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Chinese automaker Great Wall Motor joins German hydrogen network H_2 Mobility

Chinese car manufacturer Great Wall Motor has signed a Memorandum of Understanding with H_2 Mobility Deutschland GmbH, to become its seventh shareholder and co-owner. GWM will contribute additional investment to the joint venture, and acquire a minority share, joining Air Liquide, Daimler, Linde, OMV, Shell, and Total.

H_2 Mobility Deutschland was formed in 2015 to facilitate a staged nationwide expansion of hydrogen refueling stations to serve fuel cell electric vehicles in Germany [*FCB, November 2015, p6*]. In the first phase, the partnership aims to have 100 stations in operation by the end of 2019, serving the metropolitan areas of Hamburg, Berlin, Rhine-Ruhr, Frankfurt, Nuremberg, Stuttgart and Munich, and along motorways and highways [*see pages 9 and 10*]. This will be followed by up to 300 more hydrogen stations in line with FCEV rollout.

GWM has an advanced hydrogen prototype and test centre in Baoding, Hebei Province, as well as expertise in Shanghai with the recently acquired Shanghai Fuel Cell Vehicle Powertrain Co Ltd. GWM will provide FCEVs to customers in China, and later consider expanding into international markets with a focus on early markets such as Germany, with its rapidly growing hydrogen station network developed by H_2 Mobility. Earlier this year GWM joined the Hydrogen Council as the first Chinese OEM steering member [*April 2018, p13*], and is also active in the China-based International Fuel Cell and Hydrogen Association (IHFCA) and National Alliance of Hydrogen and Fuel Cell (NAHFC) [*March 2018, p5*].

H_2 Mobility and GWM will cooperate closely on the harmonisation and advancement of hydrogen codes & standards, and will work to further improve the reliability and convenience of hydrogen refueling. They will exchange learnings and experience to accelerate the deployment of hydrogen refueling station networks in China and Germany.

H_2 Mobility Deutschland: www.h2.live

Great Wall Motor Company: www.gwm-global.com

Nouryon, Tata Steel, Port of Amsterdam partner on largest green hydrogen cluster in Europe

Nouryon (formerly AkzoNobel Specialty Chemicals), Tata Steel, and the Port of Amsterdam will jointly study the feasibility of a large 'green' hydrogen cluster in the Amsterdam region. The partners consider renewably produced hydrogen as vital for reaching climate targets and building a more circular economy, for example by combining it with emissions from steel manufacturing to make new products.

Initially they will study the feasibility of a 100 MW water electrolysis facility to produce up to 15 000 tonnes of hydrogen per annum, as well as oxygen, at Tata Steel's IJmuiden site, near Amsterdam. By using renewable electricity, the initial unit will save up to 350 000 tonnes of CO_2 per annum. A final investment decision is expected in 2021, to scale up the technology further.

Nouryon will operate the facility, while Tata Steel will use the oxygen to further enhance the sustainability of its production processes. The Port of Amsterdam will focus on the infrastructure for wider distribution of green hydrogen, as the basis for the development of new industries and zero-emissions transport in the Amsterdam region, including buses and heavy transport.

Nouryon: www.nouryon.com

Tata Steel Europe: www.tatasteeleurope.com

Port of Amsterdam: www.portofamsterdam.com

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ROAD VEHICLES

EU to award €40m for H2Bus Europe project with 605 buses, fueling

The H2Bus Europe project has been selected by the Connecting Europe Facility programme (CEF) for a proposed award worth €39.6 million (US$45.6 million), to deploy 605 fuel cell buses and supporting hydrogen refueling infrastructure in Denmark, the UK, and Latvia.

The H2Bus Europe project is an ambitious project developed by Denmark-based Nel Hydrogen – through Everfuel Europe A/S – and other leading industry partners to get a total of 605 fuel cell city buses on the roads in selected regions in Europe, and establish a sufficient supply of 'green' hydrogen using Nel H2Station® hydrogen refueling station technology. The project aims to deploy the buses in London and Oxford in the UK, the Latvian capital Riga, as well as in Copenhagen and Fredericia, which is one of Denmark's largest transport hubs, on the eastern side of the Jutland peninsular, where the major E20 highway comes in from the Great Belt and Oresund Bridges. The project, with a total cost of nearly €200 million ($230 million), kicked off in May, and will run to the end of 2023.

CEF is a European Union fund for pan-European infrastructure investment in transport, energy and digital projects. At the end of September the CEF committee approved the latest list of projects for proposed awards, including the H2Bus Europe project. Nel and its partners – currently not identified – will reveal further details on the project in the coming months.

Nel Hydrogen recently inaugurated its new large-scale H2Station production plant in Herning, Denmark, capable of manufacturing 300 hydrogen refueling stations per annum [*see page 14*]. A single H2Station can serve a fleet of 30 fuel cell buses, or 400–800 fuel cell passenger vehicles.

Connecting Europe Facility:
https://ec.europa.eu/inea/en/connecting-europe-facility

Nel Hydrogen: www.nelhydrogen.com

Toyota tech in fuel cell buses for Caetanobus, Japan rail partnership

Toyota Motor Corporation will supply its hydrogen fuel cell technology to Caetanobus in Portugal, which will integrate the systems in its first fuel cell city buses, with the launch of the first hydrogen demonstration bus planned for autumn 2019. Toyota is also working with East Japan Railway Company in a hydrogen-based mobility partnership linking railways and automobiles.

Toyota's latest generation fuel cell technology features in its *Mirai* fuel cell electric vehicle, launched at the end of 2014 [*FCB, November 2014, p1*]. The Japanese automaker is now extending the application of this hydrogen fuel cell technology beyond passenger cars, including heavy-duty trucks [*July 2018, p1, and see page 4 in this issue*], small delivery trucks [*July 2018, p12*], buses [*April 2018, p2*], and forklifts [*April 2018, p4*].

To this end, Toyota will supply fuel cell systems – including stacks, hydrogen tanks, and other key components – to **Caetanobus**, the Portuguese bus engineering and production company, to build hydrogen fuel cell city buses. The first vehicles will roll off the Caetanobus production line in just over a year's time, and it will then operate them as demonstration buses. Caetanobus is the first company in Europe to benefit from Toyota's fuel cell technology.

Meanwhile, **Toyota and East Japan Railway Company** (JR East) have agreed a hydrogen-based mobility partnership between railways and automobiles. The agreement is rooted in Toyota and JR East's desire to link railways and automobiles, combine management resources, and promote initiatives that make use of hydrogen.

The partners are presently in wide-ranging discussions on hydrogen use, including establishing a hydrogen supply chain based at railway stations, and ensuring that initiatives are fully integrated into local communities. This would take the form of setting up hydrogen stations on land owned by JR East (for example as part of its Shinagawa Development Project, in what is planned to be Tokyo's second central business district), introducing FCEVs and fuel cell buses into regional transport networks connected to railways, and applying fuel cell technologies in railway carriages, including research into the safety of vehicles loaded with large volumes of hydrogen.

Toyota, Fuel Cell Vehicles:
http://tinyurl.com/toyota-fcevs

Caetanobus: www.caetanobus.pt

JR East: www.jreast.co.jp/e

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Hyundai unveils fuel cell truck design, plans first truck fleet with H_2 Energy in Switzerland

Hyundai Motor Company presented the first image of a new fuel cell powered truck, which will be launched in 2019, at the recent IAA Commercial Vehicles 2018 show in Hannover, Germany [*see also page 4 and page 12*]. The South Korean automaker subsequently announced a partnership with H_2 Energy to deploy 1000 fuel cell trucks in Switzerland by 2023.

Hyundai's **fuel cell electric truck** builds on the company's automotive fuel cell technology leadership with the Tucson/ix35 Fuel Cell [*FCB, March 2013, p2*] and NEXO passenger cars [*January 2018, p2*]. The truck has a distinctive design to set it apart from the rest of the Hyundai commercial vehicle line-up.

Hyundai subsequently announced at the IAA a Memorandum of Understanding with the Swiss hydrogen company H_2 Energy (H_2E). Over a five-year period beginning in 2019, Hyundai Motor and H_2E will provide **1000 fuel cell heavy-duty trucks** to the commercial vehicle market in Switzerland, alongside a supply chain for renewable hydrogen refueling.

The deal marks Hyundai Motor's expansion of its leadership in fuel cell electric vehicles into the commercial vehicle sector. The 18 tonne (gross vehicle weight, 34 tonnes with trailer) fuel cell truck features a new 190 kW fuel cell powertrain comprising two 95 kW hydrogen fuel cell systems (from the NEXO) connected in parallel. This should give a range of about 400 km (250 miles) in real-life driving conditions, with eight hydrogen tanks installed in areas such as between the cabin and the rigid body, holding 33 kg of hydrogen at 350 bar.

Hyundai plans to diversify its fuel cell commercial vehicle line-up; a medium-sized fuel cell electric truck (payload 4–5 tonnes) is currently under development, which can be used for cleaning vehicles in the public services sector, for example. Hyundai also introduced fuel cell express buses at the 2018 Winter Olympics in Pyeongchang in February, and is currently conducting a pilot operation with fuel cell buses in major South Korean cities, while reviewing plans for mass production by 2020. FCEV taxis and car-sharing services are already operating in Ulsan and Gwangju.

H_2 Energy specialises in the production and supply of renewable hydrogen in Switzerland [*July 2016, p8*], with subsidiaries in Germany, Norway, and Austria. The company plans to make Hyundai's fuel cell electric trucks available to its Swiss customers, starting with members of the Swiss Hydrogen Association [*October 2017, p11*], which includes several filling station operators, retailers, and other customers for logistics and goods distribution. H_2E recently formed a Swiss public-private partnership with Empa and the Paul Scherrer Institute, to further develop fuel cell technology and prepare for market entry [*August 2018, p14*].

Hyundai Commercial Vehicle: http://trucknbus.hyundai.com/global

Hyundai NEXO: www.hyundai.com/worldwide/en/eco/nexo

H_2 Energy: www.h2energy.ch/en

Swiss Hydrogen Association: www.hydropole.ch

H_2 Mobility Switzerland Association: www.h2mobilitaet.ch/en

Hydrogenics fuel cells for heavy-duty trucks in California project

Canadian-based Hydrogenics will supply six heavy-duty PEM fuel cell power modules to GTI and TransPower for a set of Class 8 Navistar drayage trucks scheduled to be deployed in southern California early next year. The trucks are part of the California Climate Investments programme [*see also next item*] of the California Air Resources Board, to enable the acceleration of low-carbon technology in commercial trucking applications.

The Fast Track Fuel Cell Truck Project is being managed by Illinois-based GTI (Gas Technology Institute), with Navistar the chassis provider, California-based TransPower the vehicle integrator, and Total Transportation Services Inc (TTSI) as the operator [*see also next item*]. Hydrogenics expects to ship the fuel cells in Q4 of 2018.

'GTI and TransPower both have extensive experience and knowledge in fuel cell integration, and this project provides an ideal opportunity to build on our recent success in deploying one of the world's first fully functional fuel cell trucks in southern California,' says Daryl Wilson, President and CEO of Hydrogenics [*see also page 11*]. The company's heavy-duty fuel cells are now in use in more than 30 freight and utility vehicles as well as seven different transport platforms, including Alstom's hydrogen-powered

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Steve Barrett

passenger trains in Germany [*FCB, September 2018, p1*].

GTI and TransPower are also working with Canadian-based Loop Energy, whose heavy-duty fuel cell range-extender will power two hybrid electric Class 8 drayage trucks that will operate for a year as part of a Fast Track Fuel Cell Truck Project in southern California, also funded by California Climate Investments [*August 2018, p5*].

Hydrogenics: www.hydrogenics.com

GTI: www.gastechnology.org

Navistar International: www.navistar.com

TransPower: www.transpowerusa.com

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

California Climate Investments: www.caclimateinvestments.ca.gov

Total Transportation Services Inc: www.tts-i.com

CARB awards $41m for fuel cell freight project at Port of LA with Toyota and Shell

The California Air Resources Board has preliminarily awarded $41 million to the Port of Los Angeles for the Zero-Emission and Near Zero-Emission Freight Facilities (ZANZEFF) project, under which Toyota, Kenworth and Shell will establish a fuel cell electric technology network for zero-emissions freight transport.

ZANZEFF will include heavy-duty hydrogen fuel cell electric trucks, heavy-duty hydrogen refueling stations, and zero-emissions cargo handling equipment vehicles. The National Renewable Energy Laboratory and South Coast Air Quality Management District will provide project implementation review and input.

The Port of LA will develop the project in several phases, ultimately encompassing initiatives in southern California, the Central Coast Area, and Merced County. The project is part of the California Climate Investments initiative [*see also item above*]; the total project cost for the initial phase is $82.6 million, with partners providing $41.4 million.

Ten new fuel cell electric **Class 8 on-road trucks** based on the Kenworth T680 platform will be developed by Kenworth and Toyota [*see also page 2*], to move cargo from the ports throughout the Los Angeles Basin, and to inland locations such as Riverside County, the Port of Hueneme, and eventually to Merced. Four trucks will be operated by Toyota Logistics Services, three by United Parcel Services, two by Total Transportation Services Inc (TTSI) [*see also item above*], and one by Southern Counties Express.

Two new large-capacity, heavy-duty **hydrogen refueling stations** will be developed by Shell in Wilmington and Ontario, joining three existing stations at Toyota facilities in the region to form an integrated heavy-duty hydrogen refueling network. The heavy-duty station to be operated by Shell for freight transport will provide more than 1 tonne per day of renewable hydrogen. Stations supplied by Air Liquide at Toyota Logistics Services in Long Beach and the Toyota Technical Center in Gardena will serve as important R&D locations.

The project also includes expanded use of zero-emissions technology in **off-road and warehouse equipment**, including the first two fuel cell powered yard tractors at the Port of Hueneme, as well as expanded use of fuel cell powered forklifts at Toyota's port warehouse.

This 'Shore to Store' (S2S) project complements the extensive zero-emissions technology already under development for testing at Los Angeles terminals through partnership with the California Energy Commission, including Toyota's Project Portal [*FCB, November 2017, p3 and July 2018, p1*] and its facility redevelopment at the Port of Long Beach [*September 2018, p8*], Kenworth and Ballard working on a Class 8 fuel cell truck [*February 2018, p3*], and Nuvera powering a top loader at the Port of LA [*August 2018, p6*].

