fuelCELLS BULLETIN

MA Business

ISSN 1464-2859 October 2021

www.markallengroup.com/brands/fuel-cells-bulletin

# Stargate hydrogen trains for Estonia operator

**Stargate Hydrogen in Estonia has signed a Letter of Intent with international rail company Operail, to convert diesel-electric locomotives to fuel cell electric trains, which will be used in shunting operations.**

As part of the retrofit, the diesel gensets that power the locomotives will be replaced by a zero-emission hybrid powertrain comprising PEM fuel cells and lithium-ion batteries. The partnership with Operail is planned in two phases. Initially, a prototype fuel cell electric locomotive will be constructed, by the end of 2022. In the second phase, the partners intend to convert an additional 40 locomotives to fuel cell powertrains. Each converted locomotive will save 370 tonnes of $CO_2$ emissions per annum, equivalent to the annual emissions of 80 average passenger cars.

'Retrofitting ageing diesel locomotives to zero-carbon alternatives is already an economically sustainable solution, and will be even more so in the future,' says Rainer Küngas, CTO at Stargate Hydrogen. 'Retrofitting also allows the reuse of existing diesel-electric locomotives that would otherwise end up as stranded assets once they no longer meet future emission standards.'

Stargate Hydrogen is developing turnkey green hydrogen solutions in Estonia, with its rail business focused on the conversion of diesel-electric locomotives to fuel cell alternatives, and developing next-generation electrolyser solutions. Operail is an Estonian state-owned railway company providing freight transport, repair and construction of locomotives and wagons, and rolling stock rental.

There is increasing interest in both newly developed and retrofitted fuel cell powered trains. Alstom is one of the leaders in developing next-generation fuel cell electric trains, in particular its Coradia iLint regional trainset [*see the News Feature in FCB, March 2017, and page 6 in this issue*], and other companies active in this sector include Loop Energy [*see page 6*] and Ballard Power Systems in Canada [*April 2021, p5*], Talgo in Spain [*September 2021, p6*], Siemens Mobility in Germany [*August 2021, p6*], tpgroup [*July 2021, p6*] and Eversholt Rail in the UK [*August 2021, p6*], and even Toyota Motor Europe [*May 2021, p5*].

Stargate Hydrogen: www.stargatehydrogen.com
Operail: www.operail.com

# Bloom Energy offers hydrogen powered SOFCs

**Bloom Energy has announced the commercial availability of its Hydrogen Energy Servers, a modular and flexible 100% hydrogen-powered solid oxide fuel cell system that delivers onsite, 24/7 zero-carbon electricity. The California-based company is now accepting orders for these systems, with commercial shipments expected to begin in 2022.**

Renewable energy sources such as solar and wind are critical to clean power generation, but are also inherently intermittent, with periods of excess energy production. Curtailment is therefore needed to balance generation with consumption. However, curtailment can be avoided by pairing renewables with the recently launched Bloom Electrolyzer [*FCB, August 2021, p12*], utilising the company's solid oxide electrolysis cell (SOEC) technology, which allows hydrogen to be produced at scale during periods of excess renewable production, compressed and stored for long durations.

Bloom Energy's Hydrogen Energy Servers – an advance on SOFC technology originally developed for operation with natural gas or biogas [*e.g. April 2021, p10*] – have been successfully tested as part of a pilot project with SK ecoplant in Ulsan, South Korea for the last five months [*May 2021, p7*], generating clean electric power at efficiency levels exceeding expectations.

Bloom Energy Corporation: www.bloomenergy.com

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ISSN 1464-2859/21 

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MA Business

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Mark Allen

*Fuel Cells Bulletin* is published by MA Business Limited
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Dartford Kent DA2 7TJ
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An annual subscription to *Fuel Cells Bulletin* includes 12 issues and online access for up to 5 users. Subscriptions run for 12 months, from the date payment is received.



ROAD VEHICLES

# Hyundai fuel cell bus for operator in Austria

**South Korean based Hyundai Motor Company is supplying a Hyundai Elec City Fuel Cell electric bus to the largest city bus operator in Austria, in the capital Vienna.**

The fuel cell electric bus, delivered through Austrian distributor Hyundai Import GmbH, will be operated by Wiener Linien, which runs a fleet of nearly 500 buses in Vienna. The Elec City Fuel Cell will serve as the company's first passenger city bus running on hydrogen from November, when Wiener Stadtwerke will be ready with its hydrogen refueling station in the Leopoldau district.

The newly founded Wiener Wasserstoff GmbH [Vienna Hydrogen] will start preparatory work for installation of its electrolysis plant on the Simmering campus of local energy utility Wiener Netze before the end of 2021. The deployment of Hyundai's Elec City Fuel Cell bus is part of the HyBus Implementation programme supported by the Austrian Climate and Energy Fund.

The Elec City Fuel Cell has been commercially available in Korea since 2019, with more than 100 vehicles now in operation [*FCB, July 2019, p15*]. Hyundai recently trialed it with bus operators in Munich, Germany, to explore opportunities in the European market [*July 2021, p3*].

Hyundai Truck & Bus: https://trucknbus.hyundai.com

Wiener Linien: www.wienerlinien.at/en

# Kamaz unveils fuel cell bus, partners with GreenGT for trucks

**One of the largest Russian truck manufacturers presented its first hydrogen-electric bus at the recent COMTRANS 2021 commercial transport exhibition in Moscow. Kamaz is also partnering with French-Swiss engineering group GreenGT to develop hydrogen-powered trucks and establish a framework for long-term business cooperation.**

The **Kamaz-6290** is the company's first low-floor hydrogen fuel cell electric bus, based on the Kamaz-6282 battery electric model. It has a range of 250 km, allowing it to serve interurban transportation. Kamaz's Nefaz subsidiary assembled the chassis and body, with the Kamaz R&D Center installing roof-mounted equipment, including six compressed hydrogen cylinders. The fuel cell power plant generates up to 45 kW.

Kamaz plans to test the prototype bus in Moscow in 2022–2023 under real-world operating conditions. The company will assemble the vehicles at the Sokolniki Railway Car Repair and Construction Plant in Moscow, where it already assembles electric buses.

In other news, Kamaz has signed a Memorandum of Understanding with **GreenGT**, a pioneering developer of high-power hydrogen-electric systems for transportation and motor racing [*e.g. FCB, July 2020, p4*]. They have demonstrated a 44 tonne testbed truck with a 170 kW fuel cell system, developed by GreenGT. The truck will be formally presented at the transport-CH motor show in Bern, Switzerland from 11–13 November.

Kamaz: www.kamaz.ru/en

GreenGT: www.greengt.com

# Liverpool orders 20 double-decker fuel cell buses from ADL

**Liverpool City Region Combined Authority in the UK has selected Alexander Dennis Ltd to supply 20 double-decker hydrogen fuel cell electric buses. This is the first order for ADL's H2.0 second-generation hydrogen platform, designed to be more energy efficient and offer longer range.**

The ADL Enviro400FCEV buses are being directly purchased through the Liverpool City Region's Transforming Cities Fund, and will initially serve the region's busiest route, the 10A between St Helens and Liverpool city centre. Subject to final agreement of the project plan, the first vehicles could be delivered as soon as 2022.

The Enviro400FCEV has been developed on ADL's next-generation H2.0 platform, powered by a PEM fuel cell power module from Ballard Power Systems through the Voith Electrical Drive System [*FCB, March 2021, p3*]. The hydrogen tanks and key components have been integrated and packaged to balance weight and maximise passenger space. ADL unveiled its first double-decker fuel cell electric bus in 2018 [*December 2018, p4*], which was equipped with a ZF electric drive [*February 2019, p2*].

The region also plans to build hydrogen refueling facilities, the first of their kind in the North West of England, starting later this year.

Alexander Dennis Ltd: www.alexander-dennis.com/products/double-deck-buses-2-axle/enviro400fcev

Liverpool City Region Combined Authority: www.liverpoolcityregion-ca.gov.uk

## Loop Energy links for commercial vehicles in Russia, Slovakia

**Onboard fuel cell systems developer Loop Energy is partnering with Mettem-M, a Russian vehicle control systems company, to provide hydrogen fuel cell electric powertrain solutions to commercial vehicle OEMs in Russia and beyond. Loop has also shipped its first complete fuel cell system to Mobility & Innovation in Slovakia, for testing in hydrogen-electric minibuses.**

Loop Energy and **Mettem-M**'s first joint project – a hydrogen-powered transit bus for GAZ Group, a leading Russian commercial vehicle producer – was presented at the recent COMTRANS 2021 commercial transport exhibition in Moscow. The 12 m (40 ft) transit bus – based on GAZ's battery electric bus platform – is expected to enter regular service in Moscow in early 2022, after road testing and vehicle certification. Mettem will use Loop's eFlow™ fuel cell modules – created in its earlier incarnation as PowerDisc [*see the feature in FCB, March 2014*] – to develop and supply hydrogen-electric subsystems, powertrains and complete vehicle solutions for applications including transit buses, logistics vehicles, and rail transport.

Meanwhile, Loop Energy has delivered a complete eFlow fuel cell system to **Mobility & Innovation** in Slovakia, the first under their commercial agreement [*July 2021, p3*], for integration into M&I's 8 m (26 ft) transit bus. In addition to Loop's S300 fuel cell module, the solution includes an integrated cooling system that repurposes some of the thermal energy produced by the operating hydrogen fuel cell for bus heating.

Loop Energy: www.loopenergy.com

## Wrightbus showcases new fuel cell bus

**Northern Ireland-based Wrightbus unveiled two new single-deck, zero-emission buses at the recent Cenex LCV21 (Low Carbon Vehicle) event in the UK, showcasing its GB Kite Hydroliner hydrogen fuel cell electric bus alongside the GB Kite Electroliner battery electric bus.**

Wrightbus manufactures the world's first hydrogen-powered double-decker bus [*FCB, December 2018, p3*], and recently announced the creation of up to 300 permanent jobs after winning a string of orders in the UK and Ireland [*e.g. January 2021, p2 and September 2021, p2*], as it looks to ramp up production.

Both GB Kite models can carry 90 passengers; the Hydroliner has a range of up to 640 miles, while the Electroliner can operate for up to 300 miles on a single charge. They share an 86% parts commonality with their double-decker siblings, which delivers significant benefits to operators in terms of reducing complexity and costs for fleet maintenance.

The single-deck buses have been developed following the award of funding from the Advanced Propulsion Centre's Advanced Route to Market Demonstrator (ARMD) Competition. The new buses are expected to go into production in Q1 of 2022.

Wrightbus: www.wrightbus.com

## Quantron unveils bus with Ballard fuel cell

**German e-mobility specialist Quantron is launching its own vehicle, the electric Quantron 12 m (40 ft) low-floor bus. The city bus will be offered in two versions: the battery electric vehicle (BEV) variant can be ordered as early as the end of 2021, and the fuel cell electric vehicle (FCEV) model from spring 2022.**

The new bus – carrying up to 95 passengers – is offered in cooperation with Quantron investor and strategic partner Ev Dynamics in Hong Kong, a European-Asian consortium of companies specialising in electric and hydrogen-based mobility. The FCEV variant will be powered by PEM fuel cell modules supplied by Ballard Power Systems.

