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

ZeroAvia evaluates Hyzon high-power fuel cell

Hyzon Motors, a leading manufacturer of hydrogen fuel cell-powered heavy vehicles, has announced that zero-emissions aviation pioneer ZeroAvia has placed an order for its high power density PEM fuel cell stack. ZeroAvia will evaluate the lightweight, next-generation fuel cell for use in its hydrogen-electric aircraft development programme.

ZeroAvia selected Hyzon's fuel cell stack for this evaluation on the basis of its industry-leading power density. Hyzon's Gen3 stack achieves a volumetric power density above 6.0 kW/litre and gravimetric power density more than 5.5 kW/kg, well above industry averages, as confirmed by German technical certification provider TÜV Rheinland [*FCB, November 2020, p12*]. These factors are critical in aviation, minimising weight while providing sufficient power for the desired performance.

Hyzon has achieved such a high power density through a combination of proprietary technologies in the bipolar plate and membrane-electrode assembly (MEA), maximising catalyst utilisation in the MEA. The company is primarily known for its heavy-duty fuel cell electric trucks, buses and coaches, and other on-road commercial vehicles [*e.g. see the several items in August 2021, and page 4 in this issue*], but its core technology can be adapted to accommodate aircraft applications.

ZeroAvia will test the fuel cell stack through simulated airplane duty cycles. These tests will include customary power needs such as take-off, cruising, landing and taxiing, as well as more strenuous situations including rapid changes in altitude and other ambient conditions. Once the stack has been validated in a ground test programme, the next step will be to test it in flight.

US/UK-based ZeroAvia is focused on hydrogen-electric aviation solutions for a variety of markets, initially targeting 500 mile (800 km) range in 10–20 seat aircraft for commercial passenger transport, cargo, agriculture and more [*e.g. August 2021, p7, and see page 7 in this issue*]. The company has already secured experimental certificates for its two prototype aircraft from the UK's Civil Aviation Authority (CAA) and the US Federal Aviation Administration (FAA) [*June 2020, p1*], and is on track for commercial operations in 2024.

Hyzon Motors: www.hyzonmotors.com

ZeroAvia: www.zeroavia.com

TÜV Rheinland: www.tuv.com/world

Ballard, Quantron target fuel cell electric trucks

Canadian-based Ballard Power Systems has announced a strategic partnership with German electric vehicle integrator Quantron, to accelerate deployment and market adoption of fuel cell technologies. Their complementary expertise will enable broader customer access to fuel cell electric trucks without compromising on range, payload, vehicle utilisation or total cost of ownership.

Their initial collaboration will focus on integration of Ballard's FCmove™ family of heavy-duty PEM fuel cell power modules into Quantron's electric drivetrain and vehicles. Fuel cell electric truck platforms currently in development include a 7.5 tonne delivery truck, a 44 tonne truck and a waste collection truck..

The new collaboration will leverage the synergies between battery electric and fuel cell electric powertrains. Initial deployment of Quantron fuel cell electric trucks is scheduled for the second half of 2022 in Germany.

Quantron is already collaborating with AE Driven Solutions GmbH (AEDS) to implement hydrogen drive solutions for full-size vans, and its planned 44 tonne Energon truck features a 130 kW fuel cell system from Freudenberg Sealing Technologies [*FCB, August 2020, p2*].

Ballard Power Systems: www.ballard.com

Quantron: www.quantron.net/en

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The BMW iX5 Hydrogen combines a 125 kW PEM fuel cell system with the 5th-generation BMW eDrive system, allowing consistently high speed to be maintained over longer distances; the energy stored in the battery can boost the system output to 275 kW. Hydrogen is stored in two 700 bar tanks made of carbon fibre reinforced plastic (CFRP), which together hold nearly 6 kg of hydrogen.

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

IAA Mobility 2021: www.iaa.de/en/mobility

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The buses are being purchased as part of the council's Clean Air Hydrogen Bus Pilot [*November 2020, p2*], which is intended to be the catalyst for the next generation of hydrogen buses, hydrogen production and refueling infrastructure development. Funding is through the UK government's Office for Low Emission Vehicles (OLEV), Greater Birmingham & Solihull Local Enterprise Partnership (GBSLEP), Birmingham City Council, and project funding from the EU-supported Fuel Cells and Hydrogen Joint Undertaking (FCH JU) under the Joint Initiative for hydrogen Vehicles in Europe (JIVE) [*see the News Feature in February 2017*]. Wrightbus double-decker fuel cell buses are also being deployed in Aberdeen, Scotland [*February 2021, p3*] and London [*July 2021, p3*].

