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www.fuelcellsbulletin.com

Saga Pure acquires Hyon, partners with Nel and Norwegian Hydrogen to target maritime sector

Norwegian green investment company Saga Pure ASA has acquired hydrogen technologies hub Hyon AS, and following a subsequent transaction, Saga Pure, Nel ASA and Norwegian Hydrogen AS will have equal shareholdings in the company. Hyon has a strong position in maritime hydrogen solutions, and will now primarily focus on developing hydrogen and bunkering (ship refueling) solutions for harbours.

Saga, Nel and Norwegian Hydrogen [FCB, May 2020, p13] will each have a 29% ownership stake in Hyon, with key employees holding the remaining shares; these are Jørn Kristian Lindtvedt, appointed as CEO, and Harald Hansen as Director of Project Development & Commercial. Both have previously held key positions in the TechnipFMC-led 'Deep Purple' project [March 2021, p10], which is focused on

solutions for offshore hydrogen production and intermittency management of wind farms by storing the hydrogen subsea. The value of the transaction has not been disclosed.

Hyon has built a strong position in hydrogen energy solutions for the maritime sector since it was established in 2017 [October 2017, p10].

One of the founding partners in the Hyon joint venture, **PowerCell Sweden**, has sold its holding and will invest some of the proceeds to establish its own wholly owned Norwegian subsidiary [May 2021, p4]. At the end of last year it signed a Memorandum of Understanding with Norwegian energy giant Statkraft to partner on hydrogen and fuel cell-based energy solutions [January 2021, p14].

Saga Pure: www.sagapure.com

Nel ASA: www.nelhydrogen.com

Norwegian Hydrogen AS: www.nh2.no [in Norwegian]

PowerCell Sweden: www.powercell.se

Shell starts up Europe's largest PEM electrolyser

Europe's largest PEM hydrogen electrolyser has begun operation at Shell's Energy and Chemicals Park Rheinland in Germany. The 10 MW electrolyser will use renewable electricity to produce up to 1300 tonnes per annum of green hydrogen, which will initially be used to produce fuels with lower carbon intensity, and help to decarbonise other industries.

The fully operational plant, part of the Refhyne (Clean Refinery Hydrogen for Europe) consortium, is the first to use this technology at such a large scale in a refinery [FCB, February 2018, p10]. Plans are under way to expand the electrolyser capacity from 10 MW to 100 MW at the Rheinland site, near Cologne [March 2021, p5], where Shell also intends to produce sustainable aviation fuel (SAF) using renewable power and biomass in the future.

The consortium backing the project consists of Shell, UK-based electrolyser manufacturer ITM Power [see the ITM features in October and November 2020, and March and June 2021], Norwegian research organisation SINTEF (project coordinator), and consultancies Sphera in the US and Element Energy in the UK. The project is supported by EU funding through the Fuel Cells and Hydrogen Joint Undertaking (FCH JU).

The 100 MW electrolyser (Refhyne II) and SAF projects are at an advanced planning stage, with final investment decisions still pending. Operations are scheduled to begin in 2024, producing up to 15 000 tonnes per annum of green hydrogen.

Refhyne project: www.refhyne.eu

Shell, Hydrogen Fuel: <http://tinyurl.com/shell-h2>

ITM Power: www.itm-power.com

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

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ROAD VEHICLES

BMW starts road tests of i Hydrogen NEXT

The BMW Group is starting to test near-standard vehicles with a hydrogen fuel cell electric drivetrain in everyday conditions on European roads. Prototypes of the BMW i Hydrogen NEXT will examine how effectively the drivetrain, model-specific chassis technology and vehicle electronics systems work together under real-life conditions.

The testing programme for the BMW i Hydrogen NEXT fuel cell electric vehicle [FCB, April 2020, p1] will pave the way for the German automaker to present a small-series model with this drive technology in late 2022. Extensive field testing of these vehicles – developed on the basis of the BMW X5 mid-size SUV – will provide practical experience in the use of this technology.

The BMW i Hydrogen NEXT uses PEM fuel cells from the product development cooperation with Toyota Motor Corporation in Japan. The individual cells are supplied by Toyota, while the fuel cell stack and complete drive system have been developed by BMW. The collaboration, established in 2013 [February 2013, p2], aims to optimise the practicality and scalability of hydrogen fuel cell technology for use in each company's respective production vehicles. The 125 kW fuel cell stack is combined with a buffer battery that boosts power output to 275 kW for acceleration and overtaking, with two 700 bar carbon fibre reinforced plastic tanks which together hold 6 kg of hydrogen.

BMW, Fuel Cell Electric Vehicles:
www.bmwgroup.com/en/elektromobilitaet/technology.html

Jaguar Land Rover plans Defender FCEV

UK-based Jaguar Land Rover is developing a prototype hydrogen fuel cell electric vehicle based on the new Land Rover Defender, with testing scheduled to begin this year. The premium FCEV concept is part of JLR's aim to achieve zero tailpipe emissions by 2036, and net zero carbon emissions across its supply chain, products and operations by 2039.

Jaguar Land Rover's advanced engineering project, Project Zeus [FCB, July 2020, p5], is

part-funded by the government-backed Advanced Propulsion Centre, and will allow engineers to understand how a hydrogen powertrain can be optimised to deliver the performance and capability expected by its customers, from range to refueling, and towing to off-road ability.

JLR has teamed up with industry partners including Delta Motorsport, AVL Powertrain UK Ltd, Marelli Automotive Systems and the UK Battery Industrialisation Centre (UKBIC) to research, develop and create the prototype FCEV. The zero tailpipe emission prototype New Defender FCEV will begin testing towards the end of 2021 in the UK, to verify key attributes such as off-road capability and fuel consumption.

Jaguar Land Rover: www.jaguarlandrover.com

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

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

UK Battery Industrialisation Centre: www.ukbic.co.uk

Renault, Plug Power launch HYVIA van JV

French automotive giant Renault and US-based hydrogen and fuel cell solutions provider Plug Power have launched their HYVIA joint venture, which will market fuel cell electric light commercial vehicles (vans), hydrogen refueling stations, the supply of green hydrogen, and maintenance and management of vehicle fleets.

The joint venture – announced in January [FCB, January 2021, p1] – is equally owned by the two partners, and chaired by David Holderbach, who has more than 20 years' experience in strategic, product and international sales at Renault. The first three vehicles – the Van and Chassis cab versions for transporting goods, and the City bus version for transporting people – brought to market by HYVIA will be based on the Renault Master platform and should be available in Europe by the end of 2021, accompanied by the deployment of refueling stations and the supply of green hydrogen.

HYVIA's activities will be carried out at existing Renault facilities in France. Its head office and R&D teams will be located at Renault's LCV engineering and development centre in Villiers-Saint-Frédéric, while the process, manufacturing and logistics teams will be based in Flins, as part of the Re-Factory project, with the aim of starting the assembly of fuel cells and refueling stations by end of this year. The first vehicles will be assembled at the Batilly plant, with fuel cell integration carried

out by the Renault subsidiary PVI in Gretz-Armainvilliers.

HYVIA: www.hyvia.eu/en

Renault Group: www.renaultgroup.com/en

Plug Power: www.plugpower.com

Hyundai fuel cell bus begins trials in Munich

Hyundai Motor Company is working with two German bus operators to conduct in-service trials of the Elec City Fuel Cell electric bus in Munich, to gather feedback from bus operators and drivers as it explores opportunities to introduce the vehicles to the European market.

Hyundai handed over the test bus to Busbetrieb Josef Ettenhuber GmbH and Geldhauser Linien- und Reiseverkehr GmbH in late June, in a ceremony at the OMV hydrogen refueling station in Irschenberg, Bavaria [*FCB, March 2021, p8*]. The two bus operators will take turns running the Elec City Fuel Cell bus on existing routes in Munich, carrying paying passengers. The bus has five roof-mounted hydrogen storage tanks holding a total of 34 kg of hydrogen, for an estimated range of more than 500 km (310 miles), and its maximum power output of 180 kW makes it suitable for operation in hilly areas.

The South Korean company plans to run demonstrations with four more bus operators this year, collecting further passenger and driver feedback. The company expects these demo runs to prove that hydrogen powered buses are a viable, efficient solution for commercial transportation. The Elec City Fuel Cell has been commercially available in Korea since 2019, with a total of 108 vehicles in operation [*July 2019, p15*].

Hyundai Motor Company:
www.hyundai.com/worldwide

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

Busbetrieb Josef Ettenhuber GmbH:
www.busreisen-ettenhuber.de [in German]

Geldhauser Linien- und Reiseverkehr GmbH:
www.geldhauser.de [in German]

London gets fuel cell double-decker buses

Transport for London in the UK has taken delivery of 20 new double-decker hydrogen fuel cell electric buses, which are first being introduced

on Route 7 between East Acton and Oxford Circus.

The buses have been manufactured by Wrightbus in Northern Ireland [*FCB, December 2018, p3*], with onboard hydrogen cylinders manufactured by Luxfer in Nottingham. Canadian company Ballard Power Systems supplied the PEM fuel cell modules powering the vehicles.

The hydrogen for the buses is currently being produced at Air Liquide's plant in Runcorn, as a by-product from an industrial chloralkali plant; Oxford-based Ryze Hydrogen (formerly Ryse) is responsible for transport to the refueling station. From 2023 the hydrogen will be green, produced by electrolysis powered by a direct connection to an offshore wind farm. A new hydrogen refueling station at the Perivale bus depot in Ealing has been completed by Danish firm Nel Hydrogen.

TfL has led UK procurement within the Joint Initiative for Hydrogen Vehicles across Europe (JIVE), to buy in bulk with other UK authorities [*see the News Feature in February 2017*]. The London buses are the first fuel cell double-deckers in England, following the fleet of 15 buses recently deployed in Aberdeen, Scotland [*February 2021, p3*].

Transport for London: www.tfl.gov.uk

Wrightbus: www.wrightbus.com

Ryze Hydrogen: www.ryzehydrogen.com

Nel Hydrogen: www.nelhydrogen.com

Loop Energy module for Slovakian minibuses

Canadian-based Loop Energy has been awarded an order to supply its S300 fuel cell module to Mobility & Innovation in Slovakia, for the electric powertrain in M&I's new 8 m (26 ft) transit bus as part of its lightweight composite truck/bus platform.

This order is the first under the commercial agreement signed between Loop Energy and M&I, which anticipates over US\$1.9 million in fuel cell shipments over the next 30 months.

M&I is developing a lightweight, zero-emissions city bus platform, manufactured with laminate composite materials. The low curb weight allows higher passenger capacity, while still meeting even the most stringent axle load requirements.

To further meet the need for both power density and fuel-efficient energy, M&I has selected Loop Energy to provide its proprietary fuel cell modules, developed in its earlier incarnation as PowerDisc [*see the feature in FCB, March 2014*]. Loop can deliver power and enable a smaller fuel storage

EDITORIAL

Mark Allen Group has recently acquired *Fuel Cells Bulletin*, as part of a portfolio of industry newsletters and magazines sold by Elsevier. From this issue *FCB* is published under the MA Business Ltd imprint.