Port of Los Angeles: www.portoflosangeles.org

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

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

FPT Industrial: www.fptindustrial.com

MOBILE APPLICATIONS

Revolve unveils van range-extender with Bramble PCB fuel cell

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

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

This is the first time that a PCB-based fuel cell has been developed for use in an automotive environment. Compared with conventional systems, the PCBFC stack offers dramatically reduced system costs, while delivering reduced weight for a given power output and providing a more flexible form-factor. With the PCBFC fitted, an additional range of around 80 miles (130 km) can be expected on the NEDC (New European Driving Cycle) with 1.7 kg of hydrogen on board; the range can be further extended simply by fitting additional hydrogen storage capacity.

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

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

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

Revolve Technologies: www.revolve.co.uk

Bramble Energy: www.brambleenergy.com

WATT fulfills first Imperium order for Hymer North America

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

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

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

IN BRIEF

HTEC launches equity crowdfunding to support Canada hydrogen station rollout

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

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

IRENA on hydrogen in energy transition

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

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

Swiss H_2 Mobility association is growing

The H_2 Mobility Switzerland Association (www.h2mobilitaet.ch/en), which was founded in May [*FCB, June 2018, p5*], has welcomed its newest member, filling station operator SOCAR Energy Switzerland (www.socarenergy.ch/en), providing additional support to promote and accelerate the establishment of hydrogen mobility in Switzerland.

Things are starting to accelerate in Switzerland since the Swiss Hydrogen Association published its *Hydrogen Report Switzerland: 2016–2017* last autumn [*October 2017, p11*]. H_2 Energy recently partnered with Empa and the Paul Scherrer Institute to further develop fuel cell technology and prepare for market entry [*August 2018, p14*], and has just joined with South Korean automaker Hyundai to deploy 1000 fuel cell trucks in Switzerland by 2023 [*see page 3*].

Hyundai unveils fuel cell truck design, plans first truck fleet with H_2 Energy in Switzerland

Hyundai Motor Company presented the first image of a new fuel cell powered truck, which will be launched in 2019, at the recent IAA Commercial Vehicles 2018 show in Hannover, Germany [*see also page 4 and page 12*]. The South Korean automaker subsequently announced a partnership with H_2 Energy to deploy 1000 fuel cell trucks in Switzerland by 2023.

Hyundai's **fuel cell electric truck** builds on the company's automotive fuel cell technology leadership with the Tucson/ix35 Fuel Cell [*FCB, March 2013, p2*] and NEXO passenger cars [*January 2018, p2*]. The truck has a distinctive design to set it apart from the rest of the Hyundai commercial vehicle line-up.

Hyundai subsequently announced at the IAA a Memorandum of Understanding with the Swiss hydrogen company H_2 Energy (H_2E). Over a five-year period beginning in 2019, Hyundai Motor and H_2E will provide **1000 fuel cell heavy-duty trucks** to the commercial vehicle market in Switzerland, alongside a supply chain for renewable hydrogen refueling.

The deal marks Hyundai Motor's expansion of its leadership in fuel cell electric vehicles into the commercial vehicle sector. The 18 tonne (gross vehicle weight, 34 tonnes with trailer) fuel cell truck features a new 190 kW fuel cell powertrain comprising two 95 kW hydrogen fuel cell systems (from the NEXO) connected in parallel. This should give a range of about 400 km (250 miles) in real-life driving conditions, with eight hydrogen tanks installed in areas such as between the cabin and the rigid body, holding 33 kg of hydrogen at 350 bar.

Hyundai plans to diversify its fuel cell commercial vehicle line-up; a medium-sized fuel cell electric truck (payload 4–5 tonnes) is currently under development, which can be used for cleaning vehicles in the public services sector, for example. Hyundai also introduced fuel cell express buses at the 2018 Winter Olympics in Pyeongchang in February, and is currently conducting a pilot operation with fuel cell buses in major South Korean cities, while reviewing plans for mass production by 2020. FCEV taxis and car-sharing services are already operating in Ulsan and Gwangju.

H_2 Energy specialises in the production and supply of renewable hydrogen in Switzerland [*July 2016, p8*], with subsidiaries in Germany, Norway, and Austria. The company plans to make Hyundai's fuel cell electric trucks available to its Swiss customers, starting with members of the Swiss Hydrogen Association [*October 2017, p11*], which includes several filling station operators, retailers, and other customers for logistics and goods distribution. H_2E recently formed a Swiss public-private partnership with Empa and the Paul Scherrer Institute, to further develop fuel cell technology and prepare for market entry [*August 2018, p14*].

Hyundai Commercial Vehicle: http://trucknbus.hyundai.com/global

Hyundai NEXO: www.hyundai.com/worldwide/en/eco/nexo

H_2 Energy: www.h2energy.ch/en

Swiss Hydrogen Association: www.hydropole.ch

H_2 Mobility Switzerland Association: www.h2mobilitaet.ch/en

Hydrogenics fuel cells for heavy-duty trucks in California project

Canadian-based Hydrogenics will supply six heavy-duty PEM fuel cell power modules to GTI and TransPower for a set of Class 8 Navistar drayage trucks scheduled to be deployed in southern California early next year. The trucks are part of the California Climate Investments programme [*see also next item*] of the California Air Resources Board, to enable the acceleration of low-carbon technology in commercial trucking applications.

The Fast Track Fuel Cell Truck Project is being managed by Illinois-based GTI (Gas Technology Institute), with Navistar the chassis provider, California-based TransPower the vehicle integrator, and Total Transportation Services Inc (TTSI) as the operator [*see also next item*]. Hydrogenics expects to ship the fuel cells in Q4 of 2018.

'GTI and TransPower both have extensive experience and knowledge in fuel cell integration, and this project provides an ideal opportunity to build on our recent success in deploying one of the world's first fully functional fuel cell trucks in southern California,' says Daryl Wilson, President and CEO of Hydrogenics [*see also page 11*]. The company's heavy-duty fuel cells are now in use in more than 30 freight and utility vehicles as well as seven different transport platforms, including Alstom's hydrogen-powered

EDITORIAL

20 years have passed since the *Fuel Cells Bulletin* was launched, so it seems an appropriate time to look back at the front pages and see how the sector has changed…

The very first issue in **October 1998** kicked off with an item on the GE Power Systems–Plug Power joint venture to market the latter's fuel cell systems for residential applications. Ultimately this didn't come to anything, but Plug Power has successfully targeted materials handling [*e.g. FCB, September 2018, p12, and see page 10 in this issue*], and is also now looking at on-road applications [*see page 14*]. The other lead story reported on Siemens delivering what was then the world's largest PEM fuel cell stack, for a submarine. Several of these vessels are in service with the German and other navies, although the most recent news from Siemens is a deal with PowerCell Sweden to develop smaller-scale fuel cell-based drive and power generation systems for marine applications [*September 2018, p4*].

Five years later, the **October 2003** issue highlighted a new Japanese joint venture between US-based solid oxide fuel cell developer Acumentrics and Sumitomo. This also seems to have disappeared, and Acumentrics' SOFC activities were spun off into Atrex Energy two years ago [*October 2016, p7*]. The other lead story is more encouraging, reporting on German-based SFC Smart Fuel Cell and recreational vehicle builder Hymer launching the world's first fuel cell system available to end-users. SFC is very successful [*see pages 6 and 8*], and has sold more than 41 000 direct methanol fuel cells for a variety of applications.

In **October 2008** we led on the DLR German Aerospace Center's Antares DLR-H2 motor glider airplane, utilising a high-temperature PEM fuel cell from BASF Fuel Cell. DLR is still studying the use of fuel cells in aviation [*e.g. May 2018, p5*], but in 2013 BASF refocused on catalysts and adsorbents for fuel cells, quitting its membrane-electrode assembly business [*August 2013, p1*].

Looking back at **October 2013**, Logan Energy completed installation of the UK's largest fuel cell system at the Quadrant 3 redevelopment project in central London, featuring a 300 kW molten carbonate fuel cell from US-based FuelCell Energy. Logan is still busy [*e.g. July 2017, p11, and March 2018, p10*], as is FCE [*e.g. September 2018, p5*]. We also reported on CenturyLink installing Bloom Energy SOFCs at one of its California data centres; Bloom is now making rapid progress, including the launch of a new Bloom Energy Server-based solution utilising waste biogas [*see page 8*].

Steve Barrett

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

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

FPT Industrial: www.fptindustrial.com

MOBILE APPLICATIONS

Revolve unveils van range-extender with Bramble PCB fuel cell

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

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

This is the first time that a PCB-based fuel cell has been developed for use in an automotive environment. Compared with conventional systems, the PCBFC stack offers dramatically reduced system costs, while delivering reduced weight for a given power output and providing a more flexible form-factor. With the PCBFC fitted, an additional range of around 80 miles (130 km) can be expected on the NEDC (New European Driving Cycle) with 1.7 kg of hydrogen on board; the range can be further extended simply by fitting additional hydrogen storage capacity.

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

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

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

Revolve Technologies: www.revolve.co.uk

Bramble Energy: www.brambleenergy.com

WATT fulfills first Imperium order for Hymer North America

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

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

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

IN BRIEF

HTEC launches equity crowdfunding to support Canada hydrogen station rollout

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

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

IRENA on hydrogen in energy transition

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

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

Swiss H_2 Mobility association is growing

The H_2 Mobility Switzerland Association (www.h2mobilitaet.ch/en), which was founded in May [*FCB, June 2018, p5*], has welcomed its newest member, filling station operator SOCAR Energy Switzerland (www.socarenergy.ch/en), providing additional support to promote and accelerate the establishment of hydrogen mobility in Switzerland.

Things are starting to accelerate in Switzerland since the Swiss Hydrogen Association published its *Hydrogen Report Switzerland: 2016–2017* last autumn [*October 2017, p11*]. H_2 Energy recently partnered with Empa and the Paul Scherrer Institute to further develop fuel cell technology and prepare for market entry [*August 2018, p14*], and has just joined with South Korean automaker Hyundai to deploy 1000 fuel cell trucks in Switzerland by 2023 [*see page 3*].

technologies, recently welcomed an additional 14 members, in a second major wave of growth this year.

The Hydrogen Council was launched at the World Economic Forum Annual Meeting in Davos, Switzerland in January 2017, as the first CEO-led initiative to foster the role of hydrogen technologies in the global energy transition [*FCB, January 2017, p1*]. Earlier this year it welcomed 11 new members representing leading international oil & gas, energy, science & technology and automotive companies from Asia, North America and Europe [*April 2018, p13*]. The Council is led by two co-chairs from different geographies and sectors – currently Benoît Potier, Chairman and CEO of Air Liquide, and Dr Woong-chul Yang, Vice Chairman of Hyundai Motor Company.

Eight companies have now been added at steering member level: Airbus, Air Products, Cummins, EDF (Électricité de France), Johnson Matthey, KOGAS (Korea Gas Corporation), SINOPEC (China Petroleum & Chemical Corporation), and thyssenkrupp in Germany. These are accompanied by six new members at supporting level: AFC Energy, Mitsubishi Heavy Industries (MHI), Re-Fire Technology in China, Sumitomo Mitsui Banking Corporation, Sumitomo Corporation, and Southern California Gas. In addition, Faurecia has upgraded its membership to steering level.

The Hydrogen Council has also published a new discussion paper, *Hydrogen meets digital: New opportunities for the energy and mobility system*, which seeks to investigate the impact of digitisation on energy demand and establish a dialogue with the ICT (information and communications technology) sector on how digitisation and hydrogen could complement each other's impact during the energy transition. To this end, it explores four specific promising use cases: autonomous taxis and shuttles, digitally enabled freight chains, VTOL (vertical take-off and landing) taxis, and data centres.

This joins two previous studies, *How hydrogen empowers the energy transition* (January 2017), which explored the role of hydrogen in the energy transition, including its potential, recent achievements, and challenges to its deployment; and *Hydrogen, scaling up*, which presented the first comprehensive vision of the long-term potential of hydrogen and a roadmap for deployment [*November 2017, p1*].

Hydrogen Council: www.hydrogencouncil.com

Hydrogen Meets Digital discussion paper [PDF]: https://tinyurl.com/h2-meets-digital

RESEARCH

GenCell, AETC win R&D grant to develop ammonia cracking

Israeli alkaline fuel cell system manufacturer GenCell Energy and American Energy Technologies Company (AETC) in Chicago have been awarded a multi-year grant by the Israel-US Binational Industrial Research and Development (BIRD) Foundation, to develop a low-temperature catalyst for cracking ammonia (NH_3) into nitrogen and hydrogen. The $1.7 million grant is funded by the US Department of Energy, Israeli Ministry of Energy, and Israel Innovation Authority.

The unique catalyst is used by the GenCell A5 Off-Grid Power Solution to create hydrogen-on-demand from ammonia, the world's second most-produced industrial chemical [*FCB, July 2018, p5*]. Ammonia is readily available and less expensive than diesel in many countries. The use of ammonia allows the GenCell A5 solution to provide cost-effective, ultra-reliable, silent and weather-independent power for off-grid and poor-grid telecom base stations at a lower operational expenditure (OPEX) cost than diesel generators.

The traditional process of dissociating ammonia into nitrogen and hydrogen gases is carried out at temperatures that often exceed 700°C, which necessitates the use of expensive metal alloys and high-nickel steel components. The requirements for high energy input and costly components thus make traditional ammonia cracking an expensive process. AETC's new nanomaterial-based catalyst allows the endothermic process to occur at less than 500°C, making ammonia cracking more cost-effective.

The BIRD Foundation promotes collaboration between US and Israeli companies in various technological fields for the purpose of joint product development. In addition to providing grants for approved projects, it works with companies to identify potential strategic partners and facilitate introductions.

GenCell Energy: www.gencellenergy.com

American Energy Technologies Company: www.usaenergytech.com

BIRD Energy: www.birdf.com/what-is-bird-energy

IN BRIEF

Manchester Fuel Cell Innovation Centre opens to accelerate fuel cell technology

The Manchester Fuel Cell Innovation Centre (www.mmu.ac.uk/mfcic), a £4.1 million (US$5.3 million) dedicated facility at Manchester Metropolitan University in the UK, was officially opened at the end of September. MFCIC researchers will share their expertise and specialist equipment with small and medium-sized enterprises (SMEs) across Greater Manchester. The centre was partly funded with £1.6 million ($2.1 million) from the European Regional Development Fund, and by Manchester Metropolitan [*FCB, December 2016, p13*].