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Loop Energy: www.loopenergy.com

Técnicas Reunidas: www.tecnicasreunidas.es

Van Hool delivers first bus for Brussels trial

Belgian bus manufacturer Van Hool has delivered an A330FC hydrogen fuel cell electric bus to STIB-MIVB, which operates public bus, metro and tram transport in Brussels. STIB-MIVB will test the vehicle over a two-year period on various bus lines, to thoroughly analyse performance in different weather conditions and topographies on its network.

The 12 m (40 ft) hydrogen powered bus is a fuel cell-battery hybrid vehicle, designed to carry 25 seated and 48 standing passengers. It is equipped with an FCvelocity®-HD85 PEM fuel cell module from Canadian company Ballard Power Systems, and a 210 kW Siemens electric traction motor. This hybrid approach means that the bus, with a tank capacity of 38.2 kg of hydrogen, can carry out a full day's schedule of up to 350 km (220 miles).

Van Hool has delivered 21 hydrogen buses to North American customers since 2005 [*e.g. FCB, August 2017, p3*], and 141 buses for the European market since 2007 [*e.g. July 2021, p8*].

Van Hool, Fuel Cell Buses: www.vanhool.be/en/public-transport/agamma/hybrid-fuel-cell

STIB-MIVB Brussels Intercommunal Transport Company: www.stib-mivb.be/?l=en

Solaris hydrogen bus trial in Upper Austria

The northern Austrian state of Upper Austria recently trialed a Solaris Urbino 12 hydrogen bus on several routes in the town of Wels. The week-long trial was part of the Hydro-Motion project, a collaboration between the state, Wels, Solaris Bus & Coach, hydrogen equipment manufacturer Fronius, and transport service providers Wels Linien, SAB Tours and OÖVV.

The trial was organised by Solaris Austria, which supplied the fuel cell electric bus and technical support during the test, while Fronius International provided access to its hydrogen refueling station in nearby Thalheim, site of its Hydrogen Competence Centre [*FCB, July 2020, p15*].

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UK hydrogen transport trials in Tees Valley

The UK government is funding several projects to accelerate the use of hydrogen transport in the Tees Valley region, including diesel buses retrofitted with hydrogen fuel cells, supermarket chains benefiting from hydrogen delivery vans, and the police and National Health Service using hydrogen vehicles.

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Toyota will deliver several hydrogen vehicles, including a forklift for warehouse operations, a bus, and 10 fuel cell passenger cars. These will be deployed across local rapid-response services, including Cleveland Police and NHS patient support.

EDITORIAL

Crossover of fuel cell technologies developed for one application area being applied in a completely different field is becoming increasingly popular.

For example, we report on three good examples in this issue, with the newly announced relationship between **Hyzon Motors and ZeroAvia** making the front page. Hydrogen-electric aviation pioneer ZeroAvia has ordered a high power density PEM fuel cell stack from Hyzon, a leading manufacturer of heavy-duty fuel cell electric vehicles (i.e. trucks and buses) [*see also page 4*]. ZeroAvia will evaluate the lightweight, next-generation fuel cell for use in its hydrogen-powered aircraft development programme [*see also page 7*].

Another notable new partnership in South Korea is **Hyundai Motor Company** linking up with Hyundai Electric & Energy Systems, to develop a hydrogen fuel cell package for mobile power generators and alternative maritime power solutions, based on its proven automotive fuel cell technology [*page 9*]. Hyundai Motor is already well along the route to wider deployment of its fuel cell technology; in late 2018 the automaker announced its FCEV Vision 2030 roadmap, to leverage its automotive technologies beyond the transportation sector [*December 2018, p1*]. Its sister company Hyundai Mobis subsequently unveiled a power generation system for a building [*February 2019, p1*], and a year ago Hyundai Motor began shipping its fuel cell system technology to Europe for use by non-automotive companies [*October 2020, p14*].

Also in this issue, Swedish company **myFC** is working with a leading European OEM to develop fuel cell solutions for automated guided vehicles (AGVs) used as warehouse robots, powered by myFC's fuel cell-battery hybrid solution [*page 6*]. myFC originally developed its technology for consumer portable devices, but following a strategic review it switched to selling technology and know-how to companies planning fuel cell powered products [*July 2019, p11*], in particular for mobility [*e.g. July 2021, p14*].