Mark Allen Group (MAG, www.markallengroup.com) is a well established publisher and event organiser based in the UK. Its publications include *The Engineer* (www.theengineer.co.uk), the UK's leading engineering monthly publication, and *Electric & Hybrid Vehicle Technology International* magazine (www.electrichybridvehicletechnology.com). Both report regularly on the fuel cell and (green) hydrogen sectors. The press release on the acquisition is available at www.markallengroup.com/news/mark-allen-acquires-13-publications-from-elsevier

I will continue as Editor of *FCB* for a short interim period, while a new Editor is recruited, before focusing on content acquisition for Elsevier's energy journals.

A lot has happened in this sector since I launched *FCB* in 1998, and it has to be noted that the pace has been accelerating sharply in the last couple of years. Of particular note is the recent focus on developing and deploying fuel cell electric heavy-duty trucks from companies such as Hyzon [*see page 4*], Toyota [*also page 4*], Daimler, Hyundai and Nikola [*all reported on in the last issue*], to complement the long-running attention on fuel cell electric buses [*see page 3, for example*].

One of the 'hottest' sectors is now green hydrogen, i.e. produced via water electrolysis using renewable energy, which is attracting a number of major companies and seeing significant funding support from the European Commission in particular. I've highlighted this in several previous Editorials, and there is no sign of this slowing down. In this issue, for example, the Green Hydrogen section is the joint-biggest (with Road Vehicles), with 11 news items on advances in this field. These include the creation of the H2Global Foundation by 16 major companies in Germany [*page 10*], to ramp up the international market for green hydrogen, and the launch of the Clean Hydrogen Mission, a new global coalition to support the clean hydrogen economy [*page 11*]. From an industry perspective, PKN Orlen is launching its Hydrogen Eagle investment programme, to develop an international chain of hydrogen hubs powered by renewable energy [*page 11*], and Haldor Topsoe has established a focused green hydrogen organisation to accelerate its solid oxide electrolysis cell business [*page 12*].

Steve Barrett

system without compromising bus weight or range, while also improving total cost of ownership for M&I customers.

Loop Energy: www.loopenergy.com

Mobility & Innovation:
www.mobility-innovation.sk [in Slovak]

Hyzon wins Austrian, Dutch truck orders

Hyzon Motors has entered into a definitive agreement with JuVe AutoMotion GmbH in Austria for the sale of up to 70 hydrogen fuel cell powered heavy-duty trucks. Hyzon has also entered into purchase agreements with subsidiaries of Dutch transport companies Jan Bakker BV and Millenaar & van Schaik BV to supply a total of up to 20 fuel cell electric trucks.

JuVe is a spin-off of Austrian supermarket chain Mpreis, and will supply the trucks to Mpreis and other first movers [FCB, December 2020, p3]. The initial delivery is planned for Q4 of 2021, with the remaining trucks delivered over the next three years. The first batch of vehicles includes three different heavy-duty trucks, including tractor/puller and rigid chassis designs, built to support refrigeration units.

Hyzon and JuVe have also signed a Letter of Intent to collaborate on the H2Alpin feasibility study, to demonstrate that fuel cell electric vehicles are suitable for the demands of alpine mobility, including steep grades and extreme weather conditions. Mpreis is currently building its own hydrogen production facility near Innsbruck, as well as its own network of hydrogen refueling stations. The company will use hydropower to produce green hydrogen, creating a renewable energy ecosystem.

Hyzon also expects to deliver up to three vehicles in Q4 to Jan Bakker and Millenaar & van Schaik, and the remaining trucks in 2022. These HyMax 450 Tractors built on a Class 8 DAF truck chassis will have a range up to 520 km (325 miles), with motor power up to 550 kW. The trucks have been purchased by Duurzaam Transport BV, a subsidiary of Jan Bakker, and H2 Transport BV, a subsidiary of Millenaar & van Schaik.

The trucks are expected to be assembled at Hyzon's facility in the Groningen region in the northern Netherlands [August 2020, p3]. Both deals come ahead of Hyzon's public listing via a definitive business combination agreement with Decarbonization Plus Acquisition Corporation [March 2021, p12].

In other news, Hyzon transit coaches have completed a 15 000 km (9400 mile) durability

road test in a harsh, remote region in Western Australia, a key test before iron-ore producer Fortescue Metals Group deploys 10 custom-built coaches in the remote Pilbara region [September 2020, p4].

Hyzon Motors: www.hyzonmotors.com

Jan Bakker BV: www.janbakker.nl [in Dutch]

Millenaar & van Schaik Transport BV:
www.millenaarvanschaik.nl [in Dutch]

Fortescue Metals Group: www.fmg.com.au

Plastic Omnium fuel cell systems for trucks

German electric vehicle specialist Elektro-Fahrzeuge Stuttgart GmbH (EFA-S) has selected Plastic Omnium to deliver fuel cell systems to equip its GAZelle van with an electric powertrain. This zero-emissions commercial vehicle will first be used by the city of Esslingen for road maintenance, with EFA-S aiming to deploy a fleet of more than 100 hydrogen powered vehicles by 2023.

EFA-S converts new and used cars and trucks into zero-emissions vehicles with electric drivetrains, including the GAZelle light commercial vehicle made by Russian automaker GAZ. The fuel cell version will have a range of 500 km (310 miles) and be refueled in just 3 minutes.

Plastic Omnium's PEM fuel cell system is a fully self-controlled electric power source for heavy-duty applications. The hydrogen and air supply, cooling, power electronics and control unit are integrated into a protected and qualified package, with a standardised interface for seamless integration into the e-powertrain of a zero-emissions vehicle. The stack will be supplied by EKPO Fuel Cell Technologies, the newly established joint venture between ElringKlinger and Plastic Omnium [FCB, April 2021, p14].

Plastic Omnium: www.plasticomnium.com

EKPO Fuel Cell Technologies: www.ekpo-fuelcell.com

Elektro-Fahrzeuge Stuttgart GmbH:
www.efa-s.de [in German]

Port of LA rolls out fuel cell freight demo

The Port of Los Angeles and its partners have debuted five new hydrogen powered fuel cell electric vehicles and inaugurated two hydrogen refueling stations, under

the \$82.5 million Shore-to-Store (S2S) project in California.

The 12-month demonstration will trial zero-emissions Class 8 trucks, and be expanded to include five more hydrogen-fueled heavy-duty trucks, two battery electric yard tractors and two battery electric forklifts. The initiative will assess the operational and technical feasibility of the vehicles in a heavy-duty setting, and expand infrastructure to support hydrogen throughout the region.

The California Air Resources Board (CARB) is supporting the project with a grant of \$41.1 million from its Zero- and Near-Zero Emissions Freight Facilities (ZANZEFF) programme, and the project partners are contributing the remaining \$41.4 million in financial and in-kind support [FCB, October 2018, p4]. The port's technology development partners are Toyota Motor North America, which designed and built the powertrain's fuel cell electric power supply system; Kenworth, which designed and built the Class 8 trucks [May 2019, p5]; and Shell Oil Products US, which designed, built and will operate the project's two new high-capacity hydrogen refueling stations in Wilmington and Ontario.

The trucks are being operated by Toyota Logistics Services, UPS, and trucking companies Total Transportation Services Inc (TTSI) and Southern Counties Express (SCE), with Air Liquide supplying the hydrogen. The Port of Hueneme will partner on drayage runs, and serve as the site for testing the zero-emissions yard tractors.

Port of LA: www.portoflosangeles.org

PowerCell tech in Swedish refuse truck

The first hydrogen powered refuse collection truck in Sweden has been deployed in Gothenburg, featuring a PEM fuel cell system developed by local company PowerCell Sweden.

The hydrogen-electric refuse truck is deployed with waste management and recycling company Renova, and has been developed jointly by PowerCell, Renova, truck manufacturer Scania and truck body builder JOAB [FCB, January 2019, p2]. Electricity produced onboard by the fuel cell system will propel the vehicle and power refuse loading and compression, with the heat generated used to heat the cab. The truck project has been supported with funding from the Swedish Energy Agency under its Strategic Vehicle Research and Innovation Programme (FFI), and the KTH Royal Institute of Technology

in Stockholm also participated in the development.

PowerCell has developed industrialised fuel cell-based power solutions – now branded as PowerCellution [*March 2021, p14*] – for a wide variety of applications in the automotive segment (both on- and off-road) and for the stationary and marine segments [*e.g. June 2021, p6*]. And the world's first hydrogen-electric flight of a commercial airplane last September was powered by a fuel cell system from PowerCell [*October 2020, p6*].

PowerCell Sweden: www.powercell.se

Renova Group: www.renova.se/en

Scania, Fuel Cell Electric Truck:
<https://tinyurl.com/scania-fc-truck>

JOAB: www.joab.se/en

Proton Motor, Electra in deal for UK trucks

German company Proton Motor Fuel Cell GmbH has signed a Memorandum of Understanding with Electra Commercial Vehicles Ltd in the UK, to jointly develop the zero-emissions fuel cell electric truck market in the UK and Ireland.

Electra develops, tests and manufactures all-electric trucks, and is a leading producer of zero-emission trucks in the UK, with a production capacity of more than 200 vehicles per annum. The company supplies all-electric trucks to a number of councils throughout the UK and Ireland, as well as fleet operators. To meet rapidly increasing demand for zero-emission trucks in the UK, Electra is planning to expand its production capacity in the next 12 months. The company also plans to incorporate a fuel cell range-extender power pack in its vehicles, to provide its battery electric trucks with enhanced range and duty cycles.

Electra will act as system integrator to integrate Proton Motor's hydrogen PEM fuel cell systems into its existing electric truck portfolio, while PM will provide engineering support and training to Electra during the development and qualification of these trucks. The partners will jointly develop a prototype vehicle for serial testing, and set up joint sales and marketing activities in the UK. In addition, Electra will place an initial order for five Proton Motor fuel cell systems [*see the PM feature in FCB, May 2015*].

Proton Motor Fuel Cell: www.proton-motor.de/en

Electra Commercial Vehicles:
www.electracommercialvehicles.com

MOBILE APPLICATIONS

Hyundai HTWO fuel cell generator to power electric car racing

Hyundai Motor Group's HTWO hydrogen fuel cell system brand has made its motorsports debut, providing its fuel cell generator to the Pure ETCR (Electric Touring Car Racing) series that began in mid-June. The mobile 160 kW generator can fully charge two cars simultaneously in just one hour.

Pure ETCR is the world's first all-electric touring car racing series, providing vehicle manufacturers with a global stage to showcase electric technology in a high-performance arena. It comprises five race weekends, at Vallelunga in Italy (18–20 June), Motorland Aragon in Spain (8–11 July), Copenhagen in Denmark (6–8 August), Hungoraring in Hungary (22–22 August), and Inje in South Korea (15–17 October).