MFCIC will produce advanced materials for fuel cells and next-generation energy storage, and help to plan hydrogen and fuel cell infrastructure for the region. Anticipated work for SMEs includes rapid prototyping of new designs to increase efficiency and reduce cost. Much of the work is already taking place at Manchester Metropolitan, such as screen-printing of electrolyser electrodes using 2D nanotechnology [*September 2018, p10*]. MFCIC researchers will also educate the next generation about hydrogen power through the HySchools project [*September 2017, p10*].

Hydrogen buses in Malaysia by March

Malaysia expects to see the first hydrogen fuel cell buses on the roads of Kuching, the Sarawak state capital, by March 2019. Three buses will be deployed, according to *TheBorneoPost.com*, following the signing of a Memorandum of Understanding between Sarawak Economic Development Corporation and Chinese electric bus manufacturer Foshan Feichi Automobile Manufacturing Co Ltd to supply and deliver the buses. Foshan Feichi previously collaborated with Ballard Power Systems to build a fleet of 33 fuel cell buses for the Chinese city of Yunfu [*November 2015, p3*], and 12 fuel cell buses in Foshan, Guangdong Province [*October 2016, p2*]. Sarawak Energy is constructing a hydrogen production plant and refueling station [*September 2018, p8*].

MissionH24 plans for hydrogen racing cars to take start at Le Mans in 2024

The MissionH24 programme, created by ACO (www.lemans.org/en) in France in collaboration with Swiss company GreenGT (www.greengt.com/en), aims to see hydrogen racing cars take the start at the 24 Hours of Le Mans in 2024.

MissionH24 was launched at the Spa-Francorchamps circuit in Belgium, where spectators watched the GreenGT LMPH2G – the latest iteration of the company's hydrogen racing car [*FCB, April 2016, p3*] – do laps and refuel in the pit lane.

Patents

Ribbed bipolar plates to limit reactants bypassing flow channels in PEMFCs

Assignee: **CEA, France**
Inventors: J.-P. Poirot-Crouvezier et al.
Patent number: US 10050287
Published: 14 Aug. 2018 (Filed: 15 Nov. 2016)

Detecting and validating leaks in automotive PEMFC systems, in particular in anode subsystems

Assignee: **General Motors, USA**
Inventors: S.D. Pace et al.
Patent number: US 10050288
Published: 14 Aug. 2018 (Filed: 5 Jan. 2015)

Gas and condensed water discharge system for automotive (PEM) fuel cell system, control method

Assignees: **Hyundai Motor Company, Korea** *and* **Kia Motors Corporation, Korea**
Inventors: H. Shim et al.
Patent number: US 10050289
Published: 14 Aug. 2018 (Filed: 16 Aug. 2017)

Control method for automotive PEMFC system, to prevent oversupply of oxidant to cathode and avoid drying out of membrane

Assignee: **Honda Motor Co, Japan**
Inventors: N. Koiwa et al.
Patent number: US 10050292
Published: 14 Aug. 2018 (Filed: 23 Jan. 2017)

Method for operating SOFC system, and estimating fuel composition supplied to reformer, for improved durability

Assignee: **Panasonic, Japan**
Inventors: T. Maruyama et al.
Patent number: US 10050293
Published: 14 Aug. 2018 (Filed: 27 Oct. 2015)

PEM with mixed layer including ion-migration region and 3D network support, for excellent durability in PEMFC MEA

Assignee: **LG Chem, Korea**
Inventors: Y.S. Park et al.
Patent number: US 10050294
Published: 14 Aug. 2018 (Filed: 29 Apr. 2014)

Solid electrolyte laminate with LSC cathode layer and Ni-BZY anode layer, for IT-SOFC

Assignees: **Sumitomo Electric Industries, Japan** *and* **Kyoto University, Japan**
Inventors: C. Hiraiwa et al.
Patent number: US 10050295
Published: 14 Aug. 2018 (Filed: 26 Mar. 2013)

SOFC hermetic high-temperature dielectric conduit assemblies

Assignee: **Bloom Energy, USA**
Inventors: J. Huynh et al.
Patent number: US 10050298
Published: 14 Aug. 2018 (Filed: 29 May 2015)

Accurate automotive PEMFC stack state diagnosis based on control logic between control devices

Assignee: **Hyundai Motor Company, Korea**
Inventors: S.J. Chung et al.
Patent number: US 10052968
Published: 21 Aug. 2018 (Filed: 6 Feb. 2015)

Poly(phenylene)-based anion-exchange polymers with resonance-stabilised cationic moieties, higher AEMFC stability under high pH

Assignees: **National Technology & Engineering Solutions of Sandia LLC, USA [Sandia National Labs]** *and* **Los Alamos National Security LLC, USA [Los Alamos National Lab]**
Inventors: Y.S. Kim et al.
Patent number: US 10053535
Published: 21 Aug. 2018 (Filed: 4 Jan. 2017)

PEMFC separator with recess to prevent excessive load applied when tightening stack components

Assignee: **Honda Motor Co, Japan**
Inventors: S. Sugiura et al.
Patent number: US 10056619
Published: 21 Aug. 2018 (Filed: 26 Oct. 2012)

SOFC cathode comprising LSCF with perovskite structure for suppressed deterioration

Assignee: **NGK Insulators Ltd, Japan**
Inventors: M. Ohmori et al.
Patent number: US 10056620
Published: 21 Aug. 2018 (Filed: 13 June 2014)

Single/double perovskite structure for SOFC electrode in W-doped BSCF, to resist leaching of dopants

Assignee: **Ceres Power, UK**
Inventors: W. Xu et al.
Patent number: US 10056621
Published: 21 Aug. 2018 (Filed: 24 Dec. 2014)

Sealing of solid oxide cell stacks, sealing layers over flow-field plate and gasket to minimise corrosion

Assignee: **Elcogen, Finland**
Inventors: M. Noponen et al.
Patent number: US 10056624
Published: 21 Aug. 2018 (Filed: 17 Jan. 2017)

Fluid manifold attached by interface to fuel storage for micro fuel cell system

Assignee: **Intelligent Energy, UK**
Inventors: J. Schrooten et al. [Angstrom Power, Canada and Bic, Canada]
Patent number: US 10056625
Published: 21 Aug. 2018 (Filed: 20 Oct. 2015)

Non-invasive measurement method to control PEM or DMFC function

Assignee: **CEA, France**
Inventors: J. Bigarre et al.
Patent number: US 10056627
Published: 21 Aug. 2018 (Filed: 27 Jan. 2016)

Control method for rapid FCEV startup in cold conditions, by adjusting fuel cell voltage to lowest level allowed by system

Assignees: **Hyundai Motor Company, Korea** *and* **Kia Motors Corporation, Korea**
Inventors: D.J. Kim et al.
Patent number: US 10056628
Published: 21 Aug. 2018 (Filed: 17 Oct. 2016)

Method for adjusting PEMFC system output by comparing air flow rates, for stable FCEV driving

Assignee: **Hyundai Motor Company, Korea**
Inventor: H.S. Kim
Patent number: US 10056629
Published: 21 Aug. 2018 (Filed: 15 June 2016)

High-efficiency operation of vehicular fuel cell systems, improved service life

Assignee: **General Electric, USA**

Inventors: R.D. King et al.
Patent number: US 10056630
Published: 21 Aug. 2018 (Filed: 28 Sep. 2015)

Non-catalytic hydrogen generation process for supply to hydrodesulfurisation unit, and SOFC system combination for APU

Assignee: **Saudi Arabian Oil Company, Saudi Arabia**
Inventors: T.V. Pham et al.
Patent number: US 10056631
Published: 21 Aug. 2018 (Filed: 12 Oct. 2012)

Performance recovery method for automotive PEMFC stack in situ, removing oxide on cathode catalyst surface

Assignee: **Hyundai Motor Company, Korea**
Inventors: H.S. Choo et al.
Patent number: US 10056633
Published: 21 Aug. 2018 (Filed: 27 Dec. 2013)

Vacuum systems and methods for fuel desulfurisation without absorbent, aircraft PEMFC system

Assignee: **Honeywell International, USA**
Inventors: D. Zheng et al.
Patent number: US 10056634
Published: 21 Aug. 2018 (Filed: 10 June 2015)

Enhanced electrochemical oxidation of carbonaceous deposits in liquid hydrocarbon fueled SOFC

Assignee: **Saudi Arabian Oil Company, Saudi Arabia**
Inventors: A.D. Hammad et al.
Patent number: US 10056635
Published: 21 Aug. 2018 (Filed: 17 Feb. 2015)

PEMFC with modular base active area that allows scaling up or down of total active area

Assignee: **Nuvera Fuel Cells, USA**
Inventors: F. Gambini et al.
Patent number: US 10056637
Published: 21 Aug. 2018 (Filed: 29 Jan. 2014)

Polymers comprising phosphonium cations (e.g. 9MeTPP$_Q$), for hydroxide-exchange electrolyte membranes in water electrolysers or hydrogen fuel cells

Assignee: **University of Delaware, USA**
Inventors: Y. Yan et al.
Patent number: US 10056638
Published: 21 Aug. 2018 (Filed: 21 July 2015)

PEMFC bipolar plate in which connecting seams do not intersect or overlap with seals

Assignee: **Volkswagen, Germany**
Inventors: C. Zillich et al.
Patent number: US 10056640
Published: 21 Aug. 2018 (Filed: 10 Mar. 2014)

Thin-film cathode with triple-conducting perovskite structure of BCZYYb, for IT-SOFCs or protonic ceramic fuel cells

Assignee: **Colorado School of Mines, USA**
Inventors: J. Tong et al.
Patent number: US 10059584
Published: 28 Aug. 2018 (Filed: 16 June 2016)

SOFC with GDC/metal oxide reaction prevention layer for improved cell durability, reliability

Assignee: **POSCO, Korea**
Inventors: B.-G. Seong et al.
Patent number: US 10062908
Published: 28 Aug. 2018 (Filed: 21 Oct. 2016)

Nickelate composite electrode for SOFC with improved durability, co-doped ceria cathode barrier layer to manage material diffusion

Assignee: **LG Fuel Cell Systems, USA**
Inventors: Z. Liu et al.
Patent number: US 10062909
Published: 28 Aug. 2018 (Filed: 28 Oct. 2016)

Monolithic multilayer Fuel Cell Stick™ SOFC with layers linked internally to increase output voltage, e.g. for micro UAVs or military portable power

Applicants/Inventors: **A. Devoe** *and* **L. Devoe, USA**
Patent number: US 10062911
Published: 28 Aug. 2018 (Filed: 16 June 2015)

Thin bipolar plate for PEMFC or electrolyser, for improved local flow of reactant gases

Assignee: **CEA, France**
Inventors: J.-P. Poirot-Crouvezier et al.
Patent number: US 10062912
Published: 28 Aug. 2018 (Filed: 23 Mar. 2017)

PEMFC components, cylindrical or hexagonal stacks, and modular fuel cells with high power density

Assignee: **Loop Energy, Canada**
Inventors: D.E. Leger et al.
Patent number: US 10062913
Published: 28 Aug. 2018 (Filed: 13 Feb. 2015)

Preventing moisture condensation in automotive PEMFC system

Assignee: **Hyundai Motor Company, Korea**
Inventors: J.H. Yu et al.
Patent number: US 10062914
Published: 28 Aug. 2018 (Filed: 30 Mar. 2015)

PEMFC or electrolyser with device to measure relevant gas parameters, for monitoring and control

Assignee: **Michelin, France**
Inventor: G. Paganelli
Patent number: US 10062915
Published: 28 Aug. 2018 (Filed: 24 Sep. 2010)

Automotive PEMFC control system and method, detecting stack voltage when power generation is stopped, adjusting anode hydrogen pressure

Assignee: **Hyundai Motor Company, Korea**
Inventors: S.U. Kwon et al.
Patent number: US 10062916
Published: 28 Aug. 2018 (Filed: 12 June 2015)

Plasma reactor apparatus for efficient hydrogen generation from ammonia, use with fuel cell system

Assignees: **Gifu University, Japan, Sawafuji Electric Co Ltd, Japan** *and* **Actree Corporation, Japan**
Inventors: S. Kambara et al.
Patent number: US 10065170
Published: 4 Sep. 2018 (Filed: 1 Oct. 2013)

Method and apparatus to control output of automotive PEMFC, for enhanced efficiency

Assignee: **Hyundai Motor Company, Korea**
Inventors: S.H. Lee et al.
Patent number: US 10065524
Published: 4 Sep. 2018 (Filed: 26 Apr. 2016)

Polymeric ion-conductor materials for use in fuel cells, with improved thermal characteristics

Applicants/Inventors: **J.L. Katz** *and* **R.H. Hudson, USA**
Patent number: US 10066068
Published: 4 Sep. 2018 (Filed: 7 July 2016)

Selectively conducting PEMFC anode for reduced degradation from repeated startup/shutdown, better cell tolerance to voltage reversal

Assignees: **Daimler, Germany** *and* **Ford Motor Company, USA**
Inventors: F. Berretta et al.
Patent number: US 10069148
Published: 4 Sep. 2018 (Filed: 28 Apr. 2015)

MCFC bipolar separator assembly, fabricated without manual manipulation and installation of corrugated current collectors into areas under wet seal pockets

Assignee: **FuelCell Energy, USA**
Inventors: W. Morris et al.
Patent number: US 10069149
Published: 4 Sep. 2018 (Filed: 29 Feb. 2016)

Alternative path cooling in SOFC onboard aircraft, recovering energy from discharged coolant in turbine to drive compressor or generator

Assignee: **Boeing, USA**
Inventors: M.E. Mata et al.
Patent number: US 10069150
Published: 4 Sep. 2018 (Filed: 27 Apr. 2015)

Demineraliser for automotive PEMFC system, improves leakage of ion resin and flow rate distribution of cooling water

Assignees: **Hyundai Motor Company, Korea** *and* **Kia Motors Corporation, Korea**
Inventors: S.W. Na et al.
Patent number: US 10069151
Published: 4 Sep. 2018 (Filed: 5 Nov. 2015)

Accurate inspection of pressure loss state during SOFC operation

Assignee: **Honda Motor Co, Japan**
Inventor: Y. Yoshimine
Patent number: US 10069152
Published: 4 Sep. 2018 (Filed: 3 Mar. 2011)

Control method for PEM or DMFC system, for stable electric power output adapted to different operating environments

Assignee: **Young Green Energy Co, Taiwan**
Inventors: D.-S. Ju et al.
Patent number: US 10069153
Published: 4 Sep. 2018 (Filed: 30 Aug. 2016)

Compact, high-efficiency air feed device for automotive fuel cell system, with recovery of waste air and/or waste heat