Quantron and Ballard recently announced a strategic partnership focused on integration of the latter's FCmove™ family of heavy-duty PEM fuel cell modules into Quantron's electric drivetrain and several truck platforms [*FCB, September 2021, p1*]. Quantron is also collaborating with AE Driven Solutions (AEDS) to implement hydrogen drive solutions for full-size vans, and its planned 44 tonne Energon truck features a 130 kW fuel cell system from Freudenberg Sealing Technologies [*August 2020, p2*].

## EDITORIAL

**Farewell – this is my final issue as Editor of the Fuel Cells Bulletin, before I hand over to Andrew Pickering (andrew.pickering@markallengroup.com), who will pick up the reins for Mark Allen Group at this exciting time for fuel cells and hydrogen energy.**

I've been working on *FCB* since its germination as an idea for a new Elsevier publication in 1998, and through more than two decades of progress since then – it's been quite a rollercoaster. So much has happened in that time: a lot of companies have come and gone, quite a few have been active all that time, and now many new companies are entering the fray – plenty of startups, and some major players with significant resources. All are pushing for the wider use of fuel cell power sources and hydrogen energy, in particular with the increasing global focus on green energy and reducing carbon emissions.

The main topics reported on in this issue are representative of the currently most active fields. In terms of road vehicles, there is a great deal of interest in fuel cell electric buses – Hyundai in Austria, Kamaz and Loop Energy in Russia, ADL and Wrightbus in the UK, Quantron in Germany – and heavy-duty trucks, such as the Nikola–Iveco manufacturing facility in Germany, Hyzon Motors in China, refrigerated transport in France, and two Ballard-powered truck projects. Other key mobility applications are trains – e.g. Stargate in Estonia, Alstom's latest Coradia iLint demonstration, a Loop Energy–H2M project in Canada – and aviation, such as Doosan Mobility Innovation, Urban-Air Port, a French partnership, and Intelligent Energy's military drones.

And the other hot topic – which is part of the even hotter topic of 'Net Zero' – is green hydrogen, which can be produced for example from waste-to-hydrogen conversion, electrolysis using wind energy, or as low-carbon hydrogen utilising carbon capture and storage (CCS). There will no doubt be plenty of discussion of this at the imminent COP26 meeting in Glasgow (www.ukcop26.org). I should also mention here Elsevier's new pro bono report, *Pathways to Net Zero: The Impact of Clean Energy Research* (www.elsevier.com/connect/net-zero-report), which looks at how clean energy research can help the world hit net zero carbon emissions by 2050.

Wrapping up, I would especially like to thank the many people who have been friendly and helpful, and provided advice, news items and feature articles over the years. I look forward to seeing these technologies finally achieve widespread deployment in the many applications that need them…

*Steve Barrett*

Quantron: www.quantron.net/en

Ev Dynamics: www.evdynamics.com

Ballard Power Systems: www.ballard.com

## Ford, AVL plan fuel cell van demonstrator

**AVL Powertrain UK and Ford Motor Company are collaborating on a project to define, design, develop and test a drivable fuel cell electric commercial vehicle demonstrator. The project – funded by the Advanced Propulsion Centre (APC) – aims to accelerate UK-based FCEV expertise and know-how to support the automotive industry's drive towards zero-emission propulsion.**

The FCVGen1.0 project [*FCB, November 2020, p5*] will use a prototype Ford Transit Battery Electric Vehicle and a modularised fuel cell system approach. The heavy BEV battery will be replaced by a smaller battery and a PEM fuel cell system will be installed, while the prototype's electric motors will be retained. A concurrent simulation approach will aid design and development, to ensure appropriate battery and balance-of-plant (BOP) component sizing. This will help assess the benefits of FCEVs (long range, fast refueling, increased payload) compared with BEVs for high-payload usage in light-duty commercial vehicles.

The project aims to determine the correct vehicle attributes and relevant system requirements for a feasible fuel cell electric commercial vehicle, to facilitate predefined customer use-cases. The findings will be used to develop the package design and functionality for a drivable FCEV, help identify key challenges and critical decisions in the development process, and assist in identifying sizing the battery and fuel cell stack for near-optimal vehicle configuration.

AVL Powertrain UK: www.avl.com/web/avl-uk

Advanced Propulsion Centre UK: www.apcuk.co.uk

## Nikola, Iveco open JV truck manufacturing facility in Germany

**Nikola Corporation and Iveco have inaugurated their joint venture manufacturing facility for Nikola Tre electric heavy-duty trucks in Ulm, Germany, ready to start production by year-end.**

The first Nikola Tre models produced at the Ulm factory [*FCB, March 2020, p12*] will be the battery electric vehicle (BEV) model, for delivery to selected customers in the US in 2022. The Nikola Tre fuel cell electric vehicle (FCEV) model will enter production in Ulm by the end of 2023. The 50,000 $m^2$ manufacturing facility features a final assembly process designed for 'electric-born' vehicles. This site, and the first phase of industrialisation, represents joint investment by Nikola and Iveco and involves a projected 160 suppliers [*January 2020, p4*]. The production line will be capable of manufacturing some 1000 units per shift per annum, ramping up in the following years.

The Nikola Tre is based on the Iveco S-Way truck platform with an electric axle co-designed and produced by FPT Industrial, and features Nikola's electric and fuel cell technology, along with key components from Bosch *[see the item on page 14]*.

Nikola and Iveco have also signed a Memorandum of Understanding with **Hamburg Port Authority** to collaborate on testing and implementation of Class 8 battery electric heavy-duty vehicles and charging infrastructure at the German port during 2022.

Meanwhile, Nikola has added **Quinn Company**, a leading provider of on-highway truck service and construction equipment in central and southern California, to its expanding US dealer network [*e.g. September 2021, p5*].

Nikola Corporation: www.nikolamotor.com

Iveco: www.iveco.com

Hamburg Port Authority: www.hamburg-port-authority.de/en

Quinn Company: www.quinncompany.com

## Hyzon trucks for China logistics firm, light truck with SoCalGas

**Demand for its heavy-duty hydrogen fuel cell electric trucks has seen Hyzon Motors sign a Memorandum of Understanding with Shanghai Hydrogen HongYun Automotive Co Ltd in China, for the purchase of 500 vehicles. Hyzon is also partnering with Southern California Gas on a fuel cell electric utility truck.**

Hyzon will deliver an initial 100 of its 49 ton hydrogen-powered tractor trucks to **HongYun** before the end of 2021, subject to execution of a definitive vehicle supply agreement, with the remaining 400 vehicles to be ordered in 2022. HongYun provides logistics solutions primarily through hydrogen fuel cell electric vehicles, offering operation, leasing and maintenance services for customers across China.

Meanwhile in the US, Hyzon is developing a fuel cell electric utility truck – its first vehicle in the light truck sector – in collaboration with **SoCalGas**, which aims to replace its entire over-the-road fleet with battery and fuel cell electric vehicles by 2035. Hyzon will deliver a Class 3 commercial service body utility truck to SoCalGas by 2022. The truck is expected to offer a maximum power of 200 kW with a range of 300 miles, and will be built on the existing chassis OEM used by SoCalGas.

Hyzon is supplying fuel cell electric heavy-duty trucks and buses to customers in North America, Europe and around the world [*e.g. FCB, August 2021, pp3–5*].

Hyzon Motors: www.hyzonmotors.com

Southern California Gas: www.socalgas.com

## $FresH_2$ refrigerated transport project starts road testing in France

**The $FresH_2$® fuel cell project initiated by Bosch and Carrier Transicold, in collaboration with refrigerated vehicle builder Lamberet and temperature-controlled food transport specialist STEF, entered its road testing phase in France in early September.**

$FresH_2$ is a clean and quiet solution to replace diesel engines for powering refrigeration units installed on temperature-controlled semi-trailers (articulated trucks), used to transport fresh and frozen food products, pharmaceuticals and other heat-sensitive goods. The fuel cell is directly interfaced with the refrigeration unit through a DC/AC inverter, eliminating the use of a bulky and expensive onboard buffer battery. The team at Bosch's Rodez facility have combined this with a Carrier Transicold Vector® HE19 multi-temperature refrigeration unit.

The $FresH_2$ system – the size of a pallet rack – is located within the wheelbase of Lamberet's SR2 heavy-duty refrigerated semi-trailer, without affecting its appearance, usable volume or overall height. The system is being tested in real-world food product distribution by STEF at its Chambéry site. Bosch's ultimate goal is to produce a competitive, turnkey solution at its Rodez factory that can be integrated into any type of refrigerated semi-trailer.

Bosch recently placed an order with PowerCell Sweden for initial development of a fuel cell system to power truck-trailer refrigerator units [*FCB, August 2021, p13*]. And

Carrier Transicold took part in the Refrigerated Optimized Advanced Design (ROAD) project in 2019, which trialed a hydrogen-powered refrigerated semi-trailer [*August 2019, p3*].

Carrier Transicold: www.carrier.com/truck-trailer/en

Robert Bosch GmbH, Fuel Cell Stacks: www.bosch.com/stories/fuel-cell-stack

Lamberet: www.lamberet.fr/uk

STEF: www.stef.com/en

# Eaton and Ballard link with NREL for heavy-duty truck fuel cells

**Hydraulic and power specialist Eaton – through its Vehicle Group – and Ballard Fuel Cell Systems – a US-based subsidiary of Canadian company Ballard Power Systems [*see also the item below*] – are partnering with the Department of Energy's National Renewable Energy Laboratory, to develop heavy-duty truck fuel cell technology.**

The new technology will leverage Eaton's Twin Vortices Series (TVS) supercharger technology to improve fuel efficiency. Eaton says that this technology provides accurate airflow control in proportion to speed, and means that a water applicator can replace the humidifier for higher operating pressure ratios and isentropic efficiencies.

Eaton will leverage its Corporate Research Labs in Colorado and Additive Manufacturing Center of Excellence in Michigan to produce the technology, using cutting-edge power electronics and 3D printing. Its Vehicle Group will design and test a subscale, proof-of-concept system prototype utilising TVS technology that delivers a significant reduction in air system power consumption and enhanced fuel cell efficiency for heavy-duty truck applications.

In other news, **NREL has published** a new total cost of ownership (TCO) study which finds that battery and fuel cell electric trucks could be economically competitive with diesel trucks by 2025 in some operating scenarios. The report, *Spatial and Temporal Analysis of the Total Cost of Ownership for Class 8 Tractors and Class 4 Parcel Delivery Trucks*, compares six leading powertrain technologies to quantify the TCO of different truck options, and identify operating scenarios where each technology may have an economic advantage.