Another crossover application – in a sense – is the use of fuel cell power sources to charge battery electric vehicles, and we report on two companies targeting this emerging sector in this issue. UK-based **AFC Energy** has delivered its first hydrogen-fueled alkaline fuel cell system to ABB, for operational integration with ABB's high-power, fast-charging system for EVs [*page 9*]. And **Proton Motor**'s NEXUS-fc network has been awarded EUR1.4 million in federal funding to develop and produce a grid-independent, fuel cell powered, fast-charging station for battery electric buses in Germany [*page 9*].

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manufacturer of compressed natural gas and hydrogen systems for transit and coach buses, with its hydrogen fuel cell system featuring a fully integrated package of fuel cell module, cooling system and DC-DC power-conditioning equipment. The first order has already been placed, intended for initial testing and homologation of hydrogen electric transit buses being developed by NGVI and Ulsan Metropolitan City. Loop Energy is accelerating adoption of the eFlow platform in the transit bus market [*e.g. July 2021, p3*], and this order marks its entry into the South Korean zero-emission commercial vehicle market.

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The £2.5 million (US$3.4 million) funding follows the unveiling of a masterplan for the UK's first hydrogen transport hub [*FCB, November 2020, p14*], which could be fully operational by 2025.

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Tees Valley Combined Authority: www.teesvalley-ca.gov.uk

H2M, H2e to develop fuel cell 3-wheeler

Canadian company Hydrogen In Motion (H2M) is collaborating with H2e Power in India on a project to assess, design, install and demonstrate a hydrogen fuel cell powered three-wheeler vehicle, featuring H2e's PEM fuel cell integrated with H2M's solid-state hydrogen onboard storage technology.

The project will install a hydrogen fuel cell range-extender using H2M's low-pressure hydrogen storage tanks on an electric powered, three-wheeled auto rickshaw. The aim is to significantly extend the operational range and provide auxiliary power for home use when not in service. H2M is receiving advisory services and up to C$600,000 (US$475,000) in funding support for this project through the Canadian International Innovation Program (CIIP), while H2e is supported by the Indian Department of Science & Technology in collaboration with the Global Innovation and Technology Alliance (GITA).

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Funding for green road freight projects in UK

The UK government's Department for Transport (DfT) has announced £20 million (US$27 million) in funding – delivered by Innovate UK – for 20 zero-emission road freight trials, six of which are focused on hydrogen and fuel cell technologies for heavy goods vehicles (HGVs) and their refueling infrastructure.

In the Scottish Hydrogen Freight Trial (**SHyFT**), Arcola Energy, University of St Andrews, BOC, Scottish Power and Newcold Ltd will develop a viable scale trial with early adopters for Arcola's fuel cell powertrain in 44 tonne trucks. The **UK Aggregated Hydrogen Freight Consortium**, comprising Element Energy, TRL Ltd (Transport Research Laboratory) and Toyota GB will study nationwide deployment of hydrogen freight vehicles and associated hydrogen refueling station networks. And the **H2GVMids** project will carry out a feasibility study on using hydrogen for 44 tonne trucks, with a trial in the Midlands. The partners include EDF Energy R&D UK, Nottingham and Birmingham Universities, Adelan Ltd, Horiba Mira, Arcola, Cenex, Intelligent Energy, ITM Motive and Toyota GB.

The **INVO-EDU** (Zero Emissions 44 tonne HGV electric drive train) initiative – involving Involution Technologies Ltd, University of Salford and Bramble Energy – will design a next-generation electric drive unit for long-distance HGV haulage applications, using a Bramble Energy fuel cell. In the **HyPER** (Hydrogen Prototype Equipment for Refuelling) project, Hy-Met Ltd, University of Warwick and Logan Energy will design an innovative ultrasonic hydrogen refueling system metering solution. And in the **CHERRY** (CooltH Engines for Rapid Refuelling of hYdrogen road freight vehicles) project, Nanosun Ltd will develop a low-cost and reliable method for cooling hydrogen between refueler and vehicle.

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Successful projects: www.gov.uk/government/publications/zero-emission-road-freight-trials-funding-winners

Hyzon truck for trial in California, partnership for LH_2 stations in US

Hyzon Motors has signed an agreement to supply a Class 8 heavy-duty fuel cell electric truck to Total Transport Services Inc (TTSI) in southern California for a 30-day trial in Q4, which will be Hyzon's first customer trial in the US. Hyzon is also partnering with RenewH2 to collaborate on the supply and demand side of liquid hydrogen (LH_2) production.