Hyundai is entering its own team in the championship, as well as providing a mobile charging infrastructure that uses HTWO's fuel cell generator to charge all participating electric vehicles, each equipped with a 65 kWh battery. The charging system can generate up to 160 kW, equivalent to twice that of the Hyundai NEXO fuel cell electric vehicle [*e.g. FCB, January 2018, p2*]. The other participating automakers are Alfa Romeo (Italy), Cupra (SEAT, Spain), and MG (China).

Hyundai unveiled its HTWO brand, representing the group's hydrogen fuel cell system, at the end of 2020 [*January 2021, p13*], and in the spring started construction of its HTWO Guangzhou facility in China [*April 2021, p5*]. The mobile hydrogen power generation concept can supply power in remote areas where electricity is not accessible, or emergency power for data centres and similar applications during power outages.

HTWO is also supplying fuel cell systems to LS Electric, H2SYS and GRZ [*October 2020, p14*], and cooperating to further develop fuel cell power generation technology. The brand plans to expand its application to marine vessels, railways, urban air mobility vehicles, and other future mobility sectors.

Hyundai Motor Company:
www.hyundai.com/worldwide

Pure ETCR championship:
www.pure-etcr.com

IN BRIEF

Honda to end Clarity FCEV production

Japanese automaker Honda (<https://global.honda/innovation/FuelCell.html>) has announced that it will conclude production of the Clarity Fuel Cell and Clarity Plug-in Hybrid electric vehicles in August, as its strategy evolves to focus on increased application of its two-motor hybrid system to core models in advance of the introduction of its first volume battery electric vehicle models in 2024. The company says that ending production now will ensure it has the Clarity Fuel Cell – unveiled in 2015 [*FCB, November 2015, p2*] – available for lease through 2022. Honda aims to offer only battery or fuel cell electric vehicles by 2040.

Hyzon Zero Carbon Alliance adds Australian natural gas producer Woodside

The Hyzon Zero Carbon Alliance (www.hyzonalliance.com), an initiative of leading companies working to accelerate hydrogen powered mobility worldwide [*FCB, May 2021, p13*], has added Australia's leading natural gas producer Woodside Energy (www.woodside.com.au). The Alliance, led by US-based Hyzon Motors (www.hyzonmotors.com), a global supplier of hydrogen fuel cell electric commercial vehicles [*see also page 4*], brings together participants along the hydrogen value chain, from production to technology development, and innovation to investment.

DMI signs first European dealership deal

South Korean based Doosan Mobility Innovation (www.doosanmobility.com) is entering the European market for unmanned aerial vehicles (UAVs, or drones), signing a distribution contract with FRP Advanced Technologies Aerospace & Defence (www.frp.technology, in Spanish) in Spain. The partnership boosts FRP's plans to provide optimal solutions using DMI hydrogen fuel cell powered drones, focusing on oil & gas companies and military applications.

Peel NRE plans waste plastic to hydrogen conversion facility in Scotland

In the UK, Peel NRE (www.peellandp.co.uk/peelnre) is planning to develop its second waste plastic to hydrogen facility, at Rothesay Dock near Glasgow in Scotland. The £20 million (US\$27.4 million) facility will use non-recyclable plastics to create a local source of sustainable hydrogen. The hydrogen will be used for fueling vehicles, with plans for an onsite hydrogen refueling station.

The facility will be the second in the UK to use the Distributed Modular Generation (DMG®) technology developed by Powerhouse Energy Group (www.powerhouseenergy.co.uk), after plans for a similar facility at Peel NRE's Protos site in Cheshire, England were approved in 2019 [*FCB, May 2019, p13 and October 2020, p12*].

Alstom trials Coradia iLint train in Poland

Alstom's Coradia iLint hydrogen fuel cell powered passenger train has made its debut in Poland, on the Railway Research Institute's test track in Żmigród, near Wrocław.

The train was presented to a variety of local stakeholders, including regional operators, transport authorities, government decision-makers and leading media, to highlight the potential of the Coradia iLint for sustainable transport in Poland. The Coradia iLint train is assembled in Salzgitter, Germany, using body shells produced at the Alstom Konstal site in Katowice, Poland.

Alstom unveiled the Coradia iLint hydrogen fuel cell powered train for the European regional market in 2016 [FCB, September 2016, p1 and see the News Feature in March 2017]. The company successfully operated two pre-series trains for 18 months between 2018 and 2020 in regular passenger service in Germany [June 2020, p3], and has already sold 41 of these trains to German customers, with the first units expected to be in regular service from 2022.

Alstom will also supply six trains (with an option for eight more) to FNM in Italy [December 2020, p5], and SNCF Voyageurs in France has placed an order for the first 12 Regiolis hydrogen trains [May 2021, p5]. In addition, the Coradia iLint has been successfully tested in the Netherlands [April 2020, p5] and Austria [January 2021, p5].

Alstom, Coradia iLint: <https://tinyurl.com/coradia-ilint>

tpgroup powers UK's HydroFLEX train

In the UK, tpgroup is providing the hydrogen fuel cell systems that will power the production version of the country's first full-scale hydrogen powered train. The HydroFLEX train will be showcased at the UN Climate Change Conference (COP26) taking place in Glasgow, Scotland in November.

The tpgroup contract is with British rolling stock owner Porterbrook, and is part of an initiative that aims to show how hydrogen powered trains can be safely and efficiently operated for future public transport. This contract covers the supply of hydrogen PEM fuel cell systems to power the HydroFLEX train. tpgroup is acting as the prime contractor

for the integrated hydrogen fuel system, building on its preliminary consulting work on developing the system requirements and configuration [FCB, March 2021, p5]. The initial project will take approximately six months to complete, and will be delivered by the team at the group's Gas Technology Centre in Portsmouth. The integrated fuel cell system will be deployed on a HydroFLEX train for a series of proving and demonstration activities.

HydroFLEX is being developed by Porterbrook and the University of Birmingham's Centre for Railway Research and Education (BCRRE), in response to the UK government's challenge to remove diesel-only trains from the national network by 2040. Based on a Class 319 electric multiple unit, the HydroFLEX is fitted with hydrogen storage tanks, a PEM fuel cell system – supplied by Canadian company Ballard Power Systems [January 2019, p4] – and battery pack to provide independent traction power capable of operation with zero carbon emissions. The vehicle successfully undertook its first phase of mainline testing last September, achieving speeds of 50 mph (80 km/h) [October 2020, p5].

As part of a best-of-British low-carbon train technology showcase, the HydroFLEX will be available for discussions with invited guests in its converted boardroom, and for transport to fringe events such as the possibility of viewing the Zero Emission Train, Scotland's first hydrogen powered train [June 2021, p5].

TP Group: www.tpgroupglobal.com

Porterbrook: www.porterbrook.co.uk

University of Birmingham, Birmingham Centre for Railway Research and Education: www.birmingham.ac.uk/research/railway/index.aspx

Siemens, HI ERN link on LOHC technology for rail transport

Siemens Mobility and the Helmholtz Institute Erlangen-Nürnberg for Renewable Energy (HI ERN) in Germany have signed a Memorandum of Understanding to conduct joint research on the use of liquid organic hydrogen carrier (LOHC) technology in rail transport.

HI ERN in Nuremberg is a leader in LOHC technology, in which an organic carrier liquid absorbs hydrogen and releases it only when needed. The hydrogen is chemically bound and can't escape in gaseous form, which means it can be prepared and stored safely and transported inexpensively, with no need for storage at high pressure or low temperature.

This also makes LOHC technology suitable for onboard generation of electric power in mobile applications such as trains [e.g. FCB, May 2018, p15].

'Siemens Mobility's interest in the LOHC technology that we've decisively developed over the past few years at the Friedrich-Alexander-University Erlangen-Nuremberg and at the HI ERN is an excellent basis for a possible cooperation in the future,' says Professor Dr Peter Wasserscheid, Director of HI ERN. 'We share with Siemens Mobility the vision of developing a hydrogen technology that uses the existing fuel infrastructure to power large vehicles like trains.' The LOHC technology is being commercialised by the spinout company Hydrogenious LOHC Technologies GmbH [e.g. February 2019, p6].

Siemens Mobility is providing a Vectron mainline locomotive for demonstration of the feasibility of the LOHC concept and testing the technology. The train builder is already developing the Mireo Plus H hydrogen powered train, onboard which hydrogen is stored as a high-pressure gas in order to achieve the required high energy density [December 2020, p6].

Siemens Mobility: www.siemens.com/mobility

Helmholtz Institute Erlangen-Nürnberg for Renewable Energy: www.hi-ern.de

Hydrogenious LOHC Technologies GmbH: www.hydrogenious.net

GM targets aerospace, rail uses for Hydrotec

General Motors is collaborating with Liebherr-Aerospace to develop a Hydrotec fuel cell based electric power generation system for aircraft applications, and with Wabtec Corporation to develop and commercialise Hydrotec systems – and GM's Ultium battery technology – for Wabtec locomotives.

GM and Liebherr-Aerospace – a leading integrated onboard aircraft system supplier – recently signed a joint development agreement for an electric power generation system to demonstrate how hydrogen PEM fuel cell-based power systems could be used in aircraft applications. The construction and testing of a demonstrator – incorporating GM fuel cells, Hydrotec power cube and fuel cell system, along with GM controls and models – will take place in specialised laboratory multi-system integration testing at Liebherr-Aerospace in Toulouse, France.

GM has also signed a non-binding Memorandum of Understanding with train builder Wabtec, to utilise the latter's expertise

in energy management and systems optimisation in developing a commercial solution for heavy haul locomotives utilising GM's Hydrotec hydrogen fuel cell and Ultium battery systems. Hydrotec fuel cell systems will be assembled from globally sourced parts by Fuel Cell Systems Manufacturing LLC in Brownstown, Michigan, the manufacturing joint venture between GM and Honda [*FCB, February 2017, p8*].

GM Hydrotec: www.gmhydrotec.com

Liebherr: www.liebherr.com

Wabtec: www.wabteccorp.com

TECO 2030 concept allows ships to enter port without emissions

Norwegian company TECO 2030 has launched its Zero Emissions Operation Concept, which will enable ships to sail in and out of ports emissions-free by replacing one or more of their engines with a TECO Marine Fuel Cell.

The TECO 2030 Zero Emissions Operation Concept will make it possible for vessels operating in different countries, such as cruise ships and ferries, to comply with any emissions regulations they may encounter when crossing national borders. This is the case in Norway, for example, where by 2026 only cruise ships and ferries operating on zero emissions will be allowed entry into several of the Norwegian fjords [*e.g. FCB, January 2020, p10*].