Eaton, Vehicles: www.eaton.com/us/en-us/markets/vehicles.html

Ballard Power Systems: www.ballard.com

National Renewable Energy Laboratory: www.nrel.gov

NREL report: www.nrel.gov/docs/fy21osti/71796.pdf

# Ballard unveils Class 6 truck with Hexagon Purus, 100 kW module

**A collaboration between Hexagon Purus and Ballard Power Systems will produce Class 6 and 7 fuel cell electric trucks, powered by Ballard's fuel cell modules and Purus' electric drivetrain and hydrogen storage system solutions. Ballard has also launched its FCmove™-HD+ module for buses and trucks.**

**Ballard and Hexagon Purus** are accelerating the adoption of hydrogen fuel cells in heavy-duty transport. The truck, unveiled at the recent Advanced Clean Transportation Expo 2021 in California, offers a range of over 400 miles and refueling time comparable to conventional trucks. It combines Hexagon Purus' Type 4 lightweight, high-pressure hydrogen storage systems, high energy density ProPack battery storage and fully integrated electrified accessory systems with Ballard's 8th-generation FCmove fuel cell module. The first prototype truck will be delivered in Q2 of 2022, with first fleet deployments in and around the Los Angeles Basin.

Ballard has also added the **FCmove-HD+** fuel cell module to its heavy-duty portfolio [*FCB, July 2019, p12*], designed for buses and medium- and heavy-duty trucks [*see also the item above*]. This 100 kW module is smaller, lighter, more efficient, lower-cost, and designed for easier vehicle integration. It has been engineered for both engine bay and rooftop configurations. The first vehicles with the new module are anticipated in 2022, including trucks with Hexagon Purus and Quantron [*September 2021, p1, and see page 3 in this issue*].

Ballard Power Systems: www.ballard.com

Hexagon Purus: www.hexagonpurus.com

## MOBILE APPLICATIONS

# Mitsui E&S, PACECO target fuel cell power for container handling

**North American container handling crane manufacturer PACECO and Mitsui E&S Machinery (MES-M) in Japan are developing a hydrogen fuel cell powered Rubber-Tired-Gantry (RTG) crane for use in ports.**

## IN BRIEF

### Hyzon order to supply 154 ton fuel cell electric trucks to Ark Energy in Australia

US-based Hyzon Motors (www.hyzonmotors.com) [*see also page 4*] has received a definitive order for five 154 ton fuel cell electric trucks from Ark Energy Corporation (www.arkenergy.com.au), the Australian subsidiary of Korea Zinc [*FCB, August 2021, p4*].

Ark Energy will take delivery by the end of 2022, and lease the ultra-heavy-duty trucks to its sister company Townsville Logistics, which will deploy them in triple (three-trailer) road-train configurations as part of its short-haul fleet operating on a 30 km loop from the Port of Townsville to the group's Sun Metals zinc refinery. Hyzon expects to assemble the vehicles in Australia, in line with its plans to boost local production.

### HYCAP £1bn hydrogen investment fund

Green entrepreneur Jo Bamford – the man behind Ryze Hydrogen (www.ryzehydrogen.com) and Wrightbus [*e.g. FCB, July 2021, p3, and see page 3 in this issue*] – has joined forces with Vedra Partners (www.vedrapartners.com) to launch the HYCAP hydrogen investment fund (www.hycapgroup.com), which has set its sights on raising £1 billion (US$1.4 billion). The capital, already at more than £200 million after the first investment round, will be injected mainly into UK businesses, to speed up green hydrogen production and supply, create jobs and contribute to the government's Net Zero targets.

With the UK hosting COP26 (www.ukcop26.org) in Glasgow shortly, Mr Bamford says there was no time to wait in order to harness the appetite of sustainably focused investors. The team has already identified more than 40 firms in the hydrogen space that will be evaluated for investment.

### Hino Trucks XL8 fuel cell prototype

Hino Trucks (www.hino-global.com) – a Toyota subsidiary that manufactures and sells commercial trucks in the US – unveiled its Class 8 Hino XL8 prototype hydrogen fuel cell electric truck at the recent Advanced Clean Transportation (ACT) Expo 2021 in Long Beach, California. The next stage is to validate the performance, reliability and efficiency of the hydrogen fuel cell electric powertrain in the XL Series chassis.

Toyota Motor North America (www.toyota.com) and Hino Trucks announced last autumn they there were collaborating on building a heavy-duty fuel cell electric truck, targeting the North American market [*FCB, November 2020, p4*]. The initiative, called Project Z, expands on the group's ongoing work to develop a 25 tonne fuel cell electric truck for the Japanese market [*April 2020, p4*].

More than 270 PACECO-Mitsui Hybrid Transtainer® RTGs are in use today at container terminals around the world. PACECO and MES-M recently launched the NZE Transtainer® RTG, a near-zero-emissions crane with a small diesel engine that could easily be replaced by a zero-emissions power source. The partners have now been awarded a grant from the New Energy and Industrial Technology Development Organization (NEDO) in Japan, to develop a hydrogen fuel cell Rubber-Tired-Gantry crane. MES-M will use the NEDO grant to develop a next-generation, zero-emission (ZE Transtainer) RTG, powered by a hydrogen fuel cell power module. Preparation is ongoing, targeting completion of the initial demonstration of the hydrogen fuel cell powered RTG by March 2022, followed by testing at a to-be-determined terminal. The aim is to achieve a level of performance equivalent to a conventional diesel engine-driven RTG.

PACECO Corporation: www.pacecocorp.com

Mitsui E&S Machinery Co Ltd: www.mes.co.jp/english

## Alstom demos fuel cell train in France, links with Plastic Omnium

**Kicking off its first French demonstration, Alstom has showcased its Coradia iLint hydrogen fuel cell powered train at the Centre d'Essais Ferroviaires (Railway Testing Centre) in Valenciennes in northeastern France. Alstom is also partnering with Plastic Omnium to develop hydrogen storage systems for the railway sector.**

The Coradia iLint train is suitable for use on non-electrified lines, making it an ideal solution for small local lines. The train presented in Valenciennes was in a German configuration; adaptations will be necessary for approval according to French standards. A trial of the Coradia iLint train on the French network will be held in 2022 on the Tours-Loches line, a small local line in the Centre-Val de Loire region.

The first two Coradia iLint hydrogen trains [*see the News Feature in FCB, March 2017*] entered commercial service in Germany in 2018. To date, 41 trainsets have been ordered in Germany [*June 2019, p4 and June 2020, p3*], and Italian operator FNM has ordered 14 trains [*December 2020, p5*]. Successful trials have also taken place in the Netherlands [*April 2020, p5*], Austria [*January 2021, p5*], Poland [*July 2021, p6*] and Sweden [*September 2021, p6*].

Alstom has also signed a Memorandum of Understanding with **Plastic Omnium**, and set up a joint team to manage the technical and commercial development of onboard hydrogen storage solutions for the railway market, with development projects already under way. The partners aim to launch these solutions for regional trains in France and Italy from 2022.

Alstom, Coradia iLint: www.alstom.com/solutions/rolling-stock/coradia-ilinttm-worlds-1st-hydrogen-powered-train

Plastic Omnium: www.plasticomnium.com

## Loop Energy, H2M in project to convert train

**Solid-state hydrogen storage specialist Hydrogen In Motion (H2M) is collaborating with fuel cell-based solutions provider Loop Energy, to convert a diesel-electric switcher locomotive owned and operated by Southern Railway of British Columbia to hydrogen-electric.**

The companies will combine Loop Energy's 50 kW eFlow™ fuel cell system – created in its earlier incarnation as PowerDisc [*see the feature in FCB, March 2014*] – and a low-pressure, solid-state hydrogen storage tank developed by H2M. This is the first instance of Loop supplying its products for use in a rail transport application.

H2M [*e.g. September 2021, p4*] and Loop Energy will work with the School of Engineering at the University of British Columbia-Okanagan Campus (UBCO) and Southern Railway of BC (SRY Rail Link). UBCO's research component will conduct computational modeling of H2M low-pressure tanks, comparing the hydrogen-electric powertrain performance characteristics and operational functionality with those of the previous diesel-electric locomotive, while SRY will demonstrate this hydrogen-powered switcher locomotive to prove its viability.

Loop Energy: www.loopenergy.com

Hydrogen In Motion: www.hydrogeninmotion.com

## myFC fuel cell tech for Japanese e-bicycles

**Fuel cell developer myFC has signed an agreement for technology development and integration with a global – but not yet named – leader in bicycle and e-bicycle systems in Japan.**

In the summer Swedish-based myFC announced that it had received an order for its micro PEM fuel cell systems from a Japanese partner in the electromobility sector [*FCB, July 2021, p14*]. This order has now led to a cooperation agreement for technology development, under which the bicycle systems manufacturer will evaluate myFC's fuel cell solution in its e-bike system.

The main battery in the e-bike system will be replaced with fuel cells and a hydrogen tank, to get a lighter bike with the same dimensions, and much faster refueling with hydrogen compared with recharging a battery. The cooperation agreement covers the development of a proof of concept, which is expected to continue through the end of this year. No additional order has been made yet.

myFC: www.myfc.se

## Iris detect-and-avoid system for DMI drones

**Onboard systems developer Iris Automation in the US is partnering with South Korean company Doosan Mobility Innovation to integrate its Casia detect-and-avoid (DAA) system with DMI's family of hydrogen fuel cell powered systems and drones.**

**Iris Automation**'s Casia technology allows an unmanned aerial vehicle (UAV) to see and react to the environment around the aircraft. It detects other aircraft, classifies them using computer vision algorithms and makes intelligent decisions about the threat they may pose, then triggers an alert to execute manoeuvres to avoid collisions. This will enable DMI clients to operate safer beyond-visual-line-of-sight (BVLOS) missions, and accelerates the Korean manufacturer's entrance into the US market.

DMI's commercial fuel cell powered UAVs are BVLOS-capable and ideal for long flights. The company will provide US customers with the option of Casia integrated with its drones, or as a combined purchase with stand-alone powered systems. The partners will also collaborate on professional services to advance compliance with emerging US aircraft regulatory requirements.

In other news, Doosan Mobility has signed a Memorandum of Understanding with Korean drone solution provider **Airon**, to jointly identify overseas Official Development Assistance (ODA) project tasks. DMI plans to provide services such as vaccine and logistics deliveries, surveying and patrolling using hydrogen-powered drones [*e.g. FCB,*

*June 2021, p5*]. They will also develop a maintenance management service to improve customer convenience and usability, and provide specialised training in hydrogen drone operation and maintenance.

Doosan Mobility Innovation: www.doosanmobility.com

Iris Automation: www.irisonboard.com

Airon: www.theairon.com

## AFC partners with Urban-Air Port, first deployment in 2022

**Reducing emissions in the aviation sector is the aim of AFC Energy's hydrogen fuel cell supply and collaboration agreement with Urban-Air Port, a designer and operator of ground infrastructure for autonomous drones and electric takeoff and landing (eVTOL) passenger aircraft.**

AFC Energy will provide zero-emission, off-grid power solutions for Urban-Air Port's integrated sustainable transport hubs that, in addition to airborne vehicles, will serve battery electric vehicles, buses and scooters. The modular and compact hub design facilitates airport deployment in urban centres, and is also ideal for disaster emergency relief operations.