The **truck for TTSI**, built on a 2022 Freightliner Cascadia chassis, is expected to have 600 peak horsepower (450 kW) and a range of up to 400 miles (640 km). This would allow the truck to go straight into TTSI's heavy-load logistics operations, hauling up to 82,000 lb (36 tonne) gross combined vehicle weight (GCVW). It will utilise the heavy-duty hydrogen refueling station in Wilmington, close to TTSI's Long Beach operations. The trial – which will run full loads from Long Beach to Sacramento – will be TTSI's first experience with a zero-emissions vehicle capable of 400 miles range. TTSI is already participating in a demonstration of Toyota/Kenworth fuel cell electric trucks [*FCB, July 2021, p4*], and recently ordered 100 Class 8 battery and fuel cell electric semi-trailer trucks from Nikola [*June 2021, p4*].

Hyzon has also signed a Memorandum of Understanding with **RenewH2** to collaborate on the supply and demand side of liquid (cryogenic) hydrogen production. RenewH2 will reform biogenic methane to generate hydrogen, which would be liquefied and delivered to refueling stations that are expected to be developed in collaboration with Hyzon. This will allow the stations to be located near Hyzon customers, providing consistent demand. RenewH2 expects to begin producing hydrogen at its Wyoming facility in 2023,

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HV Systems plans to demonstrate hydrogen powered delivery vans, operated in collaboration with a supermarket chain, running between 19 superstores and a main distribution centre. The project aims to show how delivery vans fitted with fuel cells can have increased range, faster refueling than battery electric versions, and speed parity with diesel vehicles. And **Element Energy** and supermarket chain Sainsbury's will trial a hydrogen powered heavy goods vehicle (HGV), operated from a local distribution centre and carrying out deliveries.

The £2.5 million (US$3.4 million) funding follows the unveiling of a masterplan for the UK's first hydrogen transport hub [*FCB, November 2020, p14*], which could be fully operational by 2025.

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Toyota Europe, Mirai: www.toyota-europe.com/world-of-toyota/electrified/fuel-cell

HV Systems: www.hv-systems.com

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Tees Valley hydrogen hub masterplan: www.gov.uk/government/publications/tees-valley-multi-modal-hydrogen-transport-hub

Tees Valley Combined Authority: www.teesvalley-ca.gov.uk

H2M, H2e to develop fuel cell 3-wheeler

Canadian company Hydrogen In Motion (H2M) is collaborating with H2e Power in India on a project to assess, design, install and demonstrate a hydrogen fuel cell powered three-wheeler vehicle, featuring H2e's PEM fuel cell integrated with H2M's solid-state hydrogen onboard storage technology.

The project will install a hydrogen fuel cell range-extender using H2M's low-pressure hydrogen storage tanks on an electric powered, three-wheeled auto rickshaw. The aim is to significantly extend the operational range and provide auxiliary power for home use when not in service. H2M is receiving advisory services and up to C$600,000 (US$475,000) in funding support for this project through the Canadian International Innovation Program (CIIP), while H2e is supported by the Indian Department of Science & Technology in collaboration with the Global Innovation and Technology Alliance (GITA).

Hydrogen In Motion – based in Vancouver, British Columbia – has developed a nanomaterial that stores hydrogen at low pressure (50 bar rather than 350 or 700 bar), for a smaller, safer and cheaper hydrogen storage system. h2e Power Systems, part of the Poonawalla Group in Pune, produces and integrates solid oxide fuel cell systems and solutions utilising green hydrogen. Its focus is on SOFC and electrolyser cell technology, originally developed by Fraunhofer IKTS in Germany [*FCB, October 2015, p5*], but last year it acquired Hexis's SOFC technology [*July 2020, p13*], and has worked with Convion [*November 2017, p7*].

Hydrogen In Motion: www.hydrogeninmotion.com

h2e Power Systems: www.h2epower.net

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The UK government's Department for Transport (DfT) has announced £20 million (US$27 million) in funding – delivered by Innovate UK – for 20 zero-emission road freight trials, six of which are focused on hydrogen and fuel cell technologies for heavy goods vehicles (HGVs) and their refueling infrastructure.