TECO can deliver hydrogen PEM fuel cell stacks ranging in size from 400 kW to 25 MW [*February 2021, p8*], facilitating secure operation regardless of the size of the engine they replace. The use of green hydrogen, produced utilising renewable energy, allows ships to cut their greenhouse gas emissions to zero. The company plans to establish Norway's first large-scale production facility for hydrogen fuel cells in Narvik, as it gears up for the full-scale commercial launch of its products [*April 2021, p18*].

TECO 2030: www.teco2030.no

Nedstack, Koedood to supply plug-and-play maritime PEMFC unit

Future Proof Shipping (FPS) in the Netherlands has selected Koedood Marine Group to supply a complete fuel cell system for retrofitting in its

Maas inland container vessel. The 825 kW system will comprise PEM fuel cell stacks and technology from fuel cell manufacturer Nedstack.

FPS has led the vessel's zero-emissions retrofit design in close cooperation with Koedood, Nedstack, the shipyard and other main suppliers. FPS has now given the green light to Holland Shipyards Group (HSG) to procure the complete fuel cell system from Koedood [*FCB, April 2021, p8*].

Koedood will build three 275 kW fuel cell units, subcontracting Nedstack to supply the PEM fuel cell stacks for these units as part of their co-development partnership for inland navigation [*January 2020, p5, and see the Nedstack feature in August 2014*]. HSG will install the fuel cell units onboard the *Maas*, a 110 m (360 ft) long inland container vessel, in a retrofit at its shipyard in Hardinxveld this year, with the aim of achieving hydrogen powered operation by year-end. The *Maas* will then go into service carrying shipping container cargo between Rotterdam and an inland terminal near Antwerp.

Future Proof Shipping: www.futureproofshipping.com

Koedood Marine Group: www.koedood.nl [in Dutch]

Nedstack Fuel Cell Technology BV: www.nedstack.com

SMALL STATIONARY

SFC links with GWU in wind energy field

In Germany, SFC Energy has signed an expanded cooperation agreement with GWU-Umwelttechnik GmbH in the wind energy sector.

SFC and GWU, which specialises in water, soil and air sensor and measurement systems for environmental applications, have been working together for several years [*FCB, March 2013, p5*]. GWU systems such as the Doppler wind LiDAR system WindCube are used to measure wind fields, with the data obtained from long-term measurements providing information on whether a site is suitable for a wind farm, for example. These measuring stations need to be supplied with electric power for perhaps 12 months or longer, far from the grid, so SFC's EFOY direct methanol fuel cells help to ensure that GWU applications can collect valid data reliably and without interruption.

SFC is a leading provider of hydrogen and direct methanol fuel cells for stationary and mobile hybrid power solutions [*see the SFC feature in January 2013*], and has sold more than 50 000 fuel cells to date. The company is headquartered near Munich, and also operates

production facilities in the Netherlands, Romania and Canada.

SFC Energy: www.sfc.com or www.efoy-pro.com

GWU-Umwelttechnik GmbH:
www.gwu-umwelttechnik.de [in German]

GenCell A5 at Iceland emergency comms site

Israel-based GenCell Energy has successfully completed an advanced testing period of its GenCell A5 off-grid power solution at the site of an active Emergency Communications System (ECS) station outside Reykjavik, Iceland operated by Neyðarlínan ohf.

State-owned telecom provider Neyðarlínan operates the national emergency number 112, the TETRA National Telecommunication Service and the Icelandic Maritime Service. The off-grid alkaline fuel cell power system, installed in a compact container housing the ammonia cracker integrated with the AFC generator, has successfully completed 1500 continuous working hours in inclement weather conditions, including temperatures down to -10°C, heavy rain and strong winds [*FCB, February 2021, p8*]. GenCell's A5 off-grid solution has been designed to provide ultra-reliable power and high efficiency in the harshest weather conditions, operating on economical and widely available liquid ammonia fuel [*July 2018, p5*].

Looking ahead, GenCell and Neyðarlínan have agreed to carry out a second testing period in the extreme weather conditions typical of the Arctic region in the winter months, between December 2021 and February 2022. Following satisfactory completion of this winter evaluation, the companies will negotiate the deployment of GenCell A5 units at active 112 emergency communication sites across Iceland.

GenCell Energy: www.gencellenergy.com

Neyðarlínan ohf: www.112.is/en

HPS partners to install units in German homes

Berlin-based HPS Home Power Solutions GmbH is partnering with architect and builder Wohnwerke GmbH in Stuttgart to equip private homes with HPS's picea solar-hydrogen based power supply. HPS has also signed a sales partnership with Energieinsel GmbH in Berlin, a service

provider specialising in photovoltaic and storage systems.

Wohnwerke will offer its customers HPS's picea hydrogen-based electricity storage system as standard equipment for one-family homes. The combination of modern architecture and innovative energy system will be demonstrated in a planned show home in Asperglen-Rudersberg, near Stuttgart.

Meanwhile, **Energieinsel** will include picea system solutions in its sales portfolio, enabling HPS to gain additional access to an environmentally conscious customer base. Energieinsel will benefit from the partnership by expanding the technology base of its range of products and services for private homes. The company is a leading vendor in this market segment, having sold more than 1700 electricity storage systems and 7000 solar PV systems to date.

The picea system for one- and two-family houses optimises the use of solar PV to supply homes with zero-carbon electricity via hydrogen storage. HPS's manufacturing partner Zollner Elektronik began production at the end of last year [*FCB, January 2021, p7*].

HPS Home Power Solutions:
www.homepowersolutions.de/en

Wohnwerke GmbH: www.neubauten.de [in German]

Energieinsel GmbH:
www.meine-energieinsel.de [in German]

LARGE STATIONARY

Rolls-Royce preparing 250 kW PEMFC demo

Rolls-Royce Power Systems is commissioning a 250 kW hydrogen fuel cell demonstration system at its Friedrichshafen plant in southern Germany, to test standby, prime power and uninterruptible power supply (UPS) functionality.

The complex hydrogen supply infrastructure has now been installed at Rolls-Royce Power Systems' Friedrichshafen Plant 1, and the container holding four PEM fuel cell modules has been set up [*FCB, December 2019, p1*]. The container was designed at the company's plants in Ruhstorf (Bavaria) and Friedrichshafen (Baden-Württemberg), with safety reasons dictating that it has two separate compartments for the fuel cells and batteries, along with a substantial amount of power electronics. The control system has now been fully refined, cooling and air-conditioning are on the roof, and a rack system enables simple maintenance,

allowing individual system modules to be replaced as required.

The system – using fuel cell modules from the automotive sector [*June 2020, p10*] – has been put through its paces on the test stand. 'Power flexing characteristics and performance are excellent, and as expected there are no vibrations or no loud noises,' says Dr Peter Riegger, VP of Rolls-Royce PowerLab [*September 2020, p14*]. The next step is to connect all four demo modules together in the container and hook up the batteries and power circuit. Commissioning is anticipated before the end of 2021.

The demonstrator will be used for test purposes, and to show interested parties which applications the system is suitable for. These include standby power, prime power, UPS and black-start capability, i.e. allowing the system to be started from scratch without a grid connection.

Rolls-Royce Power Systems:
www.rrpowersystems.com

RRPS white paper on fuel cell technology:
<https://tinyurl.com/rr-fc-whitepaper>

PORTABLE & MICRO

UltraCell to integrate wearable RMFC tech

California-based UltraCell has received a contract from the US Department of Defense to focus on completing the MIL-STD certification of its 'Honey Badger' 50 W reformed methanol fuel cell wearable power system, to advance the unit for US Army integration.

The Honey Badger is optimised to operate on a soldier-worn plate carrier or rucksack for on-the-move battery charging, and designed to integrate with materials already in the US Army supply chain. The versatile, lightweight fuel cell was recently selected by DOD's National Defense Center for Energy and Environment (NDCEE) to take part in its 2021 demonstration/validation programme [*FCB, April 2021, p10*].

The effort will drive efforts to complete the full MIL-STD and finalise integrated filtration for Cleaning Compound, Windshield NSN 9850-00-926-2275, to allow the use of logistically sound materials as the primary fuel source. The contract was signed with the US Army DEVCOM's Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) Center with funding through

the Project Manager Integrated Visual Augmentation System (PM IVAS).

UltraCell – now a subsidiary of Massachusetts-based Advent Technologies [*March 2021, p11*] – is developing Honey Badger 20 and 50 W portable generators for the US Army's Integrated Visual Augmentation System, and surveillance systems that can be powered by its proven XX55™ GEN3 50 W RMFC [e.g. *March 2015, p7*].

UltraCell: www.ultracell-llc.com

Advent Technologies: www.advent.energy

C5ISR Center: <https://c5isr.ccdc.army.mil>

FUELING

Groningen unveils 20 buses, refueling station

The Qbuzz bus depot in Groningen, in the northern Netherlands, has opened a new hydrogen refueling station, and seen the presentation of 20 new Van Hool fuel cell electric buses.

This new hydrogen station – with two dispensing points – is one of the largest in Europe, and is Shell's first operational hydrogen refueling station for buses. Shell also supplies the certified green hydrogen dispensed there, delivered by trailer. Refueling takes about 10 minutes; with a full tank of 25 kg of hydrogen, the buses can cover about 400 km (250 miles).

'Before refueling, the hydrogen is compressed and cooled. All this happens at the refueling station located next to the 160 battery electric buses of Qbuzz,' explains Lisa Montanari, Commercial Manager for Hydrogen at Shell. 'With a full tank, the hydrogen buses can run for a whole day. The buses come to the depot and are refueled immediately.'

The Van Hool buses are powered by fuel cell modules supplied by Ballard Power Systems [*FCB, January 2020, p3*]; the fleet deployment is partly funded by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) under the JIVE 2 project [*March 2018, p2*].

Qbuzz: www.qbuzz.nl/english

Van Hool, Fuel Cell Buses:
<https://tinyurl.com/vanhool-fuelcell>

Shell, Hydrogen Fuel: <http://tinyurl.com/shell-h2>

OV-bureau Groningen Drenthe:
www.ovbureau.nl/en

Ballard Power Systems: www.ballard.com

CMB.Tech multimodal hydrogen station, truck

CMB.Tech has announced a multimodal hydrogen refueling station in Antwerp, Belgium, to produce and dispense green hydrogen for ships, tube trailers, cars, trucks and buses by the end of this year. The company – the cleantech division of Compagnie Maritime Belge – has also unveiled the Lenoir dual-fuel hydrogen powered truck.

In 2017 CMB.Tech launched the *Hydroville* hydrogen powered passenger ship, which has so far been served via a tube trailer-based mobile hydrogen refueling station. But now the *Hydroville* – and other CMB.Tech hydrogen applications – will be able to refuel directly in Antwerp.