Urban-Air Port's 'Air-One' site – its first fully operational hub for eVTOL aircraft – will be unveiled in Coventry city centre in early 2022. AFC will provide a fully operational hydrogen fuel cell system, on a three-week lease, enabling clean power generation and EV charging onsite [*e.g. FCB, July 2019, p11*].

Under the terms of their collaboration, Urban-Air Port and AFC Energy will look to expand their partnership to support wider integration of sustainable power systems within the Urban-Air Port hub ecosystem in grid-absent or constrained environments.

Urban-Air Port is also partnering with the Urban Air Mobility division of Hyundai Motor Group [*e.g. January 2021, p13*] to develop 65 electric urban airports worldwide, to meet growing demand for e-mobility in the aviation sector. This partnership forms a key part of Urban-Air Port's plan to build 200 sites globally in the next five years.

AFC Energy: www.afcenergy.com

Urban-Air Port Ltd: www.urbanairport.com

Hyundai, Urban Air Mobility: www.hyundai.com/au/en/why-hyundai/concept-cars/urban-air-mobility



## Ceres SOFC tech for UK maritime demos

**Advanced solid oxide fuel cell developer Ceres Power reports that its technology will be evaluated for reducing maritime emissions in two projects under the UK government's Clean Maritime Demonstration Competition [*see also the items below*].**

The first project, with Carnival UK, University of Southampton, Shell and Lloyd's Register, will investigate the feasibility of using Ceres SOFC technology to replace diesel generators for providing cruise ship baseload 'hotel' power while in port.

The second project, with General Electric, Mediterranean Shipping Company (MSC) and Lloyd's Register, will explore how best to address the barriers to utilising fuel cells in large ship applications. It will examine how an SOFC can be integrated into a ship's operational functionality and existing power and propulsion architecture and layout, integration trade-offs, and will compare the impact of using SOFC technology on ship functionality and reducing emissions. Both projects will conclude in March 2022.

Earlier this year, Doosan partnered with Korea Shipbuilding & Offshore Engineering to develop a MW-class SOFC system for marine propulsion and power generation, utilising Ceres SOFC technology [*FCB, April 2021, p8, and see the Doosan–Ceres item on page 8*].

Ceres Power: www.ceres.tech

Clean Maritime Demonstration Competition: www.gov.uk/government/publications/clean-maritime-demonstration-competition-cmdc

## French partnership to promote hydrogen for decarbonising aviation

**Leading companies Airbus, Air Liquide and Vinci Airports – major players in the aviation, hydrogen and airport sectors, respectively – are collaborating to promote the use of hydrogen at airports, and build a European airport network to accommodate future hydrogen-powered aircraft and support the decarbonisation of air travel. Lyon–Saint-Exupéry Airport in France will host the first installations as early as 2023.**

The partners have chosen Lyon–Saint-Exupéry Airport for the pilot project, comprising several phases. From 2023, a hydrogen distribution station will be deployed, to supply the airport's ground vehicles (airside buses, trucks, handling equipment) and those of its partners, as well as the heavy goods vehicles driving around the airport. This first phase will test the airport's facilities and dynamics as a hydrogen hub.

Between 2023 and 2030 liquid hydrogen infrastructure will be rolled out, to supply future hydrogen-powered aircraft. And beyond 2030 a complete hydrogen infrastructure – from production to mass distribution of liquid hydrogen – will be deployed at the airport. The partners will also then look to equip Vinci Airports' European network with the hydrogen production, storage and supply facilities needed for use on the ground and onboard aircraft.

In the summer Air Liquide and Airbus partnered with Paris airports operator Groupe ADP to prepare for the arrival of hydrogen in airports by 2035 [*FCB, July 2021, p10*].

Air Liquide, Hydrogen Energy: www.airliquide.com/science-new-energies/hydrogen-energy

Vinci Airports: www.vinci-airports.com/en

Airbus, ZEROe programme: www.airbus.com/innovation/zero-emission/hydrogen/zeroe.html

## Intelligent Energy in project to extend flight time in military drones

**Loughborough-based Intelligent Energy is participating in a new project, funded by the UK Ministry of Defence, to develop hydrogen PEM fuel cells ready for MOD operational capability in unmanned aerial vehicles (UAVs, or drones) with extended flight times.**

As part of the initial phase, Project Pegasus will focus on development of the company's IE-Soar™ 800 W module, which is currently available to commercial UAV operators who need long-endurance solutions [*FCB, October 2018, p6*]. The next-generation product will be designed with an enhanced level of robustness required for military environments. This phase will also look at sourcing suitable expeditionary

hydrogen refueling stations for onsite hydrogen generation and refueling in remote locations, eliminating fuel logistics requirements.

NavyX, the innovation arm of the Royal Navy, will manage this project with funding from the Royal Navy, Army, Strategic Command (StratComm), Royal Air Force and MOD's Defence Innovation Fund. Phase one of the project will run for eight months under the Defence and Security Accelerator programme (DASA) contract. The exploitation plan anticipates trials of the IE-Soar module integrated into military surveillance drones next year, subject to funding being available for phase two, with MOD operational deployment expected in 2023.

Intelligent Energy: www.intelligent-energy.com

## EMEC wins funding for HIMET maritime project in Orkney

**The European Marine Energy Centre in Orkney, Scotland has won funding from the UK government for a seven-month project to demonstrate maritime decarbonisation technologies.**

The £2.2 million (US$3 million) Hydrogen in an Integrated Maritime Energy Transition (HIMET) project will explore solutions for decarbonising ferries as well as shoreside activities in ports. It is one of 55 projects selected for funding under the Department for Transport's flagship Clean Maritime Demonstration Competition, delivered in partnership with Innovate UK [*see also the items above and below*].

Led by EMEC Hydrogen [*e.g. FCB, March 2021, p9*], HIMET will focus on decarbonisation of two key local maritime sectors: ferry services and cruise terminal operations. To decarbonise ferries, various solutions will be designed and demonstrated including hydrogen storage specifically intended for use onboard a vessel, and the supply of onboard auxiliary power using a fuel cell. A conventional ferry propulsion engine will also be tested running on pure hydrogen. And to develop resilient shoreside power, a hydrogen engine will be deployed at Hatston in Orkney to power crew welfare facilities at the cruise terminal, and microgrid solutions will be evaluated for ferry terminals.

The HIMET consortium also includes Aquatera, Eneus Energy, OakTec, Orcades Marine Management Consultants, Orkney Islands Council, Ricardo, RINA, Schneider Electric, ULEMCo, and Urban Foresight.

EMEC Hydrogen: www.emec.org.uk/facilities/hydrogen

Clean Maritime Demonstration Competition: www.gov.uk/government/publications/clean-maritime-demonstration-competition-cmdc

## Bramble PCBFC tech in maritime projects

**High-performance fuel cell developer Bramble Energy is participating in two new projects, funded through the UK government's Clean Maritime Demonstration Competition [*see also the items above*], to develop and demonstrate its PCBFC™ (printed circuit board fuel cell) technology in zero-emission maritime operations.**

**SEA-KIT International** – which designs and builds uncrewed surface vessels (USVs) – will retrofit Bramble Energy's hydrogen fuel cell in its 12 m (40 ft) USV *Maxlimer* demonstration vessel. SEA-KIT USVs have a dual diesel-electric hybrid drive, with propulsion from an electric motor powered by batteries charged by diesel generators – one of which will be replaced with Bramble's fuel cell. SEA-KIT will utilise data from bench testing and sea trials for the design and construction of similar USVs, as well as for larger uncrewed vessels in the near future.

Bramble Energy – a spinout from UCL (University College London) and Imperial College London [*e.g. FCB, September 2020, p14*] – will design and manufacture a marinised, customised version of its PCBFC, which will sit inside an enclosure within the USV to prevent seawater ingress and corrosion. The company says that the use of PCBs, rather than metallic or graphite end plates, makes the technology more suited to rugged, marine environments.

In the **BRAMBUS Feasibility** project, Bramble Energy will partner with marine engine supplier EP Barrus Ltd, to develop a detailed design and business case for a marinised hybrid PCBFC-battery combined heat and power (CHP) system. This will lead to a commercially viable, fully integrated and packaged design that can operate in a recreational inland waterway vessel [*October 2020, p7*].

Bramble Energy: www.brambleenergy.com

SEA-KIT International: www.sea-kit.com

EP Barrus Ltd: www.barrus.co.uk

Clean Maritime Demonstration Competition: www.gov.uk/government/publications/clean-maritime-demonstration-competition-cmdc

SMALL STATIONARY

## Doosan preps 10 kW SOFC system for 2022

**English solid oxide fuel cell developer Ceres Power has supplied two 5 kW SOFC stacks to Doosan Corporation in South Korea, which has completed development of its initial 10 kW system for buildings and houses, and is planning a small-scale 'soft launch' of the commercial product in 2022. The system delivers 40% higher power generation efficiency compared with Doosan's existing PEM-based technology.**

The 10 kW system, similar in size to 5 kW SOFC products already on the market in Korea, is the result of a two-year collaboration between Ceres and Doosan [*FCB, August 2019, p6*]. Last October, the partners announced a further strategic alliance and licence agreement, with a commitment to build a 50 MW facility initially for the mass manufacture under licence of Ceres' fuel cell stacks in Korea by 2024 [*October 2020, p1*]. Doosan has now secured a domestic supply chain for the 10 kW product, and laid the foundations for growth with domestic component manufacturers.

Ceres' stack technology is also being used in a Korean collaboration to develop MW-class SOFC systems for the shipbuilding and offshore industries, involving Doosan Fuel Cell and Korea Shipbuilding & Offshore Engineering [*April 2021, p8*].

Doosan Corporation: www.doosan.com

Ceres Power: www.ceres.tech

## Tokuyama, Panasonic demo fuel cell using by-product hydrogen

**Factory by-product hydrogen is being used in a demonstration of Panasonic pure hydrogen fuel cell generators at the Tokuyama Factory in Shunan City, Yamaguchi Prefecture, which will run to the end of March 2023.**

The demonstration equipment is configured into a single system incorporating six pure hydrogen PEM fuel cell generators developed by Panasonic [*FCB, June 2021, p6*]. Hydrogen supply piping, thermal piping, and power output lines are connected and integrated

with the unit. This is the first Japanese demonstration of the integrated control of six hydrogen fuel cell generators.

Tokuyama is providing a stable supply of by-product hydrogen, generated during the manufacturing of caustic soda via brine electrolysis with an ion-exchange membrane process. Electric power generated by the demonstration equipment is being used in the factory's offices, and the heat generated during power generation recovered as hot water.

Panasonic is verifying and evaluating integrated control of the system, and its operating performance using by-product hydrogen. On-off operation of the system's six 700 W generators can be individually controlled, allowing a flexible power output from 700 W to 4.2 kW. Moreover, if one generator breaks down, the remaining five continue to operate; this feature also enables a continuous power supply if maintenance is sequentially performed on individual generators.