Assignee: **BorgWarner Inc, USA**
Inventors: D. Metz et al.
Patent number: US 10069154
Published: 4 Sep. 2018 (Filed: 17 Aug. 2012)

Process control for integrated hydrogen storage in reversible SOFC energy storage system for remote locations, to mitigate explosion risk from air ingress

Assignee: **Boeing, USA**
Inventor: J.M. Mermelstein
Patent number: US 10069155
Published: 4 Sep. 2018 (Filed: 24 Aug. 2015)

Separator plate with micropore body structure and barrier ribs in reaction surfaces, for improved stack manufacturing productivity

Assignees: **Hyundai Motor Company, Korea** *and* **Kia Motors Corporation, Korea**
Inventors: S.M. Jin et al.
Patent number: US 10069156
Published: 4 Sep. 2018 (Filed: 24 Oct. 2015)

Automotive PEMFC system with valve module in air supply feed between stack and humidifier

Assignee: **Hyundai Motor Company, Korea**
Inventors: J.J. Lee et al.
Patent number: US 10069157
Published: 4 Sep. 2018 (Filed: 30 Nov. 2015)

Control method for automotive PEMFC system, to dilute unreacted hydrogen using bypass valve between bypass passage, stack inlet

Assignee: **Hyundai Motor Company, Korea**
Inventors: S.U. Kwon et al.
Patent number: US 10069158
Published: 4 Sep. 2018 (Filed: 6 May 2015)

Control of automotive PEMFC system to rapidly increase power output despite drop in cell humidity

Assignee: **Toyota Motor Corporation, Japan**
Inventors: S. Kawahara et al.
Patent number: US 10069159
Published: 4 Sep. 2018 (Filed: 4 Nov. 2014)

Stack voltage control for recovery mode using boost converter in automotive fuel cell system

Assignee: **General Motors, USA**
Inventors: J. Berg et al.
Patent number: US 10069160
Published: 4 Sep. 2018 (Filed: 27 July 2016)

SOFC with uniform fuel gas pressure distribution in buffer chamber, for uniform gas diffusion in power generation region

Assignee: **NGK Spark Plug Co Ltd, Japan**
Inventors: D. Komatsu et al.
Patent number: US 10069162
Published: 4 Sep. 2018 (Filed: 5 Feb. 2014)

SOFC with middle layer between separator and cathode to suppress diffusion of constitutional elements, maintaining efficiency

Assignee: **Murata Manufacturing Co, Japan**
Inventor: K. Takata
Patent number: US 10069163
Published: 4 Sep. 2018 (Filed: 2 Feb. 2015)

Control method for external electric power supply mounted on vehicle

Assignee: **Toyota Motor Corporation, Japan**
Inventors: Y. Matsubara et al.
Patent number: US 10071649
Published: 11 Sep. 2018 (Filed: 12 Nov. 2015)

Method to prevent hydrogen entering FCEV cabin, switching air-conditioning system to internal air circulation mode if hydrogen is detected in fuel cell space

Assignee: **Toyota Motor Corporation, Japan**
Inventor: H. Saito

Patent number: US 10071650
Published: 11 Sep. 2018 (Filed: 27 Oct. 2015)

Integrated electrochemical compressor and cascade fuel storage, to maintain pressure within hydrogen refueling station

Assignee: **Nuvera Fuel Cells, USA**
Inventors: A. Prescott et al.
Patent number: US 10072342
Published: 11 Sep. 2018 (Filed: 27 Aug. 2014)

Hydrogen filling method for FCEV, sequentially using low-, medium- and high-pressure storage tanks to completely and quickly fill vehicle

Assignee: **Hyundai Motor Company, Korea**
Inventor: Y.W. Jung
Patent number: US 10072799
Published: 11 Sep. 2018 (Filed: 14 Sep. 2016)

Ti or Ti alloy material for automotive PEMFC separator with high contact conductivity with carbon, and enhanced durability

Assignee: **Nippon Steel & Sumitomo Metal Corporation, Japan**
Inventors: H. Kihira et al.
Patent number: US 10074857
Published: 11 Sep. 2018 (Filed: 30 July 2013)

Controlling reactant gas supply to suppress flooding, concentration polarisation in PEMFC separator

Assignee: **Doosan Corporation, Korea**
Inventors: S.-J. Oh et al.
Patent number: US 10074858
Published: 11 Sep. 2018 (Filed: 11 Mar. 2016)

Manufacturing process for catalyst-coated membrane-seal assembly for PEMFC or electrolyser, without high-temperature/high-pressure lamination

Assignee: **Johnson Matthey Fuel Cells, UK**
Inventors: D.E. Barnwell et al.
Patent number: US 10074860
Published: 11 Sep. 2018 (Filed: 24 Mar. 2015)

Self-heating PEMFC systems, using changes in internal electrical resistance to allow rapid heating-up

Assignee: **EC Power LLC, USA**
Inventor: C.-Y. Wang [Penn State University]
Patent number: US 10074861
Published: 11 Sep. 2018 (Filed: 21 Jan. 2016)

Higher energy density, hydrogen-generating compositions including hydride and Lewis acid

Assignee: **Intelligent Energy, UK**
Inventors: S.J. Eickhoff et al. [Honeywell International, USA]
Patent number: US 10074862
Published: 11 Sep. 2018 (Filed: 19 Apr. 2016)

Reliable variable pressure control of automotive (PEM) fuel cell system, preventing performance deterioration and malfunction

Assignees: **Hyundai Motor Company, Korea** *and* **Kia Motors Corporation, Korea**
Inventors: S.U. Kwon et al.
Patent number: US 10074863
Published: 11 Sep. 2018 (Filed: 24 Aug. 2015)

Multiple gas inlets or outlets for solid oxide cell (SOFC or SOEC), using stacked layers with cutouts for overlapping gas channels

Assignee: **Haldor Topsoe A/S, Denmark**
Inventors: T. Heiredal-Clausen et al.
Patent number: US 10074864
Published: 11 Sep. 2018 (Filed: 2 May 2013)

Automotive PEMFC system control method, to inhibit decrease in pump starting properties in low-temperature environment

Assignee: **Toyota Motor Corporation, Japan**
Inventors: M. Toida et al.
Patent number: US 10074865
Published: 11 Sep. 2018 (Filed: 12 Nov. 2015)

PEMFC MEA with suppressed reduction in power output due to gas crossover, improved durability

Assignee: **Panasonic, Japan**
Inventors: S. Kikuzumi et al.
Patent number: US 10074866
Published: 11 Sep. 2018 (Filed: 3 June 2013)

Automotive PEMFC stack with simple and secure attachment and detachment via boss and bracket

Assignee: **Honda Motor Co, Japan**
Inventors: Y. Nara et al.
Patent number: US 10074868
Published: 11 Sep. 2018 (Filed: 7 Mar. 2017)

PEMFC with intermediate layer between PEM and GDL, to prevent stress concentration under repeated PEM swelling and contraction in start/stop operation

Assignee: **Honda Motor Co, Japan**
Inventors: M. Sakano et al.
Patent number: US 10074869
Published: 11 Sep. 2018 (Filed: 3 Dec. 2013)

Vehicle electrical system assembly and operating method for FCEV

Assignee: **Volkswagen, Germany**
Inventors: M. Duvel et al.
Patent number: US 10076972
Published: 18 Sep. 2018 (Filed: 29 June 2015)

Distributed compressed hydrogen refueling cascade method and system, for hydrogen dispenser

Assignee: **Nuvera Fuel Cells, USA**
Inventor: S. Blanchet
Patent number: US 10077871
Published: 18 Sep. 2018 (Filed: 30 May 2014)

EVENTS CALENDAR

4–7 November 2018
7th Baltic Electrochemistry Conference: Finding New Inspiration, BEChem 2018
Tartu, Estonia
More information: http://bechem2018.ut.ee

6–8 November 2018
Energy Storage North America Conference & Expo
Pasadena, California, USA
More information: www.esnaexpo.com

8–9 November 2018
The IV Energy & Materials Research Conference, EMR2018
Torremolinos-Malaga, Spain
More information: www.emrconference.org

14–16 November 2018
FCH JU Stakeholder Forum & Programme Review Days 2018
Brussels, Belgium
More information: https://tinyurl.com/fchju-2018

19–20 November 2018
LEVS 2018, Light Electric Vehicle Summit
Lisbon, Portugal
More information: www.levs.mobi

22 November 2018
Hydrogen & Fuel Cell Showcase
University of Nottingham, UK
More information: www.climate-change-solutions.co.uk/events/hydrogen-and-fuel-cell-showcase-hfcshowcase18

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

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

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

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

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

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

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

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

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

5–8 May 2019
Sixth International Symposium Frontiers in Polymer Science
Budapest, Hungary
More information: www.elsevier.com/events/conferences/frontiers-in-polymer-science
Abstract deadline: 11 January 2019

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

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

27–30 May 2019
7th Regional Symposium on Electrochemistry for South-East Europe, RSE SEE 7
Split, Croatia
More information: www.aseee.eu/index.php/rse-see7-home
Abstract deadline: 20 February 2019

2–7 June 2019
11th International Symposium on Electrochemical Impedance Spectroscopy, EIS 2019
Lège-Cap-Ferret, France
More information: www.eis2019.org
Abstract deadline: 31 January 2019

13–14 June 2019
5th International Symposium on Hydrogen Energy, Renewable Energy & Materials, HEREM 2019
Bangkok, Thailand
More information: www.herem.org
Paper submission deadline: 28 February 2019

16–20 June 2019
6th Nano Today Conference (including Nanomaterials for Energy and Environmental Applications)
Lisbon, Portugal
More information: www.elsevier.com/events/conferences/nano-today-conference
Abstract deadline: 18 December 2018

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

22–24 July 2019
International Congress on Advanced Materials Sciences and Engineering 2019, AMSE-2019
Osaka, Japan
More information: www.istci.org/ICAMSE2019
Abstract deadline: 31 May 2019

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

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

FPT Industrial: www.fptindustrial.com

MOBILE APPLICATIONS

Revolve unveils van range-extender with Bramble PCB fuel cell

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

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

This is the first time that a PCB-based fuel cell has been developed for use in an automotive environment. Compared with conventional systems, the PCBFC stack offers dramatically reduced system costs, while delivering reduced weight for a given power output and providing a more flexible form-factor. With the PCBFC fitted, an additional range of around 80 miles (130 km) can be expected on the NEDC (New European Driving Cycle) with 1.7 kg of hydrogen on board; the range can be further extended simply by fitting additional hydrogen storage capacity.

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

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

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

Revolve Technologies: www.revolve.co.uk

Bramble Energy: www.brambleenergy.com

WATT fulfills first Imperium order for Hymer North America

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

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

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

IN BRIEF

HTEC launches equity crowdfunding to support Canada hydrogen station rollout

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

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

IRENA on hydrogen in energy transition

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

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

Swiss H_2 Mobility association is growing

The H_2 Mobility Switzerland Association (www.h2mobilitaet.ch/en), which was founded in May [*FCB, June 2018, p5*], has welcomed its newest member, filling station operator SOCAR Energy Switzerland (www.socarenergy.ch/en), providing additional support to promote and accelerate the establishment of hydrogen mobility in Switzerland.

Things are starting to accelerate in Switzerland since the Swiss Hydrogen Association published its *Hydrogen Report Switzerland: 2016–2017* last autumn [*October 2017, p11*]. H_2 Energy recently partnered with Empa and the Paul Scherrer Institute to further develop fuel cell technology and prepare for market entry [*August 2018, p14*], and has just joined with South Korean automaker Hyundai to deploy 1000 fuel cell trucks in Switzerland by 2023 [*see page 3*].

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EHGNA, as well as the fulfilment of orders received from other partners in the residential and rail markets, are expected to continue well into 2019. WATT supported EHGNA when it introduced the SOFC technology to its dealer network at the recent RV Suppliers & Vendors Exhibition in Elkhart, Indiana.

The Imperium SOFC hybrid power management system generates small-scale power (500 W to 1.5 kW) from readily available and easily accessible fuels (such as propane) and manages renewable energy sources such as solar. The system delivered to EHGNA will utilise a hybrid power manager to integrate the fuel cell with solar generation while optimising onboard energy storage. The Imperium recently passed ETL certification for compliance to North American safety standards, for operation with both propane and methane [*June 2018, p11*].

WATT Fuel Cell Corporation: www.wattfuelcell.com

Erwin Hymer Group North America: www.erwinhymergroupna.com

SFC, Oneberry unveil autonomous fuel cell powered security robot

Munich-based SFC Energy and its Singaporean partner Oneberry Technologies presented the Oneberry RoboGuard™ security robot, featuring an EFOY Pro direct methanol fuel cell, at the recent Security Essen trade fair in Germany. The robot incorporates multifunctional proactive security, surveillance, marketing, and administrative functions.

The Oneberry RoboGuard – launched a year ago [*FCB, September 2017, p6*] – is intended for non-mobile, mobile, and vehicle-based use in events and infrastructure monitoring, retail and shopping centre security surveillance, exhibition and conference operations, border security, industrial and construction site surveillance and safety detection, safety of public spaces and danger areas.

SFC Energy's fully autonomous, silent and environmentally friendly EFOY Pro DMFC enables 24/7 uninterrupted off-grid operation of the robot, with extremely long power autonomy [*see the SFC feature in January 2013, and page 8 in this issue*]. This offers decisive advantages over conventional, battery-powered robots, which require hours of recharging between assigned tasks.

In addition to its fuel cell power supply, the Oneberry RoboGuard also offers a variety of applications customised to suit user-defined operations and tasks. For use in shopping centres, for example, the robot will also take over a broad range of information, marketing, and administrative functionalities.

SFC Energy: www.sfc.com/en

Oneberry Technologies: www.oneberry.com

Doosan sets foot in UAV fuel cell market

South Korean industrial conglomerate Doosan has entered the unmanned aerial vehicle (UAV) fuel cell market, revealing its in-house developed UAV fuel cell power pack at the recent InterDrone 2018 conference and exposition in Las Vegas, Nevada [*see also next item*]. The unit offers more than two hours of flight time on a single fueling.

Doosan established Doosan Mobility Innovation (DMI) in 2016 to lead the company's UAV fuel cell business, and has now successfully developed a hydrogen fuel cell power pack for drones with its own technology. The DP20 power pack has a rated power output of 2.1 kW while weighing just 6.3 kg (14 lb), including two 1800 mAh lithium polymer batteries. The 350 bar hydrogen tank is easily replaced, and offers more than 2 h of flight time, compared to 20–30 minutes for drones powered by battery technology.