The station is under construction at the Port House in Antwerp, a location chosen to facilitate supplying hydrogen to industrial applications in the port while offering easy public access for refueling vehicles (at 350 bar for buses and trucks, 700 bar for cars). The site also has two trailer docks that can be used to transport excess green hydrogen for industrial and refueling activities elsewhere. The station has been developed in collaboration with Ekinetix, Ballast Nedam Industriebouw, Alpha Engineering, Maximator and Cummins, which supplied a 1.2 MW HyLYZER®-250 PEM electrolyser to produce hydrogen onsite.

The dual-fuel Lenoir 2.0 heavy-duty truck – named for the Belgian-French engineer Étienne Lenoir, who in 1860 built the first hydrogen internal combustion engine – is intended to kickstart emission reductions in the logistics sector.

CMB.Tech: www.cmb.tech

Cummins, Hydrogen Technology:
<https://tinyurl.com/cummins-h2-tech>

Maximator GmbH: www.maximator.de

Everfuel opens Hvam station in Norway

Danish company Everfuel has assumed ownership and operation of the green hydrogen refueling station at Hvam, northeast of Oslo in Norway. Customers are now taking part in testing of various systems, including payment solutions and data transfer.

The **Hvam station** is the first of two hydrogen refueling sites acquired by Everfuel last November [*FCB, December 2020, p9*]; Everfuel and the seller are working towards

handover of the second station, at Åsane near Bergen, in Q3, subject to Covid-19 restrictions, final approvals, and the seller delivering a fully functional station. Delivery of the Hvam station triggers the financial close of the acquisition of the two stations and associated distribution assets in Norway from H2CO AS, a Uno-X owned company [*December 2018, p10*].

This is Everfuel's first station in Norway [*April 2021, p10*], and an important step in realising the company's green hydrogen refueling strategy for trucks, buses and cars in connecting the main traffic corridors in Scandinavia [*May 2021, p7 and June 2021, p7*].

In other news, Everfuel's **HySynergy Phase II** electrolyser development at the Fredericia refinery [*June 2021, p8*] is one of six projects nominated by the Danish Business Authority for participation in the EU-funded Important Project of Common European Interest (IPCEI) initiative, to kickstart a European market for green hydrogen and contribute to the green transition across sectors and industries. Everfuel is also participating in the Blue Seal and Green Fuels for Denmark projects.

Everfuel: www.everfuel.com

HTEC creates unit to serve eastern Canada

British Columbia-based HTEC Hydrogen Technology & Energy Corporation has opened a new division, HTEC Québec in Montreal, to deliver hydrogen production, distribution and dispensing solutions to partners and customers in Quebec, Atlantic Canada, and Nunavut.

HTEC already has a presence in Quebec's hydrogen infrastructure, having provided a hydrogen refueling station in the province in 2019 [*FCB, November 2018, p9*]. The company supports Toyota Canada and station owner Harnois in the operation of the retail hydrogen station in Quebec City, and work is under way to expand HTEC's Quebec Fueling Network. HTEC has two retail hydrogen stations in design and construction, two in late-stage development, and four in early-stage development.

HTEC is a key supplier in the clean hydrogen value chain, integrating technologies, systems, people and partnerships. The company now has 17 hydrogen stations operating or in development in Canada [*e.g. July 2020, p9*] and the US [*e.g. April 2021, p4*], and also delivers engineering and design services and speciality products and solutions to customers around the world.

HTEC Hydrogen Technology & Energy Corporation:
www.htec.ca

Element 2 links with Ways2H, Logan in UK

Element 2, a hydrogen refueling station provider and fuel retailer in the UK, is collaborating with California-based renewable hydrogen systems supplier Ways2H to produce and distribute green hydrogen for public transit and other transport in the UK, Ireland and Europe. Element 2 is also partnering with Scottish hydrogen technology company Logan Energy.

Ways2H will supply facilities that convert waste into hydrogen gas to supply Element 2's network of hydrogen stations. The partners envision as many as 40 sites that will each provide 0.5–1 tonne per day of green hydrogen; the first project is planned for a location in Scotland.

Ways2H has developed a carbon-neutral thermochemical process that converts municipal solid waste, plastic, sewage sludge and other refuse into a gas, and extracts pure hydrogen that can be used in fuel cell electric vehicles or power generation. The technology is being demonstrated in a recently completed waste-to-hydrogen facility in Tokyo.

In addition, **Logan Energy** will design, manufacture and maintain hydrogen refueling stations on sites developed by Element 2. The partnership, initially for three years, will triple Logan's current headcount, creating up to 70 new roles over the next two years, with further positions to follow by 2025.

Element 2 is investing in prime locations in northern England, Scotland and Ireland, and plans to deploy more than 800 pumps in the UK network by 2027, and 2000 by 2030 [*FCB, June 2021, p7*].

Element 2: www.element-2.co.uk

Ways2H: www.ways2h.com

Logan Energy: www.loganenergy.com

GreenCore joins Loop Energy, BayoTech for EV charging stations

US-based GreenCore is partnering with Canadian company Loop Energy to develop and build hydrogen-powered fast-charging stations for battery electric vehicles. GreenCore has also signed an agreement with BayoTech, which will supply hydrogen

to the more than 1500 EV charging and hydrogen refueling stations that GreenCore plans to build through 2026.

GreenCore and Loop Energy anticipate completing their first pilot installation this year. They will work with ecosystem partners to design and build hydrogen-powered DC fast-charging stations based on Loop's high-efficiency fuel cell technology, developed in its earlier incarnation as PowerDisc [see the feature in FCB, March 2014]. GreenCore charging stations will store energy as compressed hydrogen, and convert it to electric power for charging BEVs. This will allow the stations to be grid-independent, rapidly deployable, low-cost and compact.

GreenCore is also partnering with BayoTech to exclusively supply hydrogen to its planned network of EV charging and hydrogen refueling stations. These will use fuel cells to generate electricity to charge BEVs, and dispense hydrogen for light- and heavy-duty fuel cell electric vehicles.

Loop Energy and BayoTech recently partnered to develop market opportunities for deployment of vehicles manufactured by Loop's OEM customers, in combination with onsite hydrogen generation infrastructure provided by BayoTech [May 2021, p12].

In other news, BayoTech is developing an education and training programme with San Juan College in Farmington, New Mexico, to support the fast-growing hydrogen industry. The college will create a postgraduate credential programme that provides the technical skills needed to work safely and efficiently with hydrogen production systems.

GreenCore: <https://greencore.global>

Loop Energy: www.loopenergy.com

BayoTech: www.bayotech.us

San Juan College, School of Energy:
www.sanjuancollege.edu/school-of-energy

Paris airports plan for hydrogen by 2035

Air Liquide, Airbus and Paris Airports operator Groupe ADP have signed a Memorandum of Understanding to prepare for the arrival of hydrogen in airports by 2035, as part of the development of hydrogen powered commercial aircraft.

The partnership will focus on feasibility studies to develop the liquid (cryogenic) hydrogen supply infrastructure. This will kick off with a study involving around 30 airports worldwide, to assess potential configurations for liquid hydrogen production, supply and

distribution. Detailed scenarios and plans will then be drawn up for Paris-Charles de Gaulle and Paris-Orly airports. These scenarios will be essential in defining the required infrastructure, including scope and location, and identifying and integrating the constraints relative to both industrial and aviation safety standards.

In 2018 Air Liquide opened a hydrogen refueling station at Paris-Orly airport with Groupe ADP, to facilitate deployment of the Hype taxi fleet [FCB, January 2018, p7]. And last year it partnered with Seoul-Incheon International Airport in South Korea to accelerate deployment of hydrogen mobility solutions, including buses, with two high-capacity hydrogen stations [June 2020, p6].

Meanwhile, Air Liquide's project for a high-performance hydrogen refueling truck has been selected in the framework of the French 'H2 Hub Airport' initiative. The truck could be used as early as 2025 to refuel the first hydrogen stations deployed at the airport to meet the needs of ground vehicle fleets, and also peripheral vehicle fleets such as buses and taxis. The project would consist of adapting liquid hydrogen truck trailers already in operation with Air Liquide for these applications.

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

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

Groupe ADP: www.parisaeroport.fr/en

H2 Hub Airport: <https://tinyurl.com/h2-hub-airport>

GREEN HYDROGEN

H2Global Foundation launched in Germany

The H2Global Foundation has been established by 16 major companies in Germany, with some €900 million in funding support from the Federal Ministry for Economic Affairs and Energy (BMWi), to accelerate the ramping up of the international market for green hydrogen.

This innovative instrument will demonstrate the ways in which green hydrogen and its derivatives can be produced and exported competitively and sustainably in partner countries. The award procedure for the derivatives from green hydrogen will start this year, with deliveries of the hydrogen products expected from 2024.

Green hydrogen or derivatives will be purchased abroad under long-term contracts and resold in Germany via annual auctions, ensuring

planning and investment security. A Hydrogen Intermediary Network Company (HINT.CO) will be set up to conclude long-term Hydrogen Purchase Agreements (HPAs) on the supply side and short-term resale Hydrogen Service Agreements (HSAs) on the demand side.

The founding company members include Deutsche Bank, Enertrag, Green Enesys, Hamburger Hafen und Logistik, Hydrogenious LOHC, Linde, MAN Energy Solutions, Neuman & Esser, Nordex, Reederei F. Laeisz, Salzgitter, Siemens Energy, Thyssenkrupp, Uniper, Viridi RE, and VNG.

H2Global: www.h2-global.de [in German]

FCH JU issues report on Hydrogen Valleys

The European Fuel Cells and Hydrogen Joint Undertaking (FCH JU) has released its first *Hydrogen Valleys* report, providing insights into emerging hydrogen economies around the world.

The findings are based on data gathered through the Mission Innovation Hydrogen Valley (H2V) Platform [FCB, May 2020, p14], a global information sharing platform set up by the FCH JU under the Innovation Challenge 8 'Renewable and Clean Hydrogen' of Mission Innovation [June 2019, p1, and see the next item]. Data gathered from more than 30 Hydrogen Valleys worldwide are complemented by best practice interviews for project developers, and recommendations on how to provide a favourable policy environment that paves the way to reach the Hydrogen Valleys' full potential as enablers of the global hydrogen economy.

Over the past several years, the FCH JU has been setting up Hydrogen Valleys in collaboration with European cities and regions, to enable the emergence of locally integrated hydrogen ecosystems for climate change mitigation and regional economic development. Hydrogen Valleys have recently gone global, with new projects emerging worldwide [February 2021, p13]. The report shows that the Hydrogen Valley landscape is growing, increasingly driven by the private sector and gravitating towards archetypical project setups. It is foreseen that the Hydrogen Valleys will mature during the 2020s, with an increasing number of projects overall and because announced projects themselves grow in size and complexity.

H2Valleys platform: www.h2v.eu

Hydrogen Valleys report: www.h2v.eu/analysis/reports

Mission Innovation, Clean Hydrogen Mission:
www.mission-innovation.net/missions/hydrogen

Clean Hydrogen boost for global economy

The Clean Hydrogen Mission is a new global coalition to support the clean hydrogen economy, with the specific goals of reducing the cost of clean hydrogen to the end-user to US\$2 per kg by 2030, and delivering at least 100 large-scale integrated 'hydrogen valleys' worldwide [see also the item above].