Tokuyama is already testing a 50 kW stationary fuel cell generator at the Tokuyama Factory, featuring the PEMFC system developed by Toyota for the *Mirai* fuel cell electric vehicle [*July 2020, p7*].

Tokuyama Corporation: www.tokuyama.co.jp/eng

Panasonic Corporation: www.panasonic.com/global/corporate/brand/story/clean_energy.html

## LARGE STATIONARY

# Doosan FC joins pilot project at Ulsan-Mipo

**In South Korea, Doosan Fuel Cell has joined a fuel cell pilot project using by-product hydrogen generated at the Ulsan-Mipo industrial complex. The company will supply a 3.08 MW phosphoric acid fuel cell system to generate baseload power, supported through a Long-Term Service Agreement (LTSA).**

Doosan FC has signed a Memorandum of Understanding to develop this load-response fuel cell demonstration project with Korea Hydro & Nuclear Power (KHNP), Hyundai Motor, LS Electric and SK Gas. The plant will be built on the Michang site at the Ulsan-Mipo industrial complex, on the southeastern coast. The plant – comprising seven 440 kW PureCell Model 400 systems – will use by-product hydrogen generated at the complex, in a load-response scheme interconnected with a Virtual Power Plant (VPP) platform, adjusting power generation output depending on the System Marginal Price (SMP) and fuel prices.

Last year Doosan FC supplied PureCell PAFC systems [*see the PureCell (then UTC Power) feature in FCB, February 2012*] to the 50 MW Daesan Hydrogen Fuel Cell Power Plant, which is believed to be the world's first large fuel cell power plant utilising by-product hydrogen [*August 2020, p7*].

Doosan Fuel Cell: www.doosanfuelcell.com

## PORTABLE & MICRO

# SFC wins EFOY order in US, Swiss deal

**SFC Energy in Germany has received the largest order yet for its EFOY direct methanol fuel cells, with US-based LiveView Technologies ordering more than 600 EFOY units for use in its mobile surveillance systems. SFC has also received an order for a portable power supply system for the Swiss Defence Forces.**

The EFOY DMFCs for **LiveView Technologies** will power LVT Rapid Deployment Trailers, which are equipped with camera towers and can be deployed in various locations. For example, supermarket chains place the camera systems in their car parks for monitoring and more efficient use of spaces, while on construction sites they manage access control. The order is worth some US$4 million, the largest yet for EFOY fuel cells, with deliveries scheduled over the next seven quarters. Earlier this year LVT ordered more than 100 EFOY Pro 2400 fuel cells [*FCB, June 2021, p6*].

SFC has also received an order for a portable power supply system from the Federal Office for Defence Procurement (Armasuisse) in **Switzerland**, worth several million euros. The SFC power network includes the Jenny 600S, Jenny 1200 and Emily 3000 fuel cell units, SFC Power Manager 3G, a powerful hybrid battery, foldable solar panel, methanol transfer unit and various cable connections [*see the SFC feature in January 2013*]. This will allow the Swiss defence forces to operate self-sufficiently away from the grid for several weeks during exercises in Switzerland or abroad.

SFC Energy: www.sfc.com

LiveView Technologies: www.lvt.com

Armasuisse: www.ar.admin.ch

## FUELING

# McPhy to equip high-capacity R-Hynoca station in Strasbourg

**Hydrogen refueling station manufacturer McPhy has been selected by the R-Hynoca project to set up the first hydrogen station in Strasbourg, in eastern France. The equipment includes a 350/750 bar dual-pressure refueling station with a distribution capacity of 700 kg/day, and a refueling point for pressurised hydrogen cylinders (tube trailers).**

The R-Hynoca project – led by R-ENR, a subsidiary of local gas utility R-GDS – aims to produce green hydrogen from local biomass. Hydrogen is produced utilising the Hynoca® process developed by Haffner Energy, for use as a fuel for low-carbon mobility and as a resource for industry. McPhy, the project's mobility partner, will provide a station with two terminals to refuel all types of hydrogen vehicles: a dual-pressure station for light-duty vehicles (350 and 700 bar), and a 'Hi-Flow' station for buses and trucks. This high-capacity station will deliver 700 kg/day of green hydrogen, enough to refuel the equivalent of a fleet of 30 buses, 70 light commercial vehicles, or 150 light vehicles.

McPhy will also equip the site with a refueling point for pressurised hydrogen cylinders in tube trailers, that will be transported for use in mobility or industrial applications elsewhere. The station and refueling interface are scheduled to be commissioned at the end of 2022.

McPhy: www.mcphy.com

Haffner Energy: www.haffner-energy.com/?lang=en

# Atawey unveils mobile station to serve HGVs

**Serving several heavy goods vehicles (HGVs) and ready to operate in only half a day, French company Atawey has launched its new mobile hydrogen refueling station.**

Atawey's mobile hydrogen station is designed to be set up in complete autonomy by the operator. The commissioning process is simplified through process automation and intuitive control screens. It offers a flexible hydrogen supply, with the station on a trailer

or on the ground, and an external supply by connection of frames/tube trailers or directly to a fixed hydrogen station, with a hydrogen source pressure from 200 to 500 bar. The high-performance options include 350 and 700 bar distribution, quick refueling (with pre-cooling), and battery-powered distribution.

The mobile station is targeted for use in vehicle tests and demonstrations, temporary applications on construction sites and for events, and will also serve as a temporary station (for project holders awaiting a permanent station) or as a backup for a fixed station under maintenance. This solution accelerates hydrogen mobility deployment by improving access to vehicle refueling for buses, coaches, trucks, dumpsters, vans etc. The station is now available for pre-order, with first deliveries from April 2022.

Atawey: www.atawey.com

## California expects 100 stations open by 2023

**The latest report from the California Air Resources Board anticipates that its initial target of 100 open retail hydrogen refueling stations could be achieved by the end of 2023, and more than 176 stations across the state through 2026.**

The report, *2021 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development*, admits that the rollout of hydrogen stations and fuel cell electric vehicles has been challenged by the statewide and global effects of the Covid-19 pandemic. Infrastructure development was slower than expected in 2020, and FCEV sales were significantly lower than in recent years. However, recent progress suggests that a recovery may be under way.

In addition, new station awards announced by the California Energy Commission and recently announced plans for private development of additional stations have significantly improved the outlook for 2021 and beyond [*e.g. FCB, January 2021, p9 and September 2021, p5*]. Sales of FCEVs in Q1 have already been nearly as much as all of 2019, and California's network of open-retail hydrogen stations will continue to grow in 2021.

The CARB report is focused primarily on fuel cell passenger cars, but the state is also leading the way on fuel cell electric buses [*e.g. August 2021, p3*] and heavy-duty trucks [*e.g. August 2021, p1*].

CARB Annual Hydrogen Evaluation 2021: www.arb.ca.gov/resources/documents/annual-hydrogen-evaluation

ENERGY STORAGE & P2G

## Nel to supply 5 MW alkaline electrolyser for H100 Fife project

**Eastern Scotland will host what is claimed to be the world's first 100% hydrogen-to-homes heating network, featuring a 5 MW alkaline water electrolyser recently ordered by natural gas distribution company SGN from Nel Hydrogen Electrolyser in Norway.**

The H100 Fife demonstration project in Levenmouth will highlight the role that hydrogen can play in decarbonising heat as an alternative to natural gas [*FCB, February 2021, p15*]. It is the first large-scale hydrogen-only network supplying green hydrogen from electrolysis to customers for heating and cooking. The system will be powered by a nearby offshore wind turbine and grid electricity. The newly built hydrogen gas distribution network will initially supply up to 300 households with zero-carbon heat, although the electrolyser and network have been sized to have the capacity to supply up to 900 homes as part of the project's planned expansion.

The contract for the 5 MW alkaline electrolyser includes installation and commissioning, and a service and maintenance contract. The electrolyser will deliver more than 2000 kg/day of green hydrogen at 30 bar gauge to the project.

Nel ASA: www.nelhydrogen.com

SGN: www.sgn.co.uk

H100 Fife project: www.sgn.co.uk/H100Fife

GREEN HYDROGEN

## Ways2H and Valecom waste-to-hydrogen facility for Martinique

**Valecom, an energy solutions provider in Martinique, has signed a Letter of Intent with California hydrogen systems company Ways2H to transform up to 9000 tons per annum of waste into renewable hydrogen. This first project between the companies will focus on hydrogen production for power generation on the Caribbean island, with possible future applications for clean mobility solutions including municipal buses.**

In Martinique, one of the largest waste streams is the plastic bags used to protect its main export product: bananas. Some 3000 tons of plastic film are used every year; these cannot be reused, but they are an ideal feedstock for Ways2H's waste-to-hydrogen process. Under the partnership, Ways2H will initially process 24 tons/day of mixed commercial waste, including plastics and furniture, with an additional 8 tons/day once the infrastructure is fully operational after an 18-month construction period.

Ways2H – a joint venture between US-based Clean Energy Enterprises and Japan Blue Energy Co Ltd – offers a carbon-neutral thermochemical process that extracts hydrogen from the worst waste streams – municipal solid waste, plastics, and other refuse – without incineration, to produce clean fuel for mobility and power generation. The company recently partnered with Element 2, a hydrogen refueling station provider and fuel retailer in the UK, to produce and distribute green hydrogen for public transit and other transport [*FCB, July 2021, p9*].

Ways2H: www.ways2h.com

## OYSTER hydrogen project for Grimsby

**European partners in the OYSTER consortium have chosen Grimsby on the UK's North Sea coast as the location for a project to develop and demonstrate a marinised electrolyser system integrated with offshore wind turbines, for renewable hydrogen production.**

The OYSTER project – undertaken by a consortium of ITM Power, Ørsted, Siemens Gamesa Renewable Energy, and Element Energy – will develop and test a MW-scale, fully marinised electrolyser in a shoreside pilot trial in Grimsby. The project will also explore the feasibility and potential of combining an offshore wind turbine directly with an electrolyser, and transporting green hydrogen to shore. The project is funded with EUR5 million from the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) [*FCB, February 2021, p10*].

Grimsby was selected because of the region's strong focus on offshore wind. The Humber region is also home to the Gigastack project – including ITM, Ørsted and Element Energy – which is developing a blueprint for the deployment of industrial-scale renewable

hydrogen from offshore wind [*February 2020, p1*].

ITM Power [*see the features in October and November 2020, and March and June 2021*] will design the electrolyser system to be compact, facilitating integration with a single offshore wind turbine, and to follow the turbine's power production profile. The electrolyser system will also integrate desalination and water treatment processes.

OYSTER project: www.oysterh2.eu

ITM Power: www.itm-power.com

Element Energy: www.element-energy.co.uk

## TotalEnergies, Air Liquide for Normandy low-carbon hydrogen

**Hydrogen production at TotalEnergies' Normandy platform in northern France will be decarbonised in a partnership with Air Liquide. The project will supply TotalEnergies with low-carbon hydrogen via Air Liquide's hydrogen network in Normandy and the implementation of a large-scale $CO_2$ capture and storage (CCS) solution.**

Under a long-term contract agreement, Air Liquide will take over and operate the 255 tonnes/day hydrogen production unit at the TotalEnergies platform in Normandy. Connecting the unit to Air Liquide's hydrogen network will optimise performance, and ultimately develop the world's first low-carbon hydrogen network. The network already includes a hydrogen production facility in Port-Jérôme equipped with Air Liquide's Cryocap™ carbon capture solution, which produces clean hydrogen under the CertifHy Green and Low Carbon Hydrogen Guarantees of Origin scheme [*FCB, February 2019, p11*]. Air Liquide is considering adding a large-scale unit to produce renewable hydrogen via electrolysis.