In the Scottish Hydrogen Freight Trial (**SHyFT**), Arcola Energy, University of St Andrews, BOC, Scottish Power and Newcold Ltd will develop a viable scale trial with early adopters for Arcola's fuel cell powertrain in 44 tonne trucks. The **UK Aggregated Hydrogen Freight Consortium**, comprising Element Energy, TRL Ltd (Transport Research Laboratory) and Toyota GB will study nationwide deployment of hydrogen freight vehicles and associated hydrogen refueling station networks. And the **H2GVMids** project will carry out a feasibility study on using hydrogen for 44 tonne trucks, with a trial in the Midlands. The partners include EDF Energy R&D UK, Nottingham and Birmingham Universities, Adelan Ltd, Horiba Mira, Arcola, Cenex, Intelligent Energy, ITM Motive and Toyota GB.

The **INVO-EDU** (Zero Emissions 44 tonne HGV electric drive train) initiative – involving Involution Technologies Ltd, University of Salford and Bramble Energy – will design a next-generation electric drive unit for long-distance HGV haulage applications, using a Bramble Energy fuel cell. In the **HyPER** (Hydrogen Prototype Equipment for Refuelling) project, Hy-Met Ltd, University of Warwick and Logan Energy will design an innovative ultrasonic hydrogen refueling system metering solution. And in the **CHERRY** (CooltH Engines for Rapid Refuelling of hYdrogen road freight vehicles) project, Nanosun Ltd will develop a low-cost and reliable method for cooling hydrogen between refueler and vehicle.

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Nanosun: www.nanosun.co.uk

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units (IMUs), and the UAV Satcom satellite transceiver. Honeywell – which acquired Ballard's UAV business last year [*FCB, October 2020, p1*] – says that the fuel cells in the BVLOS suite can operate for three times longer than batteries with equivalent output, and operators can refuel or swap hydrogen tanks in minutes, enabling more time in the air. Honeywell's fuel cells and RDR-84K are currently in late-stage development, with prototype fuel cells available for purchase and evaluation.

Honeywell, Hydrogen Fuel Cell: www.aerospace.honeywell.com/us/en/learn/products/honeywell-hydrogen-fuel-cell

ZeroAvia completes first 600 kW aviation powertrain ground test

US/UK-based ZeroAvia has demonstrated its flight-intent 600 kW 'ZA-600' hydrogen fuel cell electric powertrain, pulling its new 15 ton HyperTruck mobile ground testing platform across the tarmac at its Hollister, California headquarters.

The ground test is the first major milestone for ZeroAvia's HyFlyer II programme [*FCB, January 2021, p6*]. The HyperTruck, based on a heavy-duty military truck, is sized for the company's 2 MW+ 'ZA-2000' powertrain, to test systems for 40–80 seat aircraft. The ground tests of the smaller 600 kW propulsion system support development of the HyFlyer II programme, to deliver a hydrogen-electric propulsion system for 10–20 seat airframes.

This is ZeroAvia's first high-power run of the ZA-600 powertrain, kicking off its programme to prepare the system for flight. The first test flights of HyFlyer II's Dornier 228 aircraft testbed are expected to take place later this year from the company's UK facility in Kemble [*August 2021, p7*]. ZeroAvia has procured two Dornier 228 aircraft for the next phase of its 19-seat programme, building on the success of the 250 kW powerplant in a 6-seat aircraft [*October 2020, p6*], targeting commercial operations in 2024.

Meanwhile, ZeroAvia is partnering with **Octopus Hydrogen**, a new arm of Octopus Energy, which will provide green hydrogen to ZeroAvia's R&D centre at Cotswold Airport in Kemble during testing, certification and first commercial operations. Octopus will provide 250 kg/day of fuel cell grade, high-pressure green hydrogen for the mobile refueling unit.

ZeroAvia: www.zeroavia.com

Octopus Hydrogen: www.octohydrogen.com

EnaBle consortium to develop hydrogen-electric aviation tech

The EnaBle project in Germany has been awarded EUR8 million in funding to develop and optimise a modular fuel cell-battery hybrid drive system for hydrogen-electric aviation.

The consortium includes project coordinator Diehl Aerospace, MTU Aero Engines, DLR German Aerospace Center, the DLR spinoff H2Fly [*e.g. FCB, August 2021, p7*], and the University of Ulm. The project, funded by the Federal Ministry for Economic Affairs and Energy (BMWi), is focused on developing a 250 kW electric drivetrain module utilising compressed air-fed fuel cells, with the aim of implementing this in small aircraft with up to 19 seats.