After conducting a pilot project and demonstration test at home and abroad, Doosan plans to launch mass production of UAV fuel cell power packs in the first half of 2019, and will seek partnerships with firms in the drone industry in both South Korea and beyond.

Doosan has generally been associated with large-scale stationary fuel cell power plants, following its acquisition of ClearEdge Power (formerly UTC Power) in 2014 [*FCB, August 2014, p1*], with installations including the hydrogen-fueled 50 MW fuel cell power plant at the Daesan Green Energy Fuel Cell Power Plant in Korea [*August 2018, p1*]. But in 2014 it also acquired FuelCellPower, a leading Korean manufacturer of PEM fuel cells for residential use and small and mid-sized buildings [*July 2014, p5*].

Doosan, UAV Fuel Cell Power Pack: https://tinyurl.com/doosan-uav-fc

Intelligent Energy unveils 800 W fuel cell for commercial UAVs

UK-based Intelligent Energy launched its 800 W Fuel Cell Power Module (FCPM) for the commercial unmanned aerial vehicle (UAV) market at the recent InterDrone 2018 conference and exposition in Las Vegas, Nevada [*see also item above*]. Commercial UAV fleet operators will benefit from the increased flight time and payload capability provided by this latest lightweight product, facilitating access to new markets.

The new 800 W FCPM complements the company's 650 W product, which was launched at InterDrone 2017 [*FCB, October 2017, p4*]. The modules have been specifically designed for the commercial UAV market, to offer considerably longer flight time compared to traditional batteries. Key benefits of using PEM fuel cells to power UAVs include increased productivity, less downtime because of their fast refueling, and increased payload capability. The FCPMs can also be used for a wide range of other applications, such as portable power and robotics. The 800 W product will be CE and FCC certified and is now available to pre-order, with first shipments planned for January 2019.

The 800 W product is 10% more power dense than the 650 W FCPM, which means that UAV operators can carry around 1500 g more mass at the expense of only 100 g in unit weight. This can be used to carry a larger hydrogen cylinder (significantly increasing flight time), or to increase the payload capacity. Depending on the efficiency of other aircraft components, multicopters optimised around the 800 W FCPM could carry 1 kg (2.2 lb) for 2 h or 2 kg (4.4 lb) for 1 h, and fixed-wing aircraft show even greater gains. In addition, Intelligent Energy will work with customers who have the capability and knowhow to combine two 800 W modules, to provide 1.6 kW of continuous power.

Intelligent Energy is also working with Avid to commercialise and deploy fuel cell systems for the remote power products market in Australia, utilising its Fuel Cell Module 800 Series [*see page 7*].

Intelligent Energy: www.intelligent-energy.com/our-products/uavs

HES plans to launch autonomous hydrogen aviation in France

Singapore-based HES Energy Systems, which is developing high-performance hydrogen fuel cell propulsion systems for aerial platforms,

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Intelligent Energy: www.intelligent-energy.com/our-products/uavs

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The Imperium SOFC hybrid power management system generates small-scale power (500 W to 1.5 kW) from readily available and easily accessible fuels (such as propane) and manages renewable energy sources such as solar. The system delivered to EHGNA will utilise a hybrid power manager to integrate the fuel cell with solar generation while optimising onboard energy storage. The Imperium recently passed ETL certification for compliance to North American safety standards, for operation with both propane and methane [*June 2018, p11*].

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The Oneberry RoboGuard – launched a year ago [*FCB, September 2017, p6*] – is intended for non-mobile, mobile, and vehicle-based use in events and infrastructure monitoring, retail and shopping centre security surveillance, exhibition and conference operations, border security, industrial and construction site surveillance and safety detection, safety of public spaces and danger areas.

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HES's partnership will focus on creating infrastructure around smaller-scale hydrogen unmanned aircraft. The company then envisions scaling up the programme to create a continental network of hydrogen airbases for a fleet of autonomous, long-range hydrogen drones and aircraft, along with a French aerospace and hydrogen energy 'ecosystem'.

The move is part of HES's broader goals to introduce long-range, zero-emission aviation powered by renewable hydrogen. The company started introducing its range-extender propulsion technology to small drones several years ago, and is now evolving towards manned aerial platforms, such as flying cars and inter-urban electric aircraft.

HES has spent the last 10 years developing advanced ultralight hydrogen propulsion systems that are up to 10 times lighter than batteries, at its lab in Singapore. Following a number of international experiments powering small unmanned aircraft for record durations [*e.g. the News Feature in FCB, March 2016*], the company's systems are now being scaled up to power larger manned electric aircraft, potentially revolutionising aerial logistics and mobility by increasing flight range while eliminating carbon emissions.

HES is part of the growing France-Singapore innovation linkage. Last year its parent company H3 Dynamics opened its European headquarters in Paris [*July 2017, p13*]. As part of its setup in France, HES is partnering with leading unmanned aerial vehicle (UAV) builder Delair and ERGOSUP, a French startup developing energy-efficient, high-pressure electrolysers [*March 2018, p6*].

HES Energy Systems: www.hes.sg

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Delair: www.delair.aero

ERGOSUP: www.ergosup.com/en

SMALL STATIONARY

101 Telco Solutions offers fuel cell backup power from Altergy

California-based Altergy Systems has formalised its partnership with 101 Telco Solutions, a leading provider of high-end electronic equipment repair, distribution, and technical services. Altergy's PEM fuel cell backup power systems offer a more reliable, economical and 'green' solution to conventional generators and inefficient 'short-life' battery systems.

'We look forward to continued success working with the Altergy Systems team, and to adding value to our customers by offering a complete fuel cell solution inclusive of engineering, installation, and ongoing maintenance,' says Mike Fogelsonger, President and CEO of 101 Telco Solutions, based in Santa Barbara. 'The willingness to adopt this technology is evident throughout our customer base, including a national carrier who is seriously evaluating the deployment of several thousand units.'

'Our teams' combined experience in telecommunications will provide great value to the end-user by delivering the most modern and cost-effective solutions and services,' adds Eric Strayer, VP of Sales at Altergy Systems.

Altergy's PEM fuel cell design allows cost-effective manufacturing of Freedom Power™ products that are robust enough for industrial applications. The company's prime market is telecom backup power [*FCB, December 2015, p4 and November 2017, p4*], but it also addresses critical power needs in industries such as cable [*December 2010, p7*], public safety, and military and homeland security. Customers in the rail sector include backup power for the Union Pacific telecom facility in Stockton, California, serving railway switching, communications, and various other critical railway demands [*September 2011, p6*], and railroad operator CSX is using Altergy solutions for critical backup power at signal gate crossings [*June 2018, p2*].

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Intelligent Energy's zero-emission FCMs are a clean, quiet alternative to diesel generators, offering lower life cycle costs and minimal maintenance compared to traditional generators. This makes them an ideal solution for industries working to reduce their carbon footprint, improving the environment and local air quality for communities where they operate.

As well as integrating the FCMs into its off-grid power products for a range of applications, Avid will also be a point of contact for customers of Intelligent Energy's products in Australia. The two companies have signed a Memorandum of Understanding to this effect.

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Fraunhofer IMM to install PowerCell S2 stacks for CHP supply

PowerCell Sweden has delivered two S2 fuel cell stacks to the Fraunhofer Institute for Microengineering and Microsystems IMM in Germany. The stacks will be used for combined heat and power (CHP) in a new extension building in Mainz, where Fraunhofer is developing hydrogen reformer technology.

The PowerCell S2 stacks will be used to secure the power supply in a new laboratory extension in Mainz belonging to Fraunhofer IMM, which is being used for the development of chemical processes and reformer technology, i.e. for the conversion of various sorts of fuels into hydrogen. Since IMM is doing research on reformer technology, the laboratory has a strong interest in using and evaluating fuel cell technology in real-life applications. The delivered PowerCell S2 stacks have a total power output of 2 × 25 kW, and will be connected to Fraunhofer's proprietary reformer for heat and power generation from natural gas.

PowerCell Sweden – founded in 2008 as an industrial spinout from the Volvo Group [*see also page 13*] – develops and produces high energy density, modular PEM fuel cell stacks and systems for stationary and mobile applications, running on pure hydrogen or reformate. The company offers three stack platforms: S1 (1–5 kW), S2 (5–25 kW), and S3 (20–100 kW), for both stationary and mobile applications.

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HES's partnership will focus on creating infrastructure around smaller-scale hydrogen unmanned aircraft. The company then envisions scaling up the programme to create a continental network of hydrogen airbases for a fleet of autonomous, long-range hydrogen drones and aircraft, along with a French aerospace and hydrogen energy 'ecosystem'.

The move is part of HES's broader goals to introduce long-range, zero-emission aviation powered by renewable hydrogen. The company started introducing its range-extender propulsion technology to small drones several years ago, and is now evolving towards manned aerial platforms, such as flying cars and inter-urban electric aircraft.

HES has spent the last 10 years developing advanced ultralight hydrogen propulsion systems that are up to 10 times lighter than batteries, at its lab in Singapore. Following a number of international experiments powering small unmanned aircraft for record durations [*e.g. the News Feature in FCB, March 2016*], the company's systems are now being scaled up to power larger manned electric aircraft, potentially revolutionising aerial logistics and mobility by increasing flight range while eliminating carbon emissions.

HES is part of the growing France-Singapore innovation linkage. Last year its parent company H3 Dynamics opened its European headquarters in Paris [*July 2017, p13*]. As part of its setup in France, HES is partnering with leading unmanned aerial vehicle (UAV) builder Delair and ERGOSUP, a French startup developing energy-efficient, high-pressure electrolysers [*March 2018, p6*].

HES Energy Systems: www.hes.sg

H3 Dynamics: www.h3dynamics.com

Delair: www.delair.aero

ERGOSUP: www.ergosup.com/en

SMALL STATIONARY

101 Telco Solutions offers fuel cell backup power from Altergy

California-based Altergy Systems has formalised its partnership with 101 Telco Solutions, a leading provider of high-end electronic equipment repair, distribution, and technical services. Altergy's PEM fuel cell backup power systems offer a more reliable, economical and 'green' solution to conventional generators and inefficient 'short-life' battery systems.

'We look forward to continued success working with the Altergy Systems team, and to adding value to our customers by offering a complete fuel cell solution inclusive of engineering, installation, and ongoing maintenance,' says Mike Fogelsonger, President and CEO of 101 Telco Solutions, based in Santa Barbara. 'The willingness to adopt this technology is evident throughout our customer base, including a national carrier who is seriously evaluating the deployment of several thousand units.'

'Our teams' combined experience in telecommunications will provide great value to the end-user by delivering the most modern and cost-effective solutions and services,' adds Eric Strayer, VP of Sales at Altergy Systems.

Altergy's PEM fuel cell design allows cost-effective manufacturing of Freedom Power™ products that are robust enough for industrial applications. The company's prime market is telecom backup power [*FCB, December 2015, p4 and November 2017, p4*], but it also addresses critical power needs in industries such as cable [*December 2010, p7*], public safety, and military and homeland security. Customers in the rail sector include backup power for the Union Pacific telecom facility in Stockton, California, serving railway switching, communications, and various other critical railway demands [*September 2011, p6*], and railroad operator CSX is using Altergy solutions for critical backup power at signal gate crossings [*June 2018, p2*].

Altergy Systems: www.altergy.com

101 Telco Solutions: www.101telco.com

Avid EPG in Australia using IE fuel cells for remote power products

Australian energy solutions company Avid EPG Group is working with UK-based Intelligent Energy to commercialise and deploy fuel cell systems for the remote power products market in Australia.

Avid has initially integrated Intelligent Energy's Fuel Cell Module (FCM) 800 Series into four different stationary power applications. These products were showcased by Avid at the Renewable Hydrogen Energy Conference in Perth, Western Australia at the end of August. Intelligent Energy launched the FCM 800 Series of air-cooled PEM fuel cell modules last year, designed specifically for portable and stationary power applications [*FCB, July 2017, p10*].

Intelligent Energy's zero-emission FCMs are a clean, quiet alternative to diesel generators, offering lower life cycle costs and minimal maintenance compared to traditional generators. This makes them an ideal solution for industries working to reduce their carbon footprint, improving the environment and local air quality for communities where they operate.

As well as integrating the FCMs into its off-grid power products for a range of applications, Avid will also be a point of contact for customers of Intelligent Energy's products in Australia. The two companies have signed a Memorandum of Understanding to this effect.

Intelligent Energy is developing and commercialising its PEM fuel cell technologies for a range of markets including automotive [*September 2017, p3*], stationary power [*October 2017, p6*], and unmanned aerial vehicles (UAVs) [*see page 6*].

Intelligent Energy: www.intelligent-energy.com

Avid Group: www.avidgroup.net

Fraunhofer IMM to install PowerCell S2 stacks for CHP supply

PowerCell Sweden has delivered two S2 fuel cell stacks to the Fraunhofer Institute for Microengineering and Microsystems IMM in Germany. The stacks will be used for combined heat and power (CHP) in a new extension building in Mainz, where Fraunhofer is developing hydrogen reformer technology.

The PowerCell S2 stacks will be used to secure the power supply in a new laboratory extension in Mainz belonging to Fraunhofer IMM, which is being used for the development of chemical processes and reformer technology, i.e. for the conversion of various sorts of fuels into hydrogen. Since IMM is doing research on reformer technology, the laboratory has a strong interest in using and evaluating fuel cell technology in real-life applications. The delivered PowerCell S2 stacks have a total power output of 2 × 25 kW, and will be connected to Fraunhofer's proprietary reformer for heat and power generation from natural gas.

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Simark's EFOY Pro hybrid solutions are used to power the customer's SCADA instrumentation and electrical-chemical injection pumps at off-grid well-pads in the Montney and Duvernay Formations in Alberta and British Columbia, which are among the world's largest shale gas resources. Simark – a subsidiary of German hybrid power solutions provider SFC Energy [*FCB, August 2013, p8*] – customised the turnkey EFOY ProCabinet Hybrid solutions to easily integrate into the customer's existing communication and control infrastructure at the sites. The direct methanol fuel cell/solar hybrid power supply replaces conventional gas generators, cutting CO_2 equivalent emission reductions by more than 90% while ensuring power reliability and system autonomy.

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LARGE STATIONARY

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Bloom has demonstrated how a standard Bloom Energy Server integrated with a new biogas clean-up module can generate clean electricity from biogas emitted by landfill, agricultural, waste and water treatment processes. The prototype clean-up module will clean the biogas of moisture and contaminants, enabling its use in fuel cells while dramatically reducing methane emissions. Bloom expects to begin testing the new solution with customers shortly.