In addition, the companies will launch development studies to deploy a CCS project to decarbonise the hydrogen produced in this unit at the Normandy platform. Air Liquide would install its Cryocap process to capture $CO_2$, while TotalEnergies handles its transportation and storage, notably through the Northern Lights (Norway) and Aramis (Netherlands) CCS projects being developed in the North Sea.

TotalEnergies: www.totalenergies.com

Air Liquide, Hydrogen Energy: www.airliquide.com/science-new-energies/hydrogen-energy

## H-TEC electrolyser for green hydrogen plant project with Wenger

**A PEM electrolysis system from H-TEC Systems will serve a new project with Wenger Engineering in Germany. The ME450/1400 PEM electrolyser will convert renewable energy from wind turbines into 450 kg/day of green hydrogen.**

H-TEC Systems – acquired by MAN Energy Solutions earlier this year [*FCB, February 2021, p13*] – manufactures electrolysers and electrolysis stacks for green hydrogen production [*e.g. October 2019, p9*]. Its ME450/1400 PEM electrolyser is a proven turnkey solution for renewable hydrogen production, comprising a transportable 12 m (40 ft) container holding nine S450 series PEM stacks. With a total electrolysis power of 1 MW, it delivers 450 kg/day of hydrogen, the equivalent of nine truck refuelings. The multi-stack design and high availability through parallel operation minimises risks and reduces costs.

Wenger Engineering specialises in hydrogen technology, Power-to-Gas (P2G) and renewable energy, and has played a major role in developing global standards for hydrogen refueling stations. It recently signed a supply agreement with Danish company Green Hydrogen Systems, to deliver 1.3 MW of alkaline electrolysers for a green hydrogen production project in northern Germany [*August 2021, p11*].

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

Wenger Engineering: www.wenger-engineering.de/en/

## Toray, Siemens link for PEM electrolysis

**Siemens Energy KK and Toray Industries in Japan will develop PEM water electrolysis systems for green hydrogen production based on new membrane technology, as part of a government-supported R&D and demonstration project.**

Toray and Siemens Energy will jointly develop and demonstrate the largest multi-MW PEM electrolyser in Japan, featuring new membrane technology from Toray. The Green Hydrogen Project is part of the Green Innovation Funding Program organised by the Ministry of Economy, Trade and Industry (METI) and the New Energy and Industrial Technology Development Organization (NEDO). Toray and Siemens Energy will receive the funding together with six other partners, including the Yamanashi Prefectural Enterprises Bureau and Tokyo Electric Power Company (TEPCO).

The partners aim to advance the technology for green hydrogen production based on PEM water electrolysis using renewable energy sources, to serve large-scale power generation and other electric power applications, as well as for sector coupling such as heat, transport, and industrial applications. Toray will provide Siemens Energy with its proprietary hydrocarbon electrolyte membranes, and collaborate to install and demonstrate them in Siemens Energy's industrial-scale PEM water electrolyser.

Siemens Energy: www.siemens-energy.com

Toray Industries: www.toray.com

## Snam, Edison plan green hydrogen in Italy

**Large-scale green hydrogen production and transport in southern Italy has moved closer with the signing of a Memorandum of Understanding between Edison, Snam [*e.g. FCB, February 2021, p11*], Saipem and Alboran Hydrogen for the joint development of the Puglia Green Hydrogen Valley project.**

This project plans to build three green hydrogen production plants in the Puglia (Apulia) region – in Brindisi, Taranto and Cerignola (Foggia) – for a combined capacity of 220 MW, powered by 380 MW of solar photovoltaic production. It aims to accelerate the uptake of green hydrogen within Italy's energy mix, to ensure national and European climate neutrality targets are met by 2050.

Once the plants are operational they will be able to produce a total of 300 million $m^3$ per annum of renewable hydrogen, which will be used primarily for local industries, including injection into Snam's local natural gas network [*e.g. June 2021, p15*] and/or utilised for sustainable mobility. The authorisation process is already under way for the Brindisi project, which will construct a hydrogen production plant using 60 MW of electrolysers powered by a solar farm. In order to execute the project, the partners anticipate creating a special purpose company (joint venture) following the signing of binding agreements currently under negotiation.

Edison: www.edison.it/en

Snam: www.snam.it/en

Saipem: www.saipem.com

Alboran: www.alboraninvest.com

## Enertrag, Sunfire plan 10 MW pressurised alkaline electrolyser

**Enertrag has signed a cooperation agreement with electrolyser manufacturer Sunfire, to realise an electrolysis test field at Prenzlau in eastern Germany.**

The partners will install and operate a number of electrolyser systems with a total capacity of up to 15 MW at Enertrag's new hydrogen centre in Prenzlau. Under their collaboration Sunfire will deliver a new S+ generation 10 MW pressurised alkaline electrolyser. In addition, the first hydrogen refueling station in the Uckermark district will be built at the Prenzlau facility, supplied with green hydrogen produced onsite. Enertrag will connect the hydrogen centre through its own power line to the 600 MW Uckermark renewable energy plant.

The project benefits from Enertrag's experience in operating the hybrid power plant to produce green hydrogen [*see the News Feature in FCB, May 2012*]. The green hydrogen is planned to be used for the mobility sector, in particular for local public transport. Enertrag will be responsible for commercialisation of the hydrogen produced, which can also be supplied to customers via trailers.

Sunfire is also installing other electrolysis systems in Prenzlau, including a high-temperature electrolyser based on its high-efficiency solid oxide electrolysis cell (SOEC) technology [*e.g. June 2021, p13*].

Enertrag, Hydrogen: https://enertrag.com/en/audience-pages/hydrogen-customers

Sunfire: www.sunfire.de

## Lhyfe offshore green hydrogen project, starts production site

**French renewable hydrogen producer Lhyfe is partnering with UK-based Aquaterra Energy and Borr Drilling to develop the Project Haldane concept for offshore green hydrogen production in the North Sea. Lhyfe has also begun producing renewable hydrogen at its new facility in western France.**

The partners behind **Project Haldane** will develop a large-scale offshore green hydrogen production concept utilising an electrolyser on a converted jack-up rig. This flexible solution will provide an offtake for the renewable electricity produced in the immediate vicinity of the wind farm, and leverage existing platforms, pipelines, terminal infrastructure and offshore equipment to reduce costs. Lhyfe is already developing an offshore green hydrogen production facility powered by a floating wind turbine, scheduled to start operation off the French coast in 2022 [*FCB, July 2021, p12*].

Meanwhile, Lhyfe recently began producing its first green hydrogen from wind power at its **new facility in Bouin**, near Nantes, and is ready to scale up production. Following several days of testing at this site [*June 2020, p9*], Lhyfe produced 627 kg of renewable hydrogen using an electrolyser powered by nearby wind turbines [*January 2021, p10*]. This served as the final test, with full-scale production expected to start at the end of September, for new partners that will be identified shortly. Lhyfe will produce 300 kg/day of green hydrogen, ramping up to 1 tonne/day in the coming months.

Lhyfe: www.lhyfe.com

Aquaterra Energy: www.aquaterraenergy.com

Borr Drilling: www.borrdrilling.com

## California city plans first green hydrogen transport ecosystem

**The City of Lancaster in southern California, clean energy company SGH2 Energy and Japanese gases company Iwatani are partnering to launch the state's first closed-loop green hydrogen ecosystem for transportation. This will comprise green hydrogen generation, refueling stations, and light- and heavy-duty fuel cell electric vehicles.**

SGH2 Energy's gasification technology uses biogenic waste, biomass and recycled water to produce carbon-negative hydrogen, employing a stacked modular design built for rapid scale-up and linear distributed expansion at lower capital costs. The City of Lancaster, which will host and co-own the green hydrogen production facility, will facilitate the supply of guaranteed feedstock of waste paper [*FCB, June 2020, p9*].

The SGH2 Energy Lancaster plant, to be located on a 5 acre (2 ha) site zoned for heavy industry on the edge of the city, is scheduled to break ground in Q1 of 2022 and begin production in Q3 of 2023. It will produce up to 11,000 kg/day of green hydrogen, and process 42,000 tons of recycled waste annually.

Iwatani – a leading developer of hydrogen refueling stations in California [*e.g. April 2021, p12*] – will use SGH2's green hydrogen to supply both existing and new refueling stations rolling out across the state. Under a multi-year Off Take Hydrogen Supply contract, Iwatani will purchase a large portion of SGH2's green hydrogen from the plant, filling tube trailers with compressed hydrogen for delivery to hydrogen stations across southern California.

SGH2 Energy: www.sgh2energy.com

City of Lancaster: www.cityoflancasterca.org

Iwatani Corporation of America: www.iwatani.com

COMMERCIALISATION

## Optima automates fuel cell production lines

**The Optima Packaging Group has expanded its product portfolio with machine solutions to automate the required production steps – coating, cutting, assembling the individual layers, and stacking – and thereby increase fuel cell production capacity.**

Optima's Life Science business unit developed the fuel cell manufacturing technologies in cooperation with Coatema Coating Machinery GmbH. The complete solutions – launched at the recent f-cell trade show in Stuttgart – include unwinding, coating and cutting gas diffusion layers (GDLs), as well as combining the GDL and catalyst-coated membrane (CCM) to form finished membrane-electrode assemblies (MEAs). Stacking the finished MEAs into a fuel cell stack occurs in the final stages of development.

This machine solution will be market-ready by the end of this year. The development work built on technologies previously used for manufacturing and packaging processes in the medical technology, consumer goods, and paper hygiene industries.

Optima Packaging Group GmbH: www.optima-packaging.com/fuel-cell

Coatema Coating Machinery GmbH: www.coatema.de

# Hyundai Motor vision to popularise hydrogen energy for all by 2040

**Hyundai Motor Group announced its Hydrogen Vision 2040 at the recent Hydrogen Wave global online forum, and unveiled plans for electrification of all new commercial vehicle models – featuring fuel cell or battery electric powertrains, as well as the application of fuel cell systems – by 2028.**

A series of new fuel cell systems were presented at the forum, including a prototype third-generation PEM fuel cell stack – a higher-power, lower-cost, significantly smaller successor to the NEXO system, in 100 and 200 kW versions – planned for market introduction in 2023. A new Power Unit Module offers outputs from 500 kW to 1 MW by stacking 100 kW modules, ideal for emergency power for ships or data centres, and a Full-Flat System lowers stack height to 25 cm, allowing use in applications such as autonomous vehicles, buses [*see also page 2*] and trams. The Group is also developing a tractor unit based on the XCIENT Fuel Cell heavy-duty truck that will be released in 2023 [*FCB, August 2021, p4*], and 30 kW and 50 kW hydrogen fuel cell powerpacks for forklifts and excavators.