The use of an air supply module to feed compressed air to the fuel cell cathode will make it more efficient and enable higher performance. This is of particular interest in aircraft, which travel at altitudes where the air pressure is low. This is being tested at the University of Ulm, whose fuel cell research facility is unique in having a test stand integrated into an air-conditioned vacuum chamber, allowing entire drivetrain systems to be characterised and tested under realistic, flight-relevant conditions. Ulm is also responsible for developing and optimising the performance management system, to ensure the battery provides additional energy for the drivetrain when high power is required, along with in-flight recharging.

Diehl Aerospace: www.diehl.com/aviation

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of current fuel cell systems, and up to a 50% reduction in direct operating costs relative to turbine-powered rotorcraft. Piasecki will gain an exclusive licence to the technology created under the partnership, with HyPoint retaining ownership of its underlying technology. The partners intend to make the new system available to eVTOL manufacturers by customising it for use in their vehicles, or under partnerships to develop a new system based on their specific needs.

Last summer HyPoint partnered with Israeli company Urban Aeronautics to incorporate its high-temperature PEM fuel cell stack technology in an eVTOL [*FCB, July 2020, p4*], and earlier this year unveiled the first operable prototype of its turbo air-cooled hydrogen fuel cell system [*April 2021, p7*].

HyPoint: www.hypoint.com

Piasecki Aircraft Corporation: www.piasecki.com

Infinity fuel cell for Blue Origin spacecraft

Connecticut-based Infinity Fuel Cell and Hydrogen Inc reports that its Non-Flow-Through (NFT) hydrogen fuel cell power plant is on track to be onboard an upcoming unmanned launch of Blue Origin's New Shepard commercial space vehicle.

Infinity has been developing the power plant under a NASA 'Tipping Point' cooperative agreement contract initiated in 2020, building on the company's previous work [*e.g. FCB, September 2016, p10*]. The 2022 launch will demonstrate the capability of the Non-Flow-Through Proton Exchange Membrane (NFT-PEM) fuel cell technology to survive the rigours of launch and operation in a weightless environment. Blue Origin is Jeff Bezos's sub-orbital spaceflight services company – the Amazon.com founder was among the crew on its recent first manned launch.

Infinity designs and manufactures air-independent, zero-gravity electrochemical systems including PEM fuel cell systems for space and underwater applications. The company is also developing electrolysis technologies that can generate hydrogen and oxygen directly at 2000 psi (140 bar) or more.

Infinity Fuel Cell and Hydrogen: www.infinityfuel.com

Blue Origin: www.blueorigin.com

NASA, Tipping Point collaborations: www.nasa.gov/directorates/spacetech/solicitations/tipping_points

California passenger vessel launched, trials

All American Marine (AAM) and SWITCH Maritime have launched and begun operational trials of the *Sea Change* hydrogen fuel cell powered ferry, that will operate in the San Francisco Bay Area in California.

The 70 ft (21 m), 75-passenger ferry was developed and constructed to demonstrate a pathway to commercialisation for zero-emission hydrogen fuel cell marine technologies, and will be the first hydrogen fuel cell vessel in the US. The project is funded by private capital from SWITCH, an impact investment platform that is building the first fleet of exclusively zero-carbon maritime vessels in order to accelerate the decarbonisation and energy transition of the US maritime sector [*FCB, April 2020, p6*].

The vessel is equipped with a hydrogen fuel cell powertrain provided by Zero Emissions Industries (formerly Golden Gate Zero Emission Marine), comprising 360 kW of Cummins fuel cells [*March 2021, p5*] and Hexagon hydrogen storage tanks with a capacity of 246 kg. This system is integrated with a 100 kWh lithium-ion battery from XALT Energy and a 2 × 300 kW electric propulsion system supplied by BAE Systems.

SWITCH Maritime: www.switchmaritime.com

All American Marine: www.allamericanmarine.com

Zero Emission Industries: www.zeroei.com

Bloom SOFC to power Korean LNG ship

US-based Bloom Energy's solid oxide fuel cells will power an engine-less LNG (liquefied natural gas) carrier being developed by Samsung Heavy Industries (SHI) in South Korea, in a key step towards decarbonising the maritime industry.