The members of the coalition – launched on 2 June at the 6th Mission Innovation Ministerial meeting in Chile – are Australia, Austria, Canada, Chile, China, Germany, India, Italy, Morocco, Norway, Saudi Arabia, South Korea, the UK and US, along with the European Commission. The Clean Hydrogen Mission is launched for an initial period of five years, and may be extended for a further five years to support delivery of its key objectives by 2030.

The Mission will build a dynamic and ambitious alliance between countries, businesses, investors and research institutes to accelerate clean hydrogen innovation. One of the tasks of the Clean Hydrogen Joint Undertaking [FCB, March 2021, p7] will be to ensure synergies with the Clean Hydrogen Mission, and work closely to increase cooperation on hydrogen technology innovations.

Mission Innovation [June 2019, p1] is a global initiative of 22 countries and the European Commission (on behalf of the European Union) to reinvigorate and accelerate global clean energy innovation, achieve performance breakthroughs and cost reductions, and provide widely affordable and reliable clean energy solutions.

Mission Innovation, Clean Hydrogen Mission: www.mission-innovation.net/missions/hydrogen

Orlen sets up hydrogen investment programme

Polish oil refiner and fuel retailer PKN Orlen is launching the Hydrogen Eagle investment programme, to develop an international chain of hydrogen hubs powered by renewable energy sources and build facilities to convert municipal waste into zero- and low-emission hydrogen. The project also plans to construct more than 100 hydrogen refueling stations.

The scheme, covering Poland, the Czech Republic and Slovakia, will allow Orlen to achieve hydrogen production capacity of some 50 000 tonnes per annum by 2030. The

programme provides for the construction of six new renewable energy powered hydrogen hubs: two in Poland, two in the Czech Republic and one in Slovakia, and a hydrogen electrolysis plant which will be powered by electricity from the company's Baltic Power offshore wind farm. The capacity of the green electrolysis plants will ultimately total approximately 250 MW.

The initiative also envisages construction of three plants for converting municipal waste into low-emission hydrogen, to be located in Płock and Ostrołęka in Poland and in the Czech Republic, as well as an international network of more than 100 hydrogen refueling stations, comprising 54 in Poland, 22 in the Czech Republic, and 26 in Slovakia.

Orlen is already building hydrogen production plants in Włocławek, Trzebinia and Płock [FCB, June 2020, p9 and October 2020, p10], and is tendering for the construction of Poland's first hydrogen refueling stations, in Poznań and Katowice [June 2021, p7].

PKN Orlen: www.orlden.pl/en

Fronius hydrogen plant for Austrian customer, SFC emergency genset

Austrian solar hydrogen company Fronius International has begun construction of the first Solhub customer installation in the northeastern state of Lower Austria, for SAN Group in Herzogenburg. SAN has also ordered a fuel cell emergency genset for the facility from German-based SFC Energy.

The **Fronius Solhub system**, expected to commence operation by mid-2022, will produce up to 100 kg/day of green hydrogen, stored at 700 bar. It will be fed with solar energy from SAN's 1.5 MWp solar photovoltaic (PV) system. The hydrogen produced onsite will be used for the company's internal fleet, and will also be available to external partners. After completion next spring, the system will be handed over and training will be provided; Fronius also expects to sign a two-year service and maintenance contract.

SAN has also ordered a fully equipped 50 kVA emergency power generator based on **SFC Energy's** EFOY Jupiter hydrogen fuel cell, with delivery scheduled in 2022. The EFOY Jupiter system has a long service life and a short bridging time in the event of power failures. The fully integrated energy concept will supply the entire site in the future.

SAN Group is a global biotechnology and venture capital firm headquartered in Singapore, investing primarily in scalable and sustainable business models in the agro-biotech, renewable energy and real estate sectors.

Fronius is currently building its new Hydrogen Competence Centre (H2CC) in Steinhaus, near Wels in Upper Austria, with completion expected by the end of this year [FCB, July 2020, p15]. The new site will accommodate all of the company's hydrogen activities.

Fronius International: www.fronius.com

SAN Group: www.san-group.com

SFC Energy: www.sfc.com or www.efoy-pro.com

Ionomr's Aemion+ membrane released for industrial electrolysis

Canadian-based Ionomr Innovations has commercially released its Aemion+® membrane technology for industrial-scale green hydrogen production by water electrolysis. The company is now taking orders for Aemion+ membranes at widths up to 60 cm, produced using its continuous roll-to-roll processes.

Ionomr's Aemion+ alkaline membranes are ultra-stable anion-exchange membranes (AEMs) designed to replace the traditional expensive components for water electrolysis – e.g. iridium, platinum and titanium – with less expensive materials while maximising performance [FCB, January 2020, p14]. This AEM has overcome the challenge of remaining stable in concentrated KOH solutions. Ionomr is working with major customers from the energy, chemical and heavy industries, such as mining, to make AEM electrolyser technology that can already meet and exceed 2050 cost targets.

Aemion+ is produced in a continuous roll-to-roll process with a mechanical reinforcement at thicknesses between 50 and 100 µm. The materials are based on imidazolium chemistry, which is widely used in aerospace and as thin-film coatings due to its exceptional mechanical properties. Mechanical reinforcements are integrated to reduce unwanted dimensional swelling, for suitability in the largest electrolyser cells. Ionomr's patented processes enable maximum conductivity, performance and repeatability, while providing exceptional alkaline stability, enabling operation in 1M KOH at 80–100°C, and up to 3–4M KOH at 80°C.

Ionomr Innovations: www.ionomr.com

Topsoe sets up green hydrogen business unit

Danish company Haldor Topsoe has established a focused green hydrogen organisation to accelerate its solid oxide electrolysis cell business.

The new green hydrogen organisation is dedicated to accelerating all aspects of Topsoe's electrolysis business, including development of high-performance electrolysis technology, sales, and partnerships. The unit will leverage the company's SOEC expertise; it says that this highly efficient electrolysis technology can produce up to 30% more green hydrogen from the same amount of renewable power, compared to standard technologies.

Cleantech entrepreneur Chokri Mousaoui has been appointed Executive Vice President of the new organisation, and also joins Topsoe's Senior Leadership Team.

Earlier this year Topsoe announced that it will build a large-scale SOEC manufacturing facility to meet customer needs for green hydrogen production [*FCB, April 2021, p15*]. When operational in 2023, the facility will have a stack production capacity of 500 MW per annum, expandable to 5 GW.

Topsoe is supplying ammonia cracking technology for the world's largest green hydrogen facility, the Neom Helios project in Saudi Arabia, which will produce 650 tonnes/day of hydrogen to refuel trucks and buses [*August 2020, p11*].

Haldor Topsoe, Green Hydrogen:
<https://info.topsoe.com/green-hydrogen>

Lhyfe targets offshore green hydrogen facility

French company Lhyfe is developing an offshore green hydrogen production facility, powered by electricity from a floating wind turbine. The plant will be operational in 2022 at SEM-REV, Centrale Nantes' offshore test site, off the coast of Le Croisic in western France.

Lhyfe and Centrale Nantes (the École Centrale de Nantes engineering school) aim to demonstrate the reliability of an offshore electrolyser, in collaboration with shipyard Chantiers de l'Atlantique. The offshore test site meets all the criteria to validate offshore hydrogen production technology before moving towards large-scale industrial deployment in 2024. This project, which will foster development of a major hydrogen production industrial sector, is supported by the Pays de

la Loire Region, the innovation cluster Pôle Mer Bretagne Atlantique, and the Maritime Industry's Strategic Committee.

The electrolyser will be installed on GEPS Techno's floating platform and connected to various marine renewable energy sources, including the Floatgen floating wind turbine. Lhyfe and Chantiers de l'Atlantique are already working on the detailed design of an offshore hydrogen production platform that would be built in Saint Nazaire, ranging from 10 to several hundred MW, targeting deployment as early as 2024.

Lhyfe's site in Bouin is already connected to onshore wind turbines, and will produce its first hydrogen from seawater this summer [*FCB, May 2020, p10*]. This site also has an R&D facility for offshore hydrogen production.

Lhyfe: www.lhyfe.com/en

Centrale Nantes: www.ec-nantes.fr

SEM-REV: <https://sem-rev.ec-nantes.fr>

Chantiers de l'Atlantique: www.chantiers-atlantique.com

Nikola invests in US clean hydrogen hub

Arizona-based Nikola Corporation is investing \$50 million in cash and stock in exchange for a 20% equity interest in the clean hydrogen project being developed by Wabash Valley Resources (WVR) in West Terre Haute, Indiana.

The project plans to use solid waste by-products such as petroleum coke combined with biomass to produce clean, sustainable hydrogen for transportation fuel and baseload electricity generation while capturing CO₂ emissions for permanent underground sequestration. The completed facility should have the capability to produce up to 336 tonnes/day of hydrogen. Groundbreaking is expected in early 2022, and will take approximately two years to complete.

The investment is anticipated to give Nikola a significant hydrogen hub with the ability to offtake approximately 50 tonnes/day to supply its future refueling stations within a 300 mile (480 km) radius, covering a significant portion of the Midwest region. Exercising its offtake right will likely require significant additional investment by Nikola to build liquefaction, storage and transportation services. As part of this investment in the Midwest hydrogen economy, Nikola intends to build refueling stations across Indiana and the broader Midwest.

The first Nikola Tre hydrogen fuel cell prototype builds have begun in Arizona and Ulm, Germany [*FCB, March 2020, p12 and March 2021, p4*], with vehicle testing and validation planned into 2022, and serial

production expected to commence in 2023.

Nikola Corporation: www.nikolamotor.com

Wabash Valley Resources: www.wvresc.com

Plug Power plans green hydrogen site in Georgia

In the US, Plug Power has announced plans to build a green hydrogen production plant in Camden County, Georgia. The liquid (cryogenic) hydrogen production facility will extend the company's service network across the entire East Coast.

The announcement affirms Plug Power's commitment to establish the first North American green hydrogen supply network. The location, close to Interstate 95, the main north-south highway on the East Coast, enables easy access to the region's commercial and industrial centres, including Plug Power customers like Home Depot and Southern Company. The exact location and details about construction will be announced on finalisation later this year.

The plant will produce 15 tonnes/day of liquid hydrogen, produced using 100% renewable energy supplied by Okefenokee Rural Electric Membership Corporation. This is intended to supply transportation applications, including materials handling and fuel cell electric vehicle fleets. Plug Power is investing \$84 million in the facility, which is expected to create at least 24 jobs in the local community starting in 2022.

The Camden County plant joins previously announced facilities in western New York state [*FCB, March 2021, p9*] and Pennsylvania [*April 2021, p12*], and Plug Power's existing liquid hydrogen plant in Tennessee [*July 2020, p14*].

