC Director Paul Rogers says the US Army's most intriguing question with hydrogen is in the infrastructure required to get hydrogen as a fuel source to and around the battlefield. 'We know how to make the hydrogen, small-scale and large-scale,' he says. 'The question is, where does it make the most sense to reform the hydrogen in large quantities to transport

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The grant is one of the projects recently awarded DOE funding under its H2@ Scale initiative to produce and use hydrogen across multiple energy sectors [*FCB, September 2018, p14, and see page 11 in this issue*]. The WSU researchers will work with Plug Power [*see also page 10*] to improve the efficiency of liquid hydrogen storage systems, using excess hydrogen at Plug Power facilities that is currently going to waste. 'The challenge is to make sure the technology can be implemented well, and result in cost savings for Plug Power,' says Leachman.

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The project is led by Professor Tom Zawodzinski, the UT–Oak Ridge National Laboratory Governor's Chair for Electrical Energy Conversion and Storage. 'It has long been a goal to make a regenerative fuel cell, a single device that functions as both a fuel cell and an electrolyser,' he explains. 'However, such devices have previously suffered from poor overall efficiency. The new project uses an alternative approach, by changing one of the chemical reactions in the cell and bypassing the efficiency bottleneck.'

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