Several innovative concepts for vehicles and hydrogen refueling were unveiled under the Group's dedicated HTWO fuel cells brand [*January 2021, p13*]. The *Trailer Drone* is a fully autonomous, hydrogen-powered container transportation system, featuring the *Fuel Cell e-Bogie* fully enclosed fuel cell propulsion system sitting under the container like a rail bogie, to give unprecedented manoeuvrability. And the *Rescue Drone* combines with a Fuel Cell e-Bogie to allow autonomous and remote operation and for firefighting and life-saving applications, with a range of up to 500 km.

New vehicles include the *Vision FK* hydrogen-powered hybrid high-performance sports car, with a maximum output >500 kW; the *RHGV* (Rescue Hydrogen Generator Vehicle) to supply power to vehicles in aid of urgent assistance in remote, off-road areas; and the *H Moving Station*, a heavy-duty vehicle equipped with refueling facilities for fuel cell electric vehicles, offering an option in areas with limited hydrogen stations.

Hyundai Motor Company: www.hyundai.com/worldwide

Hydrogen Wave presentation: https://youtu.be/hnWFXaQwKdE

# Plug Power announces German HQ, green hydrogen in California

**Europe is a key market for US-based Plug Power, which has announced a new regional headquarters in the German state of North Rhine-Westphalia (NRW), as well as plans to build a green hydrogen production facility in California.**

The initial 70,000 ft$^2$ **facility in Germany** will house an innovation centre with engineering labs and technical support; a monitoring, diagnostics and technical support centre; a green hydrogen generator with electrolyser infrastructure onsite; a shipping, inventory and logistics centre; and a training space. Roughly 30 employees will work at the site, which will open at the start of 2022, with the workforce expected to double by mid-year.

Plug Power has made significant progress in hydrogen mobility with key European industrials, logistics customers and vehicle manufacturers, in particular its HYVIA joint venture with Renault [*FCB, July 2021, p2*].

Plug Power is also expanding its green hydrogen ecosystem in the US [*e.g. September 2021, p13*], with the construction of a new state-of-the-art production facility in Fresno County, **California**. The company says that this will be the largest green hydrogen production facility on the West Coast, utilising a new 300 MW solar farm to power 120 MW of Plug Power PEM electrolysers that will produce 30 tonnes/day of liquid (cryogenic) green hydrogen. The project includes construction of a new tertiary wastewater treatment plant in the city of Mendota, providing recycled water for residents and supplying the plant's full needs. Construction is expected to begin in early 2023, with commissioning in early 2024.

Plug Power: www.plugpower.com

# UK launches hydrogen skills coalition, report on truck supply chain

**British players in the green hydrogen sector have joined with academia and supply chain partners to launch the Hydrogen Skills Partnership, which aims to show the benefits that this industry could bring to Scotland and across the UK. And the National Composites Centre and Arcola Energy have published a report on UK supply chain opportunities in hydrogen heavy-duty vehicles.**

The **Hydrogen Skills Partnership** includes ScottishPower, ITM Power, Arcola Energy, Energy Transition Zone Ltd, Skills Development Scotland, Aberdeen University, Robert Gordon University, North East Scotland College, and the Hydrogen Partnership. The partners will collaborate in assessing the readiness of the UK supply chain to support green hydrogen projects, and highlight the potential economic value for the domestic supply chain. The partnership will also show the potential for green, sustainable skills and high-value jobs emerging from a future hydrogen sector, using live projects as case studies.

Meanwhile, Arcola and the National Composites Centre have published the key findings of a **UK Hydrogen Supply Chain Survey** [*FCB, February 2021, p12*], capturing data from 175 industrial actors in the fuel cell electric heavy-duty vehicle powertrain market. The findings suggest that key areas of opportunity and current supply chain strengths include hydrogen storage, high-power batteries, and power electronics, machines and drives, with investment in R&D, vehicle deployment and infrastructure essential to progress.

Arcola Energy: www.arcolaenergy.com

ITM Power: www.itm-power.com

National Composites Centre, report: www.nccuk.com/media/jg3d0akk/ncc073-uk-hydrogen-fuel-cell-brochure_final_web.pdf

# Johnson Matthey sets up hydrogen tech unit

**UK-based Johnson Matthey is combining its Green Hydrogen and Fuel Cells entities into a new Hydrogen Technologies business unit, to accelerate JM's growth and scale-up in both markets.**

The combination will take advantage of technical and manufacturing synergies, and build on JM's long experience in developing and manufacturing fuel cell components [*e.g. FCB, February 2021, p14*]. The new Hydrogen Technologies business will be headed by Ralph Calmes, who has been appointed Managing Director. Calmes, who previously led JM's Platinum Group Metal Services business, took up this role on 1 October, with Eugene McKenna (Green Hydrogen) and Jo Godden (Fuel Cells) reporting directly to him. Ralph

will report to Group Chief Executive Robert Macleod. Johnson Matthey's 'blue' hydrogen team will remain within its Efficient Natural Resources sector.

Johnson Matthey, Hydrogen: www.matthey.com/hydrogen

Johnson Matthey Fuel Cells: www.jmfuelcells.com

## HTEC investment by Chart, I Squared

**I Squared Capital (ISQ) and Chart Industries have completed a C$217 million (US$171 million) investment in Vancouver, BC-based HTEC Hydrogen Technology & Energy Corporation, which will fund new green hydrogen production projects and expand its hydrogen refueling station portfolio serving the light- and heavy-duty markets.**

HTEC designs, builds and operates hydrogen infrastructure to support increasing hydrogen demand, and is active across the hydrogen value chain in Canada [*e.g. FCB, May 2021, p8*], with multiple green hydrogen production projects in backlog and six stations expected by year-end [*July 2021, p9*].

This investment expands Chart's ownership of HTEC to 25% [*January 2021, p13*] and gives ISQ a 35% holding, with HTEC's original shareholders and employees retaining 40% of the company. The majority of directors of HTEC remain independent of Chart and ISQ, and the company will still be headquartered in British Columbia.

Chart Industries is a leading global manufacturer of liquefaction and cryogenic equipment serving applications in the energy and industrial gas markets, including hydrogen [*e.g. August 2021, p5*], while ISQ is an independent global infrastructure investment manager focusing on clean energy, utilities, telecoms and transport in the Americas, Europe and Asia.

HTEC: www.htec.ca

Chart Industries: www.chartindustries.com

I Squared Capital: www.isquaredcapital.com

## Feintool, SITEC link for manufacturing of bipolar plates in China

**Laser machining specialist SITEC in Germany has signed a Memorandum of Understanding with Swiss precision processing company Feintool, to collaborate on metallic bipolar plate production for fuel cells in China.**

The first step will be to set up equipment at Feintool's existing production plant in Taicang, near Shanghai, with SITEC contributing machines and experts in joining to a 'shop-within-a-shop' concept. In an integrated process of FEINforming and laser welding, high-precision individual plates are joined to form bipolar plates and then tested for leakage. This alliance will allow Feintool to supply customers with competitive, high-quality bipolar plates in high-volume production, with the partners continuously developing the manufacturing processes.

Feintool offers a complete, customer-specific solution for prototype, pre-production and high-volume production of optimised bipolar plates, while SITEC has been mass-producing laser-welded bipolar plates to customer order since 2012.

Feintool International: www.feintool.com

SITEC Industrietechnologie GmbH: www.sitec-technology.de

## Smart and MicroNova unveil simulation tech for fuel cell controllers

**Dynamic measurement and modeling companies Smart Testsolutions and MicroNova have launched their HIL (hardware-in-the-loop) system, called 'NovaCarts Fuel Cell featuring Smart-TS MCM', a powerful real-time platform for the validation of fuel cell control units (FCCUs).**

The new platform is based on MicroNova's NovaCarts Fuel Cell HIL simulator, featuring Smart's new MCM IntelliSim modules for simulating the individual cell voltages in a fuel cell, and comes from their partnership announced last year [*FCB, October 2020, p15*].

NovaCarts Fuel Cell featuring Smart-TS MCM was developed specifically to validate automotive FCCUs. It simulates the entire fuel cell stack as well as the environment of the associated control unit in the vehicle, and can be expanded via firmware updates for future FCCU technologies. The cell voltages are simulated by the compact and robust MCM IntelliSim modules from Smart Testsolutions, which can be easily plugged together to form a multicell stack in the same way as its proven CVM G5 cell voltage monitoring modules [*December 2019, p12*].

Smart Testsolutions GmbH: www.smart-testsolutions.de

MicroNova: www.micronova.de/en/NovaCartsFuelCell

## SFC partners with BEL and FC TecNrgy

**Indian companies Bharat Electronics Ltd (BEL) and FC TecNrgy Pvt Ltd, a major provider of alternative energy management solutions, have signed a Memorandum of Understanding with German-based SFC Energy.**

The MOU sets the framework for current and future cooperation between the companies, which aim to address the rapidly developing market for low-emissions, off-grid power supply for homeland security, civil protection, defence, and a range of additional applications in India. The deal will combine BEL's engineering and large-scale production strengths with SFC's fuel cell expertise and FC TecNrgy's system integration and installation know-how [*FCB, November 2016, p10, and March 2021, p6*]. The partners target local sales of EUR50–100 million by 2025.

The MOU will enable SFC to create and seize the ample opportunities available in the Indian market on the back of the government's policy initiatives, such as Make-in-India, as well as renewable and clean hydrogen programmes. At the same time, the partners will establish a centre of excellence to offer fuel cell solutions specifically geared to meet the needs of the Indian market.

SFC Energy: www.sfc.com

Bharat Electronics Ltd: www.bel-india.in

FC TecNrgy Pvt Ltd: www.fctecnrgy.com

## Nikola, Bosch deal for fuel cell manufacturing

**Nikola Corporation has signed strategic agreements with the Bosch Group of companies for Nikola Class 7 and 8 fuel cell electric heavy-duty trucks, which will enable Nikola to build Bosch fuel cell power modules at its Coolidge, Arizona facility.**

The agreements will allow the adaptation of the fuel cell power modules for the Nikola Tre and US Nikola Two vehicles. Bosch will supply both fully assembled fuel cell power modules and major components to Nikola, including the fuel cell stack, for Nikola to assemble at

its manufacturing facility in Coolidge [*FCB, August 2020, p11*]. The parties will collaborate on sourcing the remaining components for the assemblies.

The modules are expected to launch in 2023, with the first application being the Class 8 regional-haul Nikola Tre FCEV truck; Nikola plans to further expand capacity for use in its Class 8 long-haul Nikola Two FCEV truck. The vehicles are planned to utilise common fuel cell power modules in 200 and 300 kW configurations. The Nikola Tre FCEV will also be launched in the European Union, utilising the same fuel cell power modules and supporting vehicle manufacturing planned at Nikola's joint venture with Iveco in Ulm, Germany [*see page 4*].