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METI selects Toshiba H2One project for Indonesia, Philippines

The Japanese Ministry of Economy, Trade and Industry (METI) is supporting a survey project by Toshiba Energy Systems & Solutions to develop applications for its H2One™ hydrogen-based autonomous energy supply system on isolated islands in Indonesia and the Philippines. The survey will help Toshiba ESS to help solve the countries' energy problems, while expanding the H2One business and building H2One supply chains.

Selection for the **METI initiative** will accelerate business considerations for solutions to energy-related challenges in Indonesia and the Philippines. In order to build H2One supply chains in both countries, Toshiba ESS will determine locations and optimal system specifications by 2019, for subsequent implementation.

Indonesia, which comprises more than 13 000 islands, has the challenge of supplying stable, low-cost energy for each island. Its 'RUPTL' power supply business plan aims to increase the total power generation capacity rate of renewables from 12.52% in 2017 to 23% by 2020. In the Philippines, half of the current energy supply comes from coal- and oil-fired thermal power. The country is reliant on importing these fuels, and increasingly sees renewable energy as an opportunity to improve energy self-sufficiency. It is therefore seeking solutions for isolated islands with low electrification rates, and ways to reduce risk from typhoons and other natural disasters.

Toshiba ESS recently signed a Memorandum of Understanding with the **Indonesian Agency for the Assessment and Application of Technology** (BPPT), to deploy H2One systems throughout the country. Toshiba ESS and BPPT will study installation sites, optimum system specifications and operation of the system, including maintenance, and aim to install the first system by 2022.

Toshiba launched the H2One autonomous hydrogen energy system in 2015 [*FCB, April 2015, p1*], and has commissioned systems for a variety of applications in Japan, including one to aid disaster recovery at a baseball stadium in Sendai [*April 2018, p6*], and 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*].

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METI selects Toshiba H2One project for Indonesia, Philippines

The Japanese Ministry of Economy, Trade and Industry (METI) is supporting a survey project by Toshiba Energy Systems & Solutions to develop applications for its H2One™ hydrogen-based autonomous energy supply system on isolated islands in Indonesia and the Philippines. The survey will help Toshiba ESS to help solve the countries' energy problems, while expanding the H2One business and building H2One supply chains.

Selection for the **METI initiative** will accelerate business considerations for solutions to energy-related challenges in Indonesia and the Philippines. In order to build H2One supply chains in both countries, Toshiba ESS will determine locations and optimal system specifications by 2019, for subsequent implementation.

Indonesia, which comprises more than 13 000 islands, has the challenge of supplying stable, low-cost energy for each island. Its 'RUPTL' power supply business plan aims to increase the total power generation capacity rate of renewables from 12.52% in 2017 to 23% by 2020. In the Philippines, half of the current energy supply comes from coal- and oil-fired thermal power. The country is reliant on importing these fuels, and increasingly sees renewable energy as an opportunity to improve energy self-sufficiency. It is therefore seeking solutions for isolated islands with low electrification rates, and ways to reduce risk from typhoons and other natural disasters.

Toshiba ESS recently signed a Memorandum of Understanding with the **Indonesian Agency for the Assessment and Application of Technology** (BPPT), to deploy H2One systems throughout the country. Toshiba ESS and BPPT will study installation sites, optimum system specifications and operation of the system, including maintenance, and aim to install the first system by 2022.

Toshiba launched the H2One autonomous hydrogen energy system in 2015 [*FCB, April 2015, p1*], and has commissioned systems for a variety of applications in Japan, including one to aid disaster recovery at a baseball stadium in Sendai [*April 2018, p6*], and 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*].

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

PORTABLE & MICRO

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PowerCell Sweden: www.powercell.se

Fraunhofer IMM, Hydrogen Technology: https://tinyurl.com/fraunhofer-imm-h2

Simark Controls wins EFOY follow-up order for Canadian oil & gas

Canadian-based Simark Controls has received a follow-up order for turnkey EFOY ProCabinet hybrid solutions and SCADAPack panels from a leading (but unnamed) North American energy producer. The order, the biggest EFOY Pro follow-up order in the company's history, amounts to approximately C$1.2 million (US$0.9 million).

Simark's EFOY Pro hybrid solutions are used to power the customer's SCADA instrumentation and electrical-chemical injection pumps at off-grid well-pads in the Montney and Duvernay Formations in Alberta and British Columbia, which are among the world's largest shale gas resources. Simark – a subsidiary of German hybrid power solutions provider SFC Energy [*FCB, August 2013, p8*] – customised the turnkey EFOY ProCabinet Hybrid solutions to easily integrate into the customer's existing communication and control infrastructure at the sites. The direct methanol fuel cell/solar hybrid power supply replaces conventional gas generators, cutting CO_2 equivalent emission reductions by more than 90% while ensuring power reliability and system autonomy.

'This is our biggest EFOY Pro oil & gas order to date. It confirms again our strategy to offer fuel cells as reliable, lower cost and ecological off-grid power sources to the oil & gas industry,' says Dr Peter Podesser, CEO of SFC Energy [*see the SFC feature in January 2013, and page 6 in this issue*]. 'We won this order because our hybrid systems fully convinced the customer with their reliability and major emission, cost and logistic savings.'

Simark Controls Ltd: www.simarkcontrols.com

SFC Energy: www.sfc.com/en

LARGE STATIONARY

Bloom clean power from waste biogas, Key for project finance

California-based Bloom Energy unveiled a new high-efficiency, Bloom Energy Server-based solution for generating clean electricity from waste biogas at the Bay Area Air Quality Management District Climate Tech Marketplace, an event affiliated to the Global Climate Action Summit in San Francisco in mid-September. And Key Equipment Finance has announced that it will provide $100 million in project financing for new Bloom Energy commercial and industrial fuel cell deployments across the US.

Bloom has demonstrated how a standard Bloom Energy Server integrated with a new biogas clean-up module can generate clean electricity from biogas emitted by landfill, agricultural, waste and water treatment processes. The prototype clean-up module will clean the biogas of moisture and contaminants, enabling its use in fuel cells while dramatically reducing methane emissions. Bloom expects to begin testing the new solution with customers shortly.

Bloom says that its solid oxide fuel cell technology has attained an efficiency of 65% for converting natural gas or biogas to electricity. In addition, the modular design of Bloom Energy Servers allows them to be 'hot swapped' or serviced without interruption, which guarantees long-term system efficiency and output, such as over the term of a 15- or 20-year power purchase agreement. And the power draw from the integrated gas clean-up module has minimal impact on overall system efficiency.

Meanwhile, Colorado-based Key Equipment Finance, an affiliate of KeyCorp, will provide $100 million in project financing to support up to 15 MW of new Bloom Energy commercial and industrial fuel cell deployments across the US. The additional financing is also expected to enable shorter term deal structures that cater to customers who are constrained or inhibited from signing long-term contracts. Since 2014 Key has provided $300 million in project financing for some 70 Bloom Energy projects throughout the US.

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Germany adds four hydrogen stations as it boosts network past 50

Four new hydrogen refueling stations have been inaugurated in Germany, pushing it through the 50-station milestone. Two are in the east of the country – in Potsdam in Brandenburg, and Saxony's first hydrogen station in Dresden – plus facilities in Ratingen and Frechen in North Rhine-Westphalia (NRW), which now has eight stations.

The station in **Potsdam**, southwest of Berlin, is the 50th public facility in the nationwide network, and has been developed by H_2 Mobility Deutschland, Linde, and Total. The station is owned and operated by H_2 Mobility, and uses Linde hydrogen technology to refuel up to 40 fuel cell electric vehicles per day. Alongside a 700 bar dispenser for cars, a facility for an optional 350 bar dispenser for refueling buses has been pre-installed. EU funding is under the Hydrogen Mobility Europe (H2ME) project [*see the News Feature in FCB, October 2015, and June 2016, p1*], through the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2 JU), in addition to support from the German federal government, Brandenburg state government, and city of Potsdam.

In addition, the first hydrogen station in Saxony has been opened at a Total service station in **Dresden**. The technology for this station is from Air Liquide, and can refuel up to 40 FCEVs per day. The facility was built by H_2 Mobility with funding from the European Commission's Trans-European Transport Network (TEN-T) initiative under the Connecting Europe Facility (CEF), as part of the Connecting Hydrogen Refuelling Stations (COHRS) project [*September 2018, p6*]. (It was also announced at the opening ceremony that Saxony's second hydrogen station has already been completed, at a Total truck stop in Leipzig, and will open soon.)

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Meanwhile, North Rhine-Westphalia has opened its seventh and eight hydrogen stations. The station in **Ratingen** is located on the Ratingen East (A44/A3) motorway junction in the Essen–Düsseldorf commuter belt, on the key north–west axis between Hamburg and the Ruhr region. H_2 Mobility developed and is operating the station at the Shell motorway service area, using Air Liquide hydrogen technology. The station, also part of the COHRS project, holds around 200 kg of hydrogen, sufficient for refueling 40–50 vehicles per day.

Air Liquide has also inaugurated a new hydrogen station at a Mundorf Tank service station in **Frechen**, at the Cologne-West motorway junction. The station was built as part of the SWARM project [*April 2013, p8*], and partly financed by the FCH JU.

The H_2 Mobility joint venture was created in 2015 by Air Liquide, Daimler, Linde, OMV, Shell, and Total [*November 2015, p6, and see page 1 in this issue*]. Its primary goal is 100 operational stations by the end of 2019 in seven metropolitan areas (Hamburg, Berlin, Rhine-Ruhr, Frankfurt, Nuremberg, Stuttgart, and Munich) and along motorways and highways. More stations are under construction and/or at the planning stage, for example in Hamburg, Magdeburg, Erfurt, and Berlin [*see also page 10*]. Another 300 stations will follow as more FCEVs are deployed.

H_2 Mobility Deutschland: www.h2.live/en

Total Germany, Electric Mobility: https://tinyurl.com/total-h2-mobility

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

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

Hydrogen Mobility Europe: www.h2me.eu

Air Liquide, Hydrogen Energy: http://tinyurl.com/hydrogen-energy-airliquide

Connecting Hydrogen Refuelling Stations: www.cohrs-project.eu/english

Shell Global, Hydrogen: http://tinyurl.com/shell-h2

SWARM project: www.swarm-project.eu

ITM opens its seventh hydrogen station in UK at JM site in Swindon

In the UK, ITM Power has opened its latest publicly accessible hydrogen refueling station at Johnson Matthey's fuel cell component manufacturing facility in Swindon, adjacent to the M4 motorway corridor linking London with south Wales.

The Swindon station is ITM Power's seventh public hydrogen station, joining facilities at Cobham in Surrey on the M25 London orbital motorway [*FCB, March 2017, p8*], Beaconsfield in Buckinghamshire on the M40 [*April 2018, p8*], Rainham in Essex on the A13 [*November 2016, p6*], Teddington in west London [*June 2016, p9*], Rotherham in Yorkshire on the M1 [*October 2016, p8*], and Kirkwall in Orkney, Scotland [*see the News Feature in October 2016*]. It is now open for public and private fleets operating fuel cell electric vehicles. The station uses electricity via a renewable energy contract and water to generate hydrogen onsite, with no need for deliveries.

The Swindon station is the first of two hydrogen stations in the UK to be deployed as part of the pan-European Hydrogen Mobility Europe 2 (H2ME 2) project [*June 2016, p1*], funded by the European Fuel Cells and Hydrogen Joint Undertaking (FCH JU) and the UK's Office of Low Emission Vehicles (OLEV). A further station to be deployed by ITM Power under H2ME 1 [*see the News Feature in October 2015*] will be located at Gatwick Airport, and will open by the end of this year.

ITM is also participating in a feasibility study to deploy a 100 MW Power-to-Gas (P2G) energy storage project at Runcorn in Cheshire [*see page 11*].

ITM Power: www.itm-power.com

Johnson Matthey Fuel Cells: www.jmfuelcells.com

Hydrogen Mobility Europe: www.h2me.eu

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

Office of Low Emission Vehicles: http://tinyurl.com/uk-olev

Air Products, Fullcryo in deal for commercial liquid hydrogen-based fueling station in China

US-based Air Products has signed cooperation and equipment supply

agreements with Beijing Sinoscience Fullcryo Technology Co Ltd in China, to accelerate the development of hydrogen infrastructure and support China's first commercial-scale, liquid hydrogen-based refueling station. The companies will cooperate from demonstration to commercialisation, including construction, operation, maintenance, and gas supply for liquid hydrogen-based fueling stations in China.

Under the equipment supply agreement, Air Products will provide two state-of-the-art, integrated SmartFuel® hydrogen refueling stations to Fullcryo, for the construction of the first-of-its-kind facility in Guangdong Province, in southern China.

In compliance with the SAE J2601 fueling protocol, the station will consist of key components that include a liquid hydrogen storage tank, high-efficiency booster pump, high-pressure gasifier and gaseous storage tank, dispenser, and control system. Its fueling capacity is designed to provide 500 kg/day of hydrogen, and can be expanded to 1500 kg/day for both 350 and 700 bar refueling.

Air Products has participated in several hydrogen fueling demonstration projects in China, including the 2008 Summer Olympics in Beijing, 2010 Asian Games in Guangzhou [*FCB, December 2010, p9*], and 2011 Summer Universiade in Shenzhen [*September 2011, p7*]. Earlier this year, the company signed a deal with Shenhua New Energy to provide two hydrogen dispensers for China Energy Investment Corporation's first hydrogen refueling station, being built in Rugao, Jiangsu Province [*April 2018, p10*].

Fullcryo (or Fuhaicryo) is a subsidiary of the Chinese Academy of Sciences, dedicated to large-scale cryogenic systems. It provides solutions for liquid hydrogen storage and transportation, including hydrogen station investment and construction, storage tanks and related technologies, to drive hydrogen energy and fuel cell development in China. Liquid hydrogen-based fueling stations, which involve advanced gas storage and fueling technology, can bring added benefits, including higher throughput, lower energy consumption, and relatively smaller footprint.

Air Products, SmartFuel Hydrogen Energy: www.airproducts.com/Industries/Energy/Hydrogen-Energy.aspx

McPhy first contract for 700 bar hydrogen station in Germany

French-based McPhy has been awarded its first contract for a 700 bar hydrogen refueling station in Germany, by H_2 Mobility Deutschland. The station, which is designed to refuel approximately 40 vehicles per day, is due to enter service in Berlin in Q4 of 2019.