Plug Power: www.plugpower.com

Worley awarded green hydrogen contracts in Ireland, Netherlands

Australian-based Worley, a leading provider of engineering, procurement and construction services to the global energy industry, has been appointed by green energy company EI-H2 to help develop Ireland's first commercial-scale green hydrogen production facility. Worley has also been awarded an early engineering services contract by Shell to support the development of a new 200 MW electrolysis-based hydrogen plant in the Netherlands.

EI-H2's 50 MW plant in **Ireland** – located in Aghada, close to Cork Harbour – will use renewable energy to produce green hydrogen via electrolysis. The facility, expected to be operational before the end of 2023, will supply over 20 tonnes/day of green hydrogen to a diverse commercial market. Worley will develop the concept design for the facility, utilising best practice from similar projects around the globe to accelerate project delivery and achieve the earliest possible commercial production. The cost of construction and connection to the electricity grid is expected to be in the region of €120 million.

In the **Netherlands**, Shell has awarded a contract for early engineering services and related asset integration to Worley, to support the development of a new 200 MW green hydrogen electrolysis plant. Shell's Holland Hydrogen I project will be located in the Tweede Maasvlakte container port project in the Port of Rotterdam [FCB, June 2020, p8]. A final investment decision will be made later this year, with operations scheduled to start by 2023, producing some 50–60 tonnes/day of hydrogen. Renewable energy will preferably be provided by the Hollandse Kust (noord) offshore wind farm. The green hydrogen produced will initially be used at the Shell refinery in Pernis, to partially decarbonise fossil fuels production and support the industrial use of hydrogen in the heavy transportation sector.

Worley: www.worley.com

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

COMMERCIALISATION

Advent agrees to acquire SerEnergy

US-based Advent Technologies has entered into a definitive agreement to acquire the fuel cell systems businesses of fischer Group, for a total cash and stock consideration of €52 million. These businesses include SerEnergy in Aalborg, Denmark, and fischer eco solutions GmbH (FES) in Achern, Germany.

SerEnergy is a leading manufacturer of high-temperature PEM fuel cells for off-grid and stationary backup power markets in Europe and Asia [e.g. FCB, April 2021, p9]. The company employs 75 people in R&D, production, assembly and sales, with facilities in Aalborg and in Manila, the Philippines. FES provides fuel cell stack assembly and testing, and production of fuel cell components including membrane-electrode assemblies (MEAs), bipolar plates and

reformers [e.g. June 2016, p4]. It operates a facility on fischer's campus in Achern, which will be leased to Advent.

The transaction – comprising €15 million in cash and €37 million in Advent shares – is expected to close in Q3, subject to customary regulatory approvals.

Advent Technologies: www.advent.energy

SerEnergy: www.serenergy.com

fischer eco solutions: www.fischer-group.com/en/applications/green-technology

Air Products partners with Baker Hughes

Air Products and Baker Hughes have announced a strategic global collaboration to develop next-generation hydrogen compression technology to lower the cost of production and accelerate the adoption of hydrogen as a zero-carbon fuel.

Baker Hughes will provide Air Products with its advanced hydrogen compression and gas turbine technology for global projects, including NovaLT16 turbines for Air Products' net-zero hydrogen energy complex in Edmonton, Alberta, Canada, and advanced compression technology for the Neom zero-carbon hydrogen project in Saudi Arabia [FCB, August 2020, p11].

Baker Hughes has more than 2000 hydrogen compressors operating worldwide, and also offers gas turbines that can burn methane-hydrogen blends from 5% up to 100% hydrogen. The company is a founding member of the FiveT Hydrogen investment fund [May 2021, p14].

Air Products is the world's largest hydrogen producer, with extensive experience in the hydrogen supply chain [e.g. August 2020, p10 and May 2021, p8]. The company has just announced a multi-billion dollar plan to build a net-zero hydrogen energy complex that will make **Edmonton** the centre of western Canada's hydrogen economy. Initially, the complex will comprise a large-scale autothermal reformer (ATR) hydrogen production facility featuring Haldor Topsoe technology, carbon capture and sequestration (CCS), hydrogen fueled power generation including Baker Hughes NovaLT16 turbines, hydrogen liquefaction and air separation facilities designed by Air Products, and connection to its Alberta Heartland Hydrogen Pipeline network.

Air Products, Hydrogen: www.airproducts.com/gases/hydrogen

Edmonton project: www.airproducts.com/bluebutbetter

Baker Hughes, Hydrogen Technologies: www.bakerhughes.com/h2

Ballard, Gore boost fuel cell partnership

Canadian-based Ballard Power Systems and W.L. Gore & Associates in the US signed a multi-year fuel cell supply agreement at the recent 6th International Hydrogen Fuel Cell Vehicle Congress (FCVC 2021) in Shanghai, China. This builds on their prior collaborations and supply partnerships, and strengthens their commitment to advance the benefits and applications of fuel cell technologies.

Gore produced the first commercially adopted membrane for passenger fuel cell electric vehicles, and since 1994 has been advancing the performance of PEMs for other applications. The advanced technology of the Gore-Select® membrane enables compact, durable and high-output fuel cells that are proven to extend the life of the system.

Meanwhile, Ballard reports that it has received a follow-on **purchase order from New Flyer**, for 20 fuel cell modules to power 20 New Flyer Xcelsior® fuel cell electric buses planned for deployment with Alameda-Contra Costa Transit District (AC Transit) in Oakland, California [FCB, June 2021, p1]. The modules are scheduled for delivery this year.

Ballard Power Systems: www.ballard.com

Gore, Fuel Cell Technologies: www.gore.com/fuelcells3

New Flyer, Xcelsior Charge H2 bus: www.newflyer.com/chargeh2

AC Transit, Zero Emission Buses: www.actransit.org/zeb

Bosch air compressors for cellcentric trucks

In Germany, Robert Bosch GmbH has signed a major long-term agreement with cellcentric GmbH to supply electric air compressors with integrated power electronics, for use in fuel cell systems for heavy trucks and other on- and off-highway applications.

Cellcentric – the 50:50 joint venture between Daimler Truck and Volvo Group [FCB, April 2021, p13] – is responsible for all activities along the entire value chain, and aims to become a leading global manufacturer of fuel cell systems. The air compressor will be part of the cellcentric fuel cell system that will feature in heavy-duty trucks and stationary applications. Large-scale production is anticipated to begin by about 2025.

The electric air compressor is a core component in a fuel cell system, supplying the required amount of filtered air. 'Bosch is devoting a huge effort to developing this component. For example, we have 15 cross-divisional teams working to commercialise the electric air compressor,' says Dr Uwe Gackstatter, President of Bosch Powertrain Solutions.

Bosch offers the air compressor in two power classes: the 20 kW class is rated for either 250–450 V or 450–850 V, while the 30 kW class is rated for 450–850 V. 'The combination of a high-speed electric motor with integrated power electronics enables easy system integration at competitive manufacturing costs,' explains Gackstatter. In addition, the use of silicon carbide semiconductors in Bosch power electronics make this component particularly efficient.

Robert Bosch GmbH: www.bosch.com

cellcentric GmbH: www.cellcentric.net

Enapter to develop electrolyser production

Enapter is accelerating its scale-up plans with the development of machinery for mass production of its green hydrogen generators. Building on months of preparation, Enapter will develop and deploy the pioneering, automated production line it needs to massively scale up manufacturing of its anion-exchange membrane (AEM) electrolysers.

In the autumn the company will begin construction of its 'Enapter Campus' mass-production and R&D site [*FCB, November 2020, p12*]; the North Rhine-Westphalia (NRW) Ministry of Economic Affairs, Innovation, Digitalization and Energy has announced €9.3 million in funding for this endeavour, under its ELEFACT project. Up to 66 people will work on it as part of the 300+ employees expected to be hired for the Campus in NRW's Saerbeck climate community.

The new manufacturing line will be capable of automated mass production of AEM electrolyser components, as well as autonomous assembly into electrolyser cores, and assembly and testing of finished electrolyser modules. Enapter recently unveiled its MW-class AEM Multicore electrolyser, for commercial launch next year, offering low-cost, flexible and reliable green hydrogen production [*June 2021, p10*].

Enapter: www.enapter.com

McPhy production site planned for Grenoble

French company McPhy is preparing a new industrial-scale facility in Grenoble, dedicated to development and mass production of its hydrogen refueling stations.

McPhy will move into the new factory, located in an existing 4000 m² (43 000 ft²) industrial building in the heart of Grenoble, in March 2022. This will bring together the company's research and innovation, engineering and production activities currently based in nearby La Motte-Fanjas and Grenoble, as well as support functions. The facility will multiply McPhy's hydrogen station manufacturing capacities sevenfold, from 20 to 150 units per annum from 2022, and at full capacity will create more than 100 jobs.

This increase in manufacturing capacity, when McPhy has 35 stations already delivered or in the process of being delivered, will significantly lower manufacturing costs while guaranteeing optimum delivery times. The company will also implement a new integrated test platform and lean manufacturing processes based on digital manufacturing tools, with the aim of mass-producing its new range of stations for refueling all types of vehicles, from light vehicles to buses, trucks or trains [*e.g. FCB, April 2021, p11*].

McPhy also has facilities for engineering and production of Piel and McLyzer electrolysers in Italy and for engineering of high-capacity electrolysers in Germany. The company recently announced Belfort, in northeastern France, as the site of its planned electrolyser gigafactory [*June 2021, p12*].

McPhy: <https://mcphy.com>

myFC wins e-mobility systems order in Japan

Swedish micro fuel cell company myFC has received an order for an undisclosed number of hydrogen fuel cell systems for the electromobility sector from its Japanese distribution partner Lightec Inc.

The order, worth up to SEK2 million (US\$230 000), has been placed by Tokyo-based Lightec, which is representing an unidentified global e-mobility component manufacturer. The order was preceded by a feasibility study, now complete, which evaluated the integration of myFC's micro fuel cell technology and a

hydrogen tank into the manufacturer's system. With the feasibility study concluded, the development, production and integration of prototypes is now set to begin. The commercial order marks a milestone in the discussions between the parties to establish a cooperation agreement for technical development projects targeting the e-mobility sector.

The fast-growing electromobility sector is a prioritised focus for myFC's PEM fuel cell technology, which has been specifically developed to provide freedom in design, modularity, flexibility and high energy density. The company is participating in a Swedish feasibility study for a hybrid battery-fuel cell solution for electric vehicles specially adapted to the Nordic climate [*FCB, October 2020, p2*], and in a Swedish small vehicle concept study [*February 2021, p2*].

myFC: www.myfc.se

Nel deal for Howden hydrogen compressors

Nel Hydrogen Electrolyser in Norway has signed a framework agreement with Howden, a UK-based manufacturer of gas handling solutions, to supply hydrogen compressors for Nel's electrolysers.