Nikola is currently building and testing Tre FCEV alpha vehicles utilising the fuel cell modules from these agreements, and plans to begin road testing by the end of 2021 in support of customer pilot tests.

Nikola Corporation: www.nikolamotor.com

Bosch Group: www.bosch.com

## Hydrogenious funding to deploy tech at scale

**German company Hydrogenious LOHC Technologies has raised a further EUR50 million to support the deployment of commercial liquid organic hydrogen carrier (LOHC) bulk storage systems in landmark hydrogen projects in Europe, the Middle East and beyond.**

Hydrogenious' LOHC technology bonds hydrogen to a non-toxic, non-flammable liquid, making it suitable for safe, efficient transportation and distribution using existing infrastructure, and allowing hydrogen to be generated and transported at scale, anywhere in the world.

The oversubscribed funding round was led by JERA Americas, alongside Temasek in Singapore, with Chevron Technology Ventures and Pavilion Capital investing for the first time. Existing investors AP Ventures, Royal Vopak and Winkelmann Group [*FCB, August 2019, p10 and January 2020, p13*] also contributed to the round.

Hydrogenious will build on this successful fundraising by continuing to drive the industrialisation and scale-up of its StoragePlant and ReleasePlant systems to match the huge demand for green hydrogen for large-scale industrial projects. The company will also further expand the use of LOHC as an onboard fuel in maritime applications, recently initiated in its Norwegian maritime joint venture [*August 2021, p7*].

Hydrogenious LOHC Technologies GmbH: www.hydrogenious.net

JERA: www.jera.co.jp/english

Temasek: www.temasek.com.sg

## Enapter breaks ground on electrolyser factory

**Building work has begun on Enapter's electrolyser mass-production facility in Germany, which is expected to provide a production capacity of 10,000 electrolysers per month in order to meet the rapidly growing demand for low-cost green hydrogen production solutions.**

The 82,000 $m^2$ Enapter Campus is being built in 'climate community' Saerbeck in North Rhine-Westphalia [*FCB, November 2020, p12*], and will be powered entirely with locally produced renewable energy. Based on current plans, the Enapter Campus will cost around EUR105 million, and create around 300 jobs. Construction partner Goldbeck will build at an ambitious tempo, so that production can begin incrementally in Q4 of 2022, with first mass-production customer deliveries envisaged to start in 2023. The manufacturing facility will also include warehouse storage, offices and R&D laboratories, and will serve as a blueprint for further Enapter production facilities worldwide.

The automated mass-production of electrolysers will enable Enapter to cut the cost of the devices and thus quickly make green hydrogen competitive with fossil fuels. Development of the machinery necessary for mass production has been supported by some EUR9.4 million in funding from the NRW Ministry of Economic Affairs, Innovation, Digitalization and Energy [*July 2021, p14*].

Enapter already provides more than 70 integrators and project developers in 40 countries with its anion-exchange membrane (AEM) electrolysers, which are standardised but flexible in implementation for many applications. From 2022, Enapter will offer the first MW-scale AEM electrolyser – the containerised AEM Multicore – featuring 420 AEM electrolysis cell stacks [*June 2021, p10*].

Enapter has also just won a £1 million (US$1.4 million) award as part of the Earthshot Prize – set up by Prince William, Duke of Cambridge – under the 'Fix our Climate' category, to make green hydrogen affordable and accessible to all.

Enapter: www.enapter.com

Earthshot Prize: www.earthshotprize.org

## Universal Hydrogen to focus on $LH_2$ capsules

**Year-old hydrogen aviation company Universal Hydrogen Co has announced that it will locate its second engineering and design centre in Toulouse, France, which will focus on developing lightweight liquid hydrogen capsules for its modular distribution system.**

Universal Hydrogen is leasing Hangar B16 at Toulouse-Blagnac Airport, and has appointed Airbus veteran Pierre Farjounel as General Manager of its European operations. The centre will initially focus on developing a liquid hydrogen capsule for the company's modular storage and logistics system. As it grows through 2022, the centre will also support the development of conversion kits for retrofitting regional aircraft with a hydrogen fuel cell powertrain, as well as development of modular hydrogen storage technology for single-aisle aircraft, unmanned aerial vehicles (UAVs) and other applications.

In May, the company was one of 11 winners in the Paris region's 'H2 Hub Airport' competition [*e.g. FCB, July 2021, p10*], and is working to develop a full-scale hydrogen aviation demonstration, as well as a regional service centre in the Paris region by the end of 2022. It is also active in Germany [*August 2021, p7*] and the Netherlands.

In the US, the company is partnering with Plug Power to develop, build and certify a commercially viable 2 MW hydrogen fuel cell-based propulsion system to power commercial regional aircraft [*October 2020, p6*], and is part of a consortium to set up a Hydrogen Aviation Test and Service Center in Washington state [*September 2021, p7*].

Universal Hydrogen Co: www.hydrogen.aero

# EVENTS CALENDAR

29 November–3 December 2021
**2nd European Hydrogen Week, including European Hydrogen Forum, FCH JU Programme Review Days and FCH JU Awards**
*Hybrid event*
**More information:** www.fch.europa.eu/event/european-hydrogen-week-2021

8–10 December 2021
**2nd Annual Asia-Pacific Hydrogen Summit, organised by Sustainable Energy Council and Asia-Pacific Hydrogen Association**
*Online*
**More information:** www.asia-hydrogen-summit.com

13–14 December 2021
**AVERE E-Mobility Conference 2021: The End of the ICE Age**
*Brussels, Belgium*
**More information:** www.aec-conference.eu

15–17 December 2021
**9th European Fuel Cells and Hydrogen Piero Lunghi 2021 Virtual Conference**
*Online*
**More information:** www.europeanfuelcell.it

## 2022

21–24 January 2022
**5th International Conference on Advanced Energy Materials, ICAEM 2022**
*Sanya, China*
**More information:** www.icaem.org

8–10 March 2022
**SEC World Hydrogen 2022 Summit & Exhibition, Sustainable Energy Council**
*Rotterdam, The Netherlands*
**More information:** www.world-hydrogen-summit.com

16–17 March 2022
**ACI Hydrogen & Fuel Cells Energy Summit 2022**
*Porto, Portugal*
**More information:** www.wplgroup.com/aci/event/hydrogen-fuel-cells-energy-summit

16–18 March 2022
**FC EXPO 2022, International Hydrogen & Fuel Cell Expo, within World Smart Energy Week**
*Tokyo, Japan*
**More information:** www.fcexpo.jp/en-gb.html

5–7 April 2022
**SAE WCX™ Digital Summit: Autonomous, Connected, Electrified**
*Detroit, Michigan, USA*
**More information:** www.sae.org/attend/wcx

10–14 April 2022
**AIChE 2022 Spring Meeting & 18th Global Congress on Process Safety, including Topical 5: Emerging Technologies in Clean Energy, and Topical 12: Hydrogen Safety**
*San Antonio, Texas, USA*
**More information:** www.aiche.org/conferences/aiche-spring-meeting-and-global-congress-on-process-safety/2022

25–29 April 2022
**Hydrogen + Fuel Cells Europe 2022, within Hannover Messe**
*Hannover, Germany*
**More information:** www.h2fc-fair.com

5–6 May 2022
**16th International Conference on Electrochemical Impedance Spectroscopy and its Applications, ICEISA 2022**
*Dubai, United Arab Emirates*
**More information:** https://waset.org/electrochemical-impedance-spectroscopy-and-its-applications-conference-in-may-2022-in-dubai

11–12 May 2022
**All-Energy Exhibition & Conference 2022**
*Glasgow, Scotland, UK*
**More information:** www.all-energy.co.uk

25–26 May 2022
**4th Annual International Hydrogen and Fuel Cell Event, f-cell Canada 2022**
*Edmonton, Alberta, Canada*
**More information:** www.hyfcell.com

29 May–2 June 2022
**241st ECS Meeting, The Electrochemical Society, including Symposium I03: Materials for Low Temperature Electrochemical Systems 8, and I07: Advanced Electrolysis Systems for Renewable Energy Conversion and Storage**
*Vancouver, BC, Canada*
**More information:** www.electrochem.org/241
**Abstract deadline:** 3 December 2021

6–9 June 2022
**US DOE Hydrogen Program 2022 Annual Merit Review and Peer Evaluation Meeting: 2022 AMR**
*Location to be confirmed*
**More information:** www.annualmeritreview.energy.gov

7–9 June 2022
**Global Energy Show Exhibition & Conference 2022, with Hydrogen Zone**
*Calgary, Alberta, Canada*
**More information:** www.globalenergyshow.com

11–15 June 2022
**35th World Electric Vehicles Symposium, EVS35**
*Oslo, Norway*
**More information:** www.avere.org/electric-vehicle-symposium-evs

15–16 June 2022
**3rd European Conference on Hydrogen & P2X**
*Copenhagen, Denmark*
**More information:** https://fortesmedia.com/hydrogen-p2x-2022,4,en,2,1,15.html

20–22 June 2022
**32nd Topical Meeting of the International Society of Electrochemistry: Experimental and Modelling tools for Electrochemical Energy Devices**
*Stockholm, Sweden*
**More information:** events@ise-online.org

20–23 June 2022
[postponed from June 2021]
**3rd International Conference on Electrolysis 2021**
*Golden, Colorado, USA*
**More information:** https://ice2021.csmspace.com

26–30 June 2022
[postponed from July 2020]
**23rd World Hydrogen Energy Conference, WHEC-2022**
*Istanbul, Turkey*
**More information:** www.whecistanbul.org
**Abstract deadline:** 15 December 2021

3–8 July 2022
**12th International Symposium on EIS: Electrochemical Impedance Spectroscopy**
*Beijing, China*
**More information:** www.eis2022.com
**Abstract deadline:** 20 January 2022

4–7 July 2022
**Journées d'Electrochimie 2022 [in French/English]**
*University of Mons, Belgium*
**More information:** https://web.umons.ac.be/fr/evenements/journees-delectrochimie
**Abstract deadline:** 9 April 2022

5–8 July 2022
**15th European SOFC & SOE Forum: Solid Oxide Technologies, Exhibition, Tutorials, Grid Service Market Symposium**
*Lucerne, Switzerland*
**More information:** www.efcf.com
**Abstract deadline:** 30 November 2021

21–25 July 2022
**3rd International Congress on Advanced Materials Sciences and Engineering, AMSE-2022**
*Opatija, Croatia*
**More information:** www.istci.org/amse2022
**Abstract deadline:** 15 April 2022

23–24 July 2022
**Gordon Research Seminar on Fuel Cells**
*Bryant University, Rhode Island, USA*
**More information:** www.grc.org/fuel-cells-grs-conference/2022
**Abstract deadline:** 23 April 2022

24–29 July 2022
**Gordon Research Conference on Fuel Cells: Integrating Theory, Synthesis, Characterization and Validation for the Advancement of Fuel Cell Research**
*Bryant University, Rhode Island, USA*
**More information:** www.grc.org/fuel-cells-conference/2022
**Application deadline:** 26 June 2022