The H_2 Mobility consortium chose McFilling technology after conducting a rigorous selection process. McPhy will install a McFilling 200-700 station capable of delivering 200 kg/day of hydrogen at 700 bar, cooled to –40°C and compliant with the SAE J2601-1: 2016 standard.

This new addition is McPhy's first in the 700 bar station market segment, and the 14th McFilling station in total. The company now offers a full range of hydrogen stations at 350 bar, 700 bar, and 'dual pressure' offering both 350 and 700 bar, to handle all clean mobility needs. It recently completed tests on its 700 bar prototyping and testing platform at its headquarters in La Motte-Fanjas, working in collaboration with Toyota [*FCB, August 2018, p9*].

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The unit uses two BOC/Linde Genie hydrogen cylinders holding a total of 0.8 kg of hydrogen at 300 bar, with a standard 350 bar dispensing nozzle, using passive cascading only (no compression or chilling, as these would add weight, size, and cost). The development project was led by FCSL, and funded by Innovate UK. A one-off unit will cost £14 750 (US$19 200), while a week-long hire with six cylinders will cost £2000 ($2600), and longer term hires by negotiation.

Markets for the unit include breakdown recovery fleets who wish to offer comparable services for alternative fuel vehicles, as well as FCEV drivers who would like an onsite backup option. Hydrogen forklift trucks and dual-fuel vans are also becoming more popular, and this could be facilitated by a unit contained within a service shed.

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Plug Power has already completed more than 60 hydrogen refueling stations, primarily serving fuel cell powered forklifts [*e.g. April 2018, p9, and see the Plug Power feature in December 2011*].

Plug Power has also begun production of membrane-electrode assemblies for its newly designed ProGen metal plate stack, with double the power density of its graphite plate stack and a longer life cycle for on-road applications [*see page 14*].

Plug Power: www.plugpower.com

Rensselaer Polytechnic Institute, Center for Automation Technologies & Systems: www.cats.rpi.edu

National Renewable Energy Laboratory, Hydrogen & Fuel Cells: www.nrel.gov/hydrogen

ENERGY STORAGE & P2G

Haeolus W2H project in Norway will utilise Hydrogenics 2.5 MW energy storage solution

The European 'Haeolus' consortium will demonstrate a 2.5 MW electrolyser-based energy storage system, directly connected to a 45 MW wind farm in Norway, in the world's largest remotely controllable Wind-to-Hydrogen (W2H) plant.

The Haeolus (Hydrogen-Aeolic Energy with Optimised eLectrolysers Upstream of Substation) consortium comprises two universities (Université Bourgogne Franche-Comté in France and University of Sannio in Italy), two research institutes (project coordinator SINTEF in Norway and Tecnalia in Spain), a leading electrolyser manufacturer (Hydrogenics in Belgium), a focused SME (KES Knowledge Environment Security in Italy), and an end-user representing both wind farm and grid operators (Varanger Kraft in Norway). The €6.9 million (US$7.9 million) project, which runs to the end of 2021, is receiving funding from the EU-supported Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2 JU).

Varanger Kraft's Raggovidda wind farm, in the northernmost part of the country, is one of the most efficient in Europe, but local transmission grid limitations mean that its 200 MW capacity cannot currently be fully realised. The Haeolus consortium will produce clean hydrogen using some of the excess power generation.

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Natural Sciences and Engineering Research Council of Canada: www.nserc-crsng.gc.ca

GREEN HYDROGEN

HyBalance pilot site producing zero-carbon hydrogen in Denmark

The HyBalance project pilot site in Hobro, Denmark has been inaugurated for the production of zero-carbon hydrogen. The facility uses MW-scale electrolysis technology to balance the electric grid, and demonstrate the link between energy storage in the form of hydrogen and the deployment of hydrogen mobility solutions.

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Air Liquide has developed, built, and is operating the facility that produces hydrogen from water electrolysis, as well as the filling centre for its customers delivered by trailers. The 1.2 MW PEM electrolyser – supplied by Hydrogenics [*March 2017, p9, and see also pages 3 and 11 in this issue*] – produces approximately 500 kg/day of hydrogen, without releasing any CO_2. The hydrogen produced is used to supply industrial customers as well as the network of five hydrogen refueling stations installed and operated by the Copenhagen Hydrogen Network (CHN), a Danish subsidiary of Air Liquide.

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In other news, Air Liquide's new Paris Innovation Campus features a fuel cell that supplies part of the R&D Centre's heating, cooling and electricity needs, using hydrogen generated onsite. The building also has a hydrogen refueling station for vehicles.

HyBalance project: www.hybalance.eu

Air Liquide, Hydrogen Energy: http://tinyurl.com/hydrogen-energy-airliquide

Copenhagen Hydrogen Network: www.energies.airliquide.com

Hydrogenics: www.hydrogenics.com

Neas Energy: www.neasenergy.com

Hydrogen Valley: www.hydrogenvalley.dk/frontpage-en

Ludwig-Bölkow-Systemtechnik GmbH: www.lbst.de/index_e.html

Fraunhofer, E4tech identify paths to boost large-scale electrolysis

A new German study prepared by the Fraunhofer Institute for Solar Energy Systems ISE, Fraunhofer Institute for Manufacturing Engineering and Automation IPA, and the E4tech sustainable energy consultancy says that the electrolysis sector must evolve into a gigawatt industry in order for the climate goals of the federal government to be achieved.

The technology is ready for market, so further development of the electrolysis sector can only be realised with a targeted market ramp-up, by creating a market for the hydrogen that is produced and a suitable policy framework. These are the most important results of a recent study, *Industrialisation of Water Electrolysis in Germany: Opportunities and Challenges for Sustainable Hydrogen for Traffic, Electricity and Heat* [in German], which was commissioned by the Federal Ministry of Transport and Digital Infrastructure (BMVI) and coordinated by NOW GmbH.

Electrolysis plants are currently mostly manufactured under specialised factory conditions. The study therefore addresses the question of how the manufacture of electrolysis systems can be achieved on an industrial scale in Germany. The study's recommendations are summarised in a roadmap for the relevant actors. It also identifies the accompanying R&D activities needed to further reduce costs and increase service life.

Download the study [PDF, in German]: https://tinyurl.com/Studie-IndWEDe

NOW GmbH: www.now-gmbh.de/en

Fraunhofer ISE: www.ise.fraunhofer.de/en.html

Fraunhofer IPA: www.ipa.fraunhofer.de/en.html

E4tech: www.e4tech.com

COMMERCIALISATION

Ballard unveils FCgen-LCS stack for heavy-duty motive market

Canadian-based Ballard Power Systems unveiled its next-generation, liquid-cooled FCgen®-LCS fuel cell stack at the recent IAA Commercial Vehicles Trade Fair and Convention in Hannover, Germany [*see also pages 3 and 4*]. The new PEM fuel cell stack will provide power for heavy-duty motive applications, offering high performance with reduced cost.

The FCgen-LCS ('Liquid Cooled Stack') will be a core component of Ballard's 8th-generation power module portfolio for heavy-duty motive applications – including buses, commercial trucks, and trains – planned for launch in 2019, and other applications such as forklifts. The company will continue to support existing customers using its current FCvelocity®-9SSL stack technology.

Ballard says that the FCgen-LCS will give an expected 40% reduction in total-cost-of-ownership compared to the current-generation, liquid-cooled fuel cell stack that it will replace (based on life-cycle cost of a 50 kW stack operating for 50 000 hours with a single refurbishment). This is achieved through various design and processing improvements, including improved durability, lower catalyst loading, increased power density, improved unit cell performance, greater efficiency, and optimised high-volume membrane-electrode assembly (MEA) manufacturing processes.

The new stack has a planned operating lifetime of more than 30 000 hours through improved MEA design and processing, and the use of reusable carbon bipolar plates and moulded compression hardware. It offers a 33% increase in power density, enabling tighter packaging, and can start in ambient temperatures down to –25°C and operate at up to 85°C. Systems integration is simplified

for the generation of hydrogen needed for the methanisation reaction,' says Dr Prabhu Rao, Chief Operating Officer of Xebec. 'This research programme will focus on achieving high performance while being sensitive to the commercial requirements of cost and size, as Xebec continues to develop a portfolio of renewable fuel product offerings.'

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Ludwig-Bölkow-Systemtechnik GmbH: www.lbst.de/index_e.html

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Electrolysis plants are currently mostly manufactured under specialised factory conditions. The study therefore addresses the question of how the manufacture of electrolysis systems can be achieved on an industrial scale in Germany. The study's recommendations are summarised in a roadmap for the relevant actors. It also identifies the accompanying R&D activities needed to further reduce costs and increase service life.

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Fraunhofer ISE: www.ise.fraunhofer.de/en.html

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E4tech: www.e4tech.com

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The FCgen-LCS ('Liquid Cooled Stack') will be a core component of Ballard's 8th-generation power module portfolio for heavy-duty motive applications – including buses, commercial trucks, and trains – planned for launch in 2019, and other applications such as forklifts. The company will continue to support existing customers using its current FCvelocity®-9SSL stack technology.

Ballard says that the FCgen-LCS will give an expected 40% reduction in total-cost-of-ownership compared to the current-generation, liquid-cooled fuel cell stack that it will replace (based on life-cycle cost of a 50 kW stack operating for 50 000 hours with a single refurbishment). This is achieved through various design and processing improvements, including improved durability, lower catalyst loading, increased power density, improved unit cell performance, greater efficiency, and optimised high-volume membrane-electrode assembly (MEA) manufacturing processes.

The new stack has a planned operating lifetime of more than 30 000 hours through improved MEA design and processing, and the use of reusable carbon bipolar plates and moulded compression hardware. It offers a 33% increase in power density, enabling tighter packaging, and can start in ambient temperatures down to –25°C and operate at up to 85°C. Systems integration is simplified

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Xebec Adsorption Inc: www.xebecinc.com

McGill University, Catalytic Process Engineering Lab: www.mcgill.ca/cpe

Natural Sciences and Engineering Research Council of Canada: www.nserc-crsng.gc.ca

GREEN HYDROGEN

HyBalance pilot site producing zero-carbon hydrogen in Denmark

The HyBalance project pilot site in Hobro, Denmark has been inaugurated for the production of zero-carbon hydrogen. The facility uses MW-scale electrolysis technology to balance the electric grid, and demonstrate the link between energy storage in the form of hydrogen and the deployment of hydrogen mobility solutions.

The HyBalance project, initiated in 2016, is coordinated by Air Liquide, and has brought together a group of partners – Hydrogenics, consultancy LBST, Danish electricity and natural gas trading company Neas Energy, and business incubator Hydrogen Valley/CEMTEC – to construct one of the largest carbon-free hydrogen production units in Europe [*FCB, March 2016, p8*]. The €15 million (US$17.3 million) project has received €8 million ($9.2 million) in funding from the EU-supported Fuel Cells and Hydrogen 2 Joint Undertaking (FCH2 JU), and €2.6 million ($3 million) from the Danish Energy Technology Development and Demonstration Programme (EUDP).

Air Liquide has developed, built, and is operating the facility that produces hydrogen from water electrolysis, as well as the filling centre for its customers delivered by trailers. The 1.2 MW PEM electrolyser – supplied by Hydrogenics [*March 2017, p9, and see also pages 3 and 11 in this issue*] – produces approximately 500 kg/day of hydrogen, without releasing any CO_2. The hydrogen produced is used to supply industrial customers as well as the network of five hydrogen refueling stations installed and operated by the Copenhagen Hydrogen Network (CHN), a Danish subsidiary of Air Liquide.

The associate project partners are Denmark's electricity and gas grid operator Energinet.DK, AkzoNobel – which has several large salt caverns in the vicinity that could be used for the large-scale storage of gases – and Sintex, which manufactures power solutions and is also an industrial hydrogen customer supplied by Air Liquide.

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HyBalance project: www.hybalance.eu

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Ballard Power Systems: www.ballard.com

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Sunfire is a long-term partner of German-based heating systems manufacturer Vaillant, supplying its SOFC stack for integration into the latter's residential micro CHP system [*May 2011, p4*]. The business realignment also sees Sunfire take over patent licences and system development know-how from Vaillant, allowing Sunfire to expand its off-grid power portfolio to produce small units (400 W) and micro CHP solutions (750 W) for residential buildings.

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Meanwhile, **Sunfire is reorganising its SOFC and fuel processing activities**. Strategic work on renewable hydrogen and synthetic fuel production technologies will continue at its premises in Dresden, to prepare for industrial scale-up. This will concentrate on R&D as well as steam electrolysis products in the form of solid oxide electrolyser cells (SOECs). The stationary *SOFC* development and manufacturing activities will be concentrated at new enerday's site in Neubrandenburg, where Sunfire will retain all 16 employees.

Sunfire is a long-term partner of German-based heating systems manufacturer Vaillant, supplying its SOFC stack for integration into the latter's residential micro CHP system [*May 2011, p4*]. The business realignment also sees Sunfire take over patent licences and system development know-how from Vaillant, allowing Sunfire to expand its off-grid power portfolio to produce small units (400 W) and micro CHP solutions (750 W) for residential buildings.

The advanced development and manufacturing resources brought in with new enerday will help Sunfire launch its Sunfire-Home residential SOFC system, with market introduction planned in the next 12 months for residential customers with no gas grid access. A limited number of 500 units will be sold via selected liquid gas suppliers at a price comparable with traditional heating

through its compact design, flexible packaging from 20 to 220 cells, and ports located at both ends of the stack to provide easier access for fluids, as well as the ability to mount the stack in several different orientations. The stack's expanded range of operating pressure, humidity and temperature also enable enhanced vehicle integration flexibility for air and cooling systems.

Ballard recently agreed to establish a joint venture with Weichai Power in China, including technology transfer related to the LCS stack and power modules for bus, commercial truck, and forklift applications [*FCB, September 2018, p10*].

Ballard Power Systems: www.ballard.com

Thermal management from Mahle for Nikola Two fuel cell truck

German automotive systems specialist Mahle GmbH has provided its expertise in thermal management to US-based Nikola Motor Company, as the development partner and supplier for the cooling and air-conditioning systems for the Nikola Two™ fuel cell powered heavy-duty truck.

Nikola is using Mahle's extensive thermal management expertise in the development of the Nikola Two truck, whose market launch is planned for 2021. The development partnership includes the air-conditioning system for the driver's cabin and the cooling systems for all drive components [*FCB, September 2018, p12*].