The non-exclusive frame agreement with Howden is an important step towards achieving Nel's cost target of green hydrogen production at US\$1.50 per kg. The companies will work closely together to develop cost-competitive hydrogen compressor systems for Nel's industry-leading electrolysers. Earlier this year Howden signed a contract to deliver hydrogen compression for Everfuel's green hydrogen production facility, under development adjacent to Dansk Shell's Fredericia refinery in Denmark [*FCB, March 2021, p9*].

Nel Hydrogen Electrolyser – a division of Nel ASA – has also entered into a collaboration for a fossil-free **hydrogen facility in Hofors**, Sweden with partners Ovako, Volvo, Hitachi ABB Power Grids Sweden, and H2 Green Steel. The conversion to green hydrogen in the steel production process will halve CO₂ emissions, with potential future development of hydrogen infrastructure for transportation. The investment of approximately SEK180 million (US\$21 million) is supported by the Swedish Energy Agency via the Industriklivet initiative.

Nel ASA: www.nelhydrogen.com

Howden: www.howden.com

H2 Green Steel: www.h2greensteel.com

REFIRE launches fuel cell system for trucks

Shanghai REFIRE Technology Co Ltd in China has expanded its Prisma fuel cell system product line, with the launch of its all-new Prisma 12+ hydrogen fuel cell system for heavy-duty trucks. The company is also partnering with German automotive technology specialist Schaeffler Group to accelerate hydrogen fuel cell development and production.

The **Prisma 12+** system, launched at the recent 6th International Hydrogen Fuel Cell Vehicle Congress (FCVC 2021) in Shanghai, offers 10% higher efficiency over previous models, with balance-of-plant (BOP) power consumption reduced by 10 kW. The Prisma 12+ is designed to operate for at least 30 000 hours with less than 10% degradation in performance, similar to heavy-duty internal combustion engines. German certification services provider TÜV Rheinland presented REFIRE with the first-ever Verification of Performance Certificate for the Prisma 12+ system during FCVC 2021.

REFIRE has also announced a **partnership with Schaeffler**, which will help REFIRE to strengthen the quality and performance of its fuel cell systems, and bolster its supply chain capabilities and accelerate global expansion. The partners will explore key areas of fuel cell technology, including thermal management systems, stack end plates and distribution heads. They will set up a knowledge base and shared resource platform, to include joint scientific research projects to enable REFIRE to utilise Schaeffler's innovative, high-quality components.

REFIRE specialises in design, testing, prototyping, application engineering and in integrated fuel cell systems for buses, trucks, specialised vehicles, power supply units, and marine applications [e.g. *FCB*, July 2020, p13]. Its technologies and products already power more than 2700 fuel cell electric vehicles in 15 cities across China, as well as in projects in five other countries.

Shanghai REFIRE Technology:
www.refire.com/en

TÜV Rheinland: www.tuv.com/world

Schaeffler Group: www.schaeffler.com

RESEARCH

Fraunhofer toolkit to produce bipolar plates

Researchers at the Fraunhofer Institute for Machine Tools and Forming Technology IWU in Chemnitz, Germany and the Fraunhofer Institute for Production Technology IPT in Aachen are developing a virtual technology toolkit that will help users to make the best production decisions when manufacturing fuel cells. The toolkit enables the most appropriate bipolar plate forming technology to be selected for the specific application.

Fraunhofer IWU and Fraunhofer IPT are distilling their expertise in the forming processes used to create bipolar plates and their flow-fields, into a shared virtual technology toolkit. This applies evidence-based analysis to observe the initial situation, taking into account all possible outcomes, and systematically considers the various dependencies, to allow the development of a tailor-made technological solution for any need. In addition to machine capital, die-set costs and production quantity, the parameters which the researchers have factored into the decision include size, flatness and flow-field design. The raw material used also influences the choice of forming process. The technology toolkit can also provide guidance on the order of the production steps based on the technology selected.

Tailored consultation on implementing the ideal forming process is already available, and the Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart is currently developing a website for the technology toolkit, which will be available shortly. In the medium term there are plans to expand the toolkit to include additional production steps and fuel cell components, in cooperation with other Fraunhofer institutes.

Fraunhofer Institute for Machine Tools and Forming Technology IWU:
www.iwu.fraunhofer.de/en.html

Fraunhofer Institute for Production Technology IPT:
www.ipt.fraunhofer.de/en.html

Fraunhofer Institute for Manufacturing Engineering and Automation IPA:
www.ipa.fraunhofer.de/en.html

Rheinmetall, Tongji partner for China lab

German automotive technology group Rheinmetall has set up a joint laboratory with Tongji University in Shanghai, China to foster cooperation in new energy vehicle technologies. The lab, which will focus primarily on research and innovation in fuel cells, forms part of an endowed chair at the School of Automotive Studies.

Rheinmetall – which operates production plants at 17 locations across China – and Tongji University held a joint opening ceremony in April at Rheinmetall China's headquarters in Hongqiao. The holder of the endowed chair is Professor Zhang Lijun, Dean of the School of Automotive Studies.

'With the joint lab, we aim to develop application-oriented solutions related to fuel cells for the fast-growing Chinese market,' said Peter Willemsen, President of Rheinmetall China. 'We are looking forward to continuing our long-standing partnership with Tongji University, pursuing the twin goals of innovation and educating highly qualified students.'

Pierburg, a subsidiary of Rheinmetall, is further developing its existing technologies in pumps and valves for internal combustion engines to application in alternative drivetrains, such as fuel cell electric and other new energy vehicles. The company has already developed an electric coolant pump and hydrogen recirculation blower suitable for low- and high-voltage (400 and 800 V) vehicle systems [*FCB*, November 2020, p13], for which it has won a €10 million order from Daimler Truck Fuel Cell GmbH [*February 2021*, p12].

Rheinmetall Automotive GmbH:
www.rheinmetall-automotive.com/en

Pierburg GmbH:
www.rheinmetall-automotive.com/en/brands/pierburg

Tongji University, School of Automotive Studies:
<https://auto.tongji.edu.cn> [in Chinese]

Tongji University: <https://en.tongji.edu.cn>



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BULLETIN

EVENTS CALENDAR

****Some of the events in this list have been rescheduled or cancelled on account of the coronavirus pandemic – check websites for latest update****

3 August 2021

California Fuel Cell Partnership Webinar: Update on Network Development Status in California

Online

More information: <https://cafcp.org/content/april-8-hydrogen-stations-update-network-0>

16–18 August 2021

10th Annual Green Transportation Summit & Expo, GTSE 2021

Tacoma, Washington, USA and Online

More information: www.gtsummitexpo.com

16–20 August 2021

2021 World Fuel Cell Conference, WFCC 2021: International Association for Hydrogen Energy

Online

More information: www.iahe-fcd.org/wfcc2021

18–19 August 2021

RESCHEDULED TO MAY 2022: All-Energy Exhibition & Conference 2022

Glasgow, Scotland, UK

More information: www.all-energy.co.uk

29 August–3 September 2021

72nd Annual Meeting of the International Society of Electrochemistry, including Symposium 10: Electrochemical Systems for Energy Conversion: Fuel Cells and Electrolyzers

Jeju Island, South Korea

More information: <https://annual72.ise-online.org>

30 August–2 September 2021

Advanced Clean Transportation Expo, ACT Expo 2021

Long Beach, California, USA

More information: www.actexpo.com

31 August–1 September 2021

US Department of Energy Earthshots Initiative: Hydrogen Shot

Online

More information:

www.energy.gov/eere/fuelcells/hydrogen-shot

2 September 2021

2nd International Hydrogen Aviation Conference, IHAC 2021

Glasgow, Scotland, UK or Online

More information: www.hy-hybrid.com/ihac-2021

14–15 September 2021

f-cell Stuttgart: Energizing Hydrogen Markets

Stuttgart, Germany

More information: www.f-cell.de

15–17 September 2021

2021 International Zero Emission Bus Conference

Denver, Colorado, USA

More information: www.zebconference2021.com

19–23 September 2021

12th International Conference on Hydrogen Production, ICH₂P-2021 Online Conference

Online

More information: www.ich2p-2021.org

21–24 September 2021

9th International Conference on Hydrogen Safety, ICHS 2021: Safe Hydrogen for Net Zero

Edinburgh, Scotland, UK and Online

More information: www.hysafe.info/ichs2021

22–23 September 2021

14th Low Carbon Vehicle Event: Cenex-LCV 2021

Millbrook, Bedfordshire, UK and Online

More information: www.cenex-lcv.co.uk

29 September–1 October 2021

FC EXPO 2021, International Hydrogen & Fuel Cell Expo, within World Smart Energy Week

Tokyo, Japan

More information: www.fcexpo.jp/en-gb.html

6–8 October 2021

International Workshop on Functional Nanostructured Materials, FuNaM-3

Krakow, Poland and Online

More information:

www.funam.confer.uj.edu.pl/en_GB

8 October 2021

Mission Hydrogen: Hydrogen Online Conference & Virtual Exhibition [Free]

Online

More information:

www.hydrogen-online-conference.com

10–14 October 2021

240th ECS Meeting, The Electrochemical Society, including Symposium I01: Polymer Electrolyte Fuel Cells & Electrolyzers 21, PEFC&E21

Orlando, Florida, USA

More information: www.electrochem.org/240

13–14 October 2021

2021 Ohio Fuel Cell Symposium

North Canton, Ohio, USA

More information: www.fuelcellcorridor.com

20–21 October 2021

Hydrogen Technology Conference & Expo: Technologies & Solutions for a Low-Carbon Hydrogen Future

Bremen, Germany [was in Stuttgart]

More information:

www.hydrogen-worldexpo.com

27–28 October 2021

HyVolution 2021, the Hydrogen Event for Energy, Industry and Mobility

Paris, France

More information:

www.hyvolution-event.com/en

8–10 November 2021

HYPOTHESIS XVI Online 2021: HYdrogen

Power Theoretical & Engineering Solutions International Symposium

Online

More information: www.hypothesis.ws

Abstract deadline extended: 31 July 2021

16 November 2021

[rescheduled from 7 September]

2021 UK Hydrogen and Fuel Cell Conference, CCSHFC 2021

NEC, Birmingham, UK

More information: www.climate-change-solutions.co.uk/event/hydrogen-and-fuel-cells-the-time-is-now

17–18 November 2021

European Zero Emission Bus Conference, ZEB 2021

Paris, France

More information:

www.zeroemissionbusconference.eu

23–24 November 2021

2nd Fuel Cell Conference Chemnitz FC³: Clean Drives, Efficiently Produced

Chemnitz, Germany

More information: www.iwu.fraunhofer.de/en/trade-fairs-and-events/fc3-fuel-cell-conference-chemnitz1.html

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

30 November–2 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 Conference

Online

More information: www.europeanfuelcell.it

Abstract deadline: 25 August 2021

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