Cooling systems are being developed and produced for the fuel cell, traction motor, power electronics and battery, with all relevant system components coming from Mahle, including electric coolant pumps and fans. The air-conditioning system for the cabin of the heavy semitrailer tractor vehicle is also being developed and manufactured by Mahle, comprising the complete system including the 800 V electric compressor.

Mahle is developing a portfolio of modular fuel cell systems based on its current range of components, utilising its competence in complete systems, thermal and air management, as well as filtration and electronics.

Nikola unveiled its Nikola One™ semitrailer truck in late 2016 [*January 2017, p13*], and has subsequently announced partnerships with companies including Bosch [*October 2017, p3*], PowerCell Sweden [*December 2017, p9*], and Nel Hydrogen [*July 2018, p9, and see also page 14 in this issue*].

Mahle GmbH: www.mahle.com

Nikola Motor Company: www.nikolamotor.com

PowerCell order for engineering services from Euro automaker

PowerCell Sweden has received an order for engineering services worth SEK3 million (US$333 000) from a leading European vehicle manufacturer. The company has also made several changes to its management team.

The **engineering services** provided by PowerCell will be delivered over six months starting in September, and help the unnamed automaker to adapt the interface between the fuel cell stack and its vehicle platform. PowerCell has developed a fuel cell stack with what it claims is the highest energy density in the market, and has significant expertise in field of fuel cell technology.

PowerCell has previously been appointed as preferred fuel cell stack supplier by US-based fuel cell truck developer Nikola Motor Company [*FCB, December 2017, p9*]. It is also a partner in the Autostack-Industrie (ASI) project in Germany, designing the fuel cell stack and enabling high-volume stack production [*January 2018, p12 and July 2018, p15*].

PowerCell has also made some changes to its management team. Dr **Per Ekdunge**, VP and former Chief Technology Officer, will focus on the German market as CEO of the PowerCell Germany subsidiary [*see also page 7*]. Dr **Thomas Tingelöf**, who has held roles including Project Manager for Fuel Cell Stack Development, will be the new CTO. The company has also added Scania's former CTO and head of R&D **Hasse Johansson** to its Board of Directors. **Mårten Wikforss**, former Executive VP of Corporate Communications at Volvo, joins to cover Corporate Communications, Investor Relations and Corporate Affairs at PowerCell, replacing Charlotta Sahlin, who left in the summer. And **Karl Samuelsson**, Director of Product Development, took over as acting Chief Operating Officer when Robert Gustafsson left in July.

PowerCell Sweden: www.powercell.se

ElringKlinger focusing on PEMFCs, sells SOFC activities to Sunfire

German automotive supplier ElringKlinger is concentrating on proton-exchange membrane fuel cell (PEMFC) technology for mobile applications, in a strategic reorientation of its E-Mobility division. It has therefore sold its stationary solid oxide fuel cell business, including its ownership of new enerday GmbH, to Dresden-based Sunfire GmbH.

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new enerday GmbH: www.new-enerday.com

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Nel has officially opened its new state-of-the-art H2Station® production facility in Herning, Denmark, with a manufacturing capacity of 300 hydrogen refueling stations per annum. And its Nel Hydrogen Electrolyser division has received a purchase order for the first Power-to-Gas (P2G) project in Australia.

The new **large-scale manufacturing plant in Herning** provides series production according to lean principles, for significantly improved production efficiency. The factory allows CE- and UL-certified stations to be manufactured on the same production line, providing product safety assurance and more cost-effective hydrogen fueling deployment [*see also page 2*]. Nel recently launched an H2Station with increased fueling capacity, sufficient to serve 100 fuel cell electric vehicles or 50 buses per day per dispenser, and also announced that the H2Station has achieved Underwriters Laboratories (UL) certification [*FCB, May 2018, p9*].

Meanwhile, Nel Hydrogen Electrolyser in Norway has received a purchase order for the **first Power-to-Gas project in Australia**, under which the ATCO Group will use a Proton® PEM electrolyser. This contract opens up a new P2G market, and builds on the P2G experience that Nel has gained around the world. The project is expected to be operational during 2019. Nel Hydrogen Electrolyser is also extending its facility at Notodden to construct what it says is the world's largest electrolyser manufacturing plant [*September 2018, p10*].

ATCO is developing a Clean Energy Innovation Hub at its Jandakot Operations facility in Western Australia, incorporating the production, storage and use of hydrogen, as well as the commercial application of clean energy in microgrid systems. The CEIH will produce 'green' hydrogen by electrolysis using solar energy, and inject it into the microgrid.

Meanwhile, parent company **Nel ASA has invested US$5 million in Nikola Motor Company** as part of the latter's C-round financing, which raised more than $100 million [*September 2018, p12*]. Earlier this year Nikola [*see also page 13*] and Nel announced a major partnership under which Nel will deliver 448 electrolysers and associated hydrogen production equipment for Nikola's heavy-duty truck refueling network in the US [*July 2018, p9*].

In other news, **Nel ASA has settled the writ** issued against Nel Hydrogen last autumn by Pennsylvania-based PDC Machines Inc, one of Nel Hydrogen's suppliers in the US, alleging misappropriations of compressor trade secrets. The parties will continue their joint efforts to provide products and services to customers in the hydrogen industry.

Nel Hydrogen: www.nelhydrogen.com

ATCO Group: www.atco.com.au

Nikola Motor Company: www.nikolamotor.com

PDC Machines: www.pdcmachines.com

Plug Power producing MEAs for new ProGen metal plate stack

US-based Plug Power has begun production of membrane-electrode assemblies (MEAs) for its newly designed ProGen *metal* plate stack, offering double the power density of its *graphite* plate stack and a longer life cycle for on-road applications.

The new stack leverages the expertise gained through the recent acquisition of American Fuel Cell (AFC) technology [*FCB, June 2018, p1*]. The ProGen metal plate stack will be integrated into Plug Power's ProGen hydrogen fuel cell engines, accelerating on-road market development opportunities like delivery vans, buses, and trucks [*e.g. May 2018, p3*]. The newly designed MEAs and metal stacks will improve product performance, cost, and quality.

Plug Power has developed an ink, catalyst, and material formula for its MEA technology that improves efficiency and enhances durability. The company began manufacturing MEAs in Q3 of 2018 at the former AFC facility in Rochester, New York, leveraging expertise and infrastructure in fuel cell technology as well as thin-film coating and roll-to-roll manufacturing. Plug Power also recently opened a new manufacturing facility at Clifton Park, a few miles from its Latham headquarters [*September 2018, p12*].

Plug Power's hydrogen PEM fuel cells are already widely used in materials handling applications [*see the Plug Power feature in December 2011, and for example May 2018, p4*]. The company is also partnering with Rensselaer Polytechnic Institute and the National Renewable Energy Laboratory to develop a robotic hydrogen refueling technology for motive power applications [*see page 10*].

Plug Power: www.plugpower.com

Impact Coatings wins Chinese order for fuel cell coating system

Henan Yuqing Power Co Ltd in China has placed an order for a coating system from Sweden-based Impact Coatings. The order, which includes an Inlinecoater™FC machine and a licence agreement, is worth approximately €1.2 million (US$1.4 million).

The coating system will be used for coating metallic bipolar plates for fuel cells using Impact's Ceramic Maxphase™ coating. The customer will primarily deliver fuel cell stacks to the rail transport industry, and for this application is working in close cooperation with highly regarded Tongji University in Shanghai.

An already completed Inlinecoater FC that can be modified to fit the customer's specific requirements is available for the current order; delivery is planned for the first half of 2019. Impact Coatings has received pre-payment amounting to 80% of the order value, with the remaining payments on delivery and final customer acceptance.

Impact Coatings develops and delivers innovative technology for industrial PVD (physical vapour deposition) coatings with a focus on fuel cell, decorative, metallisation, and reflector applications. PVD is a method of producing thin layers of metals and ceramics under vacuum, for surface coatings that maximise performance and durability.

The company introduced its next-generation InlineCoater FC coating system earlier this year, for volume manufacturing of metal bipolar plates for hydrogen fuel cells; it says that a single system can produce more than 1 million plates per annum [*FCB, May 2018, p13*]. The company has also signed a cooperation agreement with Chinese fuel cell manufacturer Guangdong Telos Auto Power Systems in Foshan, to develop fuel cell systems with the support of the local city council [*March 2018, p13*].

Impact Coatings AB: www.impactcoatings.com

Hydrogen Council has quadrupled in size

The Hydrogen Council, a global CEO coalition for hydrogen

technologies, recently welcomed an additional 14 members, in a second major wave of growth this year.

The Hydrogen Council was launched at the World Economic Forum Annual Meeting in Davos, Switzerland in January 2017, as the first CEO-led initiative to foster the role of hydrogen technologies in the global energy transition [*FCB, January 2017, p1*]. Earlier this year it welcomed 11 new members representing leading international oil & gas, energy, science & technology and automotive companies from Asia, North America and Europe [*April 2018, p13*]. The Council is led by two co-chairs from different geographies and sectors – currently Benoît Potier, Chairman and CEO of Air Liquide, and Dr Woong-chul Yang, Vice Chairman of Hyundai Motor Company.

Eight companies have now been added at steering member level: Airbus, Air Products, Cummins, EDF (Électricité de France), Johnson Matthey, KOGAS (Korea Gas Corporation), SINOPEC (China Petroleum & Chemical Corporation), and thyssenkrupp in Germany. These are accompanied by six new members at supporting level: AFC Energy, Mitsubishi Heavy Industries (MHI), Re-Fire Technology in China, Sumitomo Mitsui Banking Corporation, Sumitomo Corporation, and Southern California Gas. In addition, Faurecia has upgraded its membership to steering level.

The Hydrogen Council has also published a new discussion paper, *Hydrogen meets digital: New opportunities for the energy and mobility system*, which seeks to investigate the impact of digitisation on energy demand and establish a dialogue with the ICT (information and communications technology) sector on how digitisation and hydrogen could complement each other's impact during the energy transition. To this end, it explores four specific promising use cases: autonomous taxis and shuttles, digitally enabled freight chains, VTOL (vertical take-off and landing) taxis, and data centres.

This joins two previous studies, *How hydrogen empowers the energy transition* (January 2017), which explored the role of hydrogen in the energy transition, including its potential, recent achievements, and challenges to its deployment; and *Hydrogen, scaling up*, which presented the first comprehensive vision of the long-term potential of hydrogen and a roadmap for deployment [*November 2017, p1*].

Hydrogen Council: www.hydrogencouncil.com

Hydrogen Meets Digital discussion paper [PDF]: https://tinyurl.com/h2-meets-digital

RESEARCH

GenCell, AETC win R&D grant to develop ammonia cracking

Israeli alkaline fuel cell system manufacturer GenCell Energy and American Energy Technologies Company (AETC) in Chicago have been awarded a multi-year grant by the Israel-US Binational Industrial Research and Development (BIRD) Foundation, to develop a low-temperature catalyst for cracking ammonia (NH_3) into nitrogen and hydrogen. The $1.7 million grant is funded by the US Department of Energy, Israeli Ministry of Energy, and Israel Innovation Authority.

The unique catalyst is used by the GenCell A5 Off-Grid Power Solution to create hydrogen-on-demand from ammonia, the world's second most-produced industrial chemical [*FCB, July 2018, p5*]. Ammonia is readily available and less expensive than diesel in many countries. The use of ammonia allows the GenCell A5 solution to provide cost-effective, ultra-reliable, silent and weather-independent power for off-grid and poor-grid telecom base stations at a lower operational expenditure (OPEX) cost than diesel generators.

The traditional process of dissociating ammonia into nitrogen and hydrogen gases is carried out at temperatures that often exceed 700°C, which necessitates the use of expensive metal alloys and high-nickel steel components. The requirements for high energy input and costly components thus make traditional ammonia cracking an expensive process. AETC's new nanomaterial-based catalyst allows the endothermic process to occur at less than 500°C, making ammonia cracking more cost-effective.

The BIRD Foundation promotes collaboration between US and Israeli companies in various technological fields for the purpose of joint product development. In addition to providing grants for approved projects, it works with companies to identify potential strategic partners and facilitate introductions.

GenCell Energy: www.gencellenergy.com

American Energy Technologies Company: www.usaenergytech.com

BIRD Energy: www.birdf.com/what-is-bird-energy

IN BRIEF

Manchester Fuel Cell Innovation Centre opens to accelerate fuel cell technology

The Manchester Fuel Cell Innovation Centre (www.mmu.ac.uk/mfcic), a £4.1 million (US$5.3 million) dedicated facility at Manchester Metropolitan University in the UK, was officially opened at the end of September. MFCIC researchers will share their expertise and specialist equipment with small and medium-sized enterprises (SMEs) across Greater Manchester. The centre was partly funded with £1.6 million ($2.1 million) from the European Regional Development Fund, and by Manchester Metropolitan [*FCB, December 2016, p13*].

MFCIC will produce advanced materials for fuel cells and next-generation energy storage, and help to plan hydrogen and fuel cell infrastructure for the region. Anticipated work for SMEs includes rapid prototyping of new designs to increase efficiency and reduce cost. Much of the work is already taking place at Manchester Metropolitan, such as screen-printing of electrolyser electrodes using 2D nanotechnology [*September 2018, p10*]. MFCIC researchers will also educate the next generation about hydrogen power through the HySchools project [*September 2017, p10*].

Hydrogen buses in Malaysia by March

Malaysia expects to see the first hydrogen fuel cell buses on the roads of Kuching, the Sarawak state capital, by March 2019. Three buses will be deployed, according to *TheBorneoPost.com*, following the signing of a Memorandum of Understanding between Sarawak Economic Development Corporation and Chinese electric bus manufacturer Foshan Feichi Automobile Manufacturing Co Ltd to supply and deliver the buses. Foshan Feichi previously collaborated with Ballard Power Systems to build a fleet of 33 fuel cell buses for the Chinese city of Yunfu [*November 2015, p3*], and 12 fuel cell buses in Foshan, Guangdong Province [*October 2016, p2*]. Sarawak Energy is constructing a hydrogen production plant and refueling station [*September 2018, p8*].

MissionH24 plans for hydrogen racing cars to take start at Le Mans in 2024

The MissionH24 programme, created by ACO (www.lemans.org/en) in France in collaboration with Swiss company GreenGT (www.greengt.com/en), aims to see hydrogen racing cars take the start at the 24 Hours of Le Mans in 2024.

MissionH24 was launched at the Spa-Francorchamps circuit in Belgium, where spectators watched the GreenGT LMPH2G – the latest iteration of the company's hydrogen racing car [*FCB, April 2016, p3*] – do laps and refuel in the pit lane.

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