Samsung Heavy and Bloom Energy first announced plans in 2019 to design and develop fuel cell powered ships [*FCB, October 2019, p5 and July 2020, p6*]. The partners have now received Approval in Principle (AiP) from international maritime classification society DNV, for an LNG carrier powered solely by SOFC technology that replaces the ship's propulsion and auxiliary internal combustion engines.

SHI will conduct tests at LNG demonstration facilities at its Geoje shipyard, and launch full-scale marketing for global ship developers. The new fuel cell powered LNG carrier is expected to provide operators with a more sustainable option to meet international emissions reduction targets. SHI is also developing a Wind Turbine Installation Vessel featuring an SOFC system operating on LNG [*April 2021, p1*].

Bloom Energy's technology has also been awarded a Concept Verified Statement of Maturity by the **American Bureau of Shipping**, which provides classification and technical advisory services to the marine and offshore industries. This verifies Bloom's SOFCs as an alternative power source for vessels under ABS's New Technology Qualification (NTQ) service, which offers guidance on early adoption and efficient implementation. Bloom Energy expects to achieve final ABS certification and classification in 2022.

Bloom Energy: www.bloomenergy.com

Samsung Heavy Industries: www.samsungshi.com/eng

DNV, Maritime: www.dnv.com/maritime/index.html

ABS, New Technology Qualification: https://ww2.eagle.org/en/Products-and-Services/offshore-energy/abs-new-technology-qualification.html

SMALL STATIONARY

Advent's new M-Zerø fuel cells cut wellhead methane emissions

Massachusetts-based Advent Technologies has launched its M-Zerø™ product family for power generation in remote environments, offering the effective elimination of methane emissions by replacing pneumatic injection technology in the oil & gas industry.

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The vessel is equipped with a hydrogen fuel cell powertrain provided by Zero Emissions Industries (formerly Golden Gate Zero Emission Marine), comprising 360 kW of Cummins fuel cells [*March 2021, p5*] and Hexagon hydrogen storage tanks with a capacity of 246 kg. This system is integrated with a 100 kWh lithium-ion battery from XALT Energy and a 2 × 300 kW electric propulsion system supplied by BAE Systems.

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The M-Zerø product family includes 50 and 150 W models, with plans for power levels up to 400 W by the end of 2022. These systems include features from Advent subsidiary UltraCell's Reformed Methanol Fuel Cell (RMFC) technology [*FCB, March 2021, p11*]. Advent has additional plans, pending its acquisition of SerEnergy [*July 2021, p13*], to jointly develop a 5 kW M-Zerø fuel cell system for launch in 2022.

Advent Technologies: www.advent.energy

UltraCell: www.ultracell-llc.com

SerEnergy: www.serenergy.com

AFC ships hydrogen fuel cell to ABB for EV charger integration

UK-based AFC Energy has delivered its first hydrogen-fueled alkaline fuel cell system to ABB, for operational integration with ABB's high-power, fast-charging system for battery electric vehicles.

Following six months of electrical engineering and controls design, AFC's fuel cell system has been shipped to ABB's product packaging facility in Estonia for operational integration and validation, in advance of marketing a complete system to customers. An AFC team is in Estonia, working closely with ABB to finalise engineering and integration of the fuel cells, battery energy storage and EV charger.

This work has been conducted under their Joint Product Development Agreement [*FCB, January 2021, p11*], which established a strategic partnership for the design and sale of high-power EV charging systems for grid-constrained locations through ABB's global market channels. Key markets include private vehicle hubs, charge point operators, logistics hubs and distribution centres, public and private urban transportation (including bus depots), marine (including port and marina charging), and vertical take-off and landing (VTOL) aircraft. ABB subsequently made a strategic investment in AFC, and expanded their partnership to target the global data centre market [*May 2021, p11*].

The system delivered to ABB features AFC Energy's HydroX-Cell(L) series of fuel cell systems [*December 2019, p12*], but plans are already in train to incorporate its higher power density S-series fuel cells in future iterations [*June 2020, p10, and see the AFC feature in December 2015*].

AFC Energy: www.afcenergy.com

ABB, EV Charging Solutions: https://new.abb.com/ev-charging

NEXUS-fc to integrate Proton Motor fuel cells in fast-charging station

Proton Motor's NEXUS-fc network has been awarded EUR1.4 million in federal funding to develop and produce a grid-independent, fuel cell powered, fast-charging station for battery electric buses in Germany.

The project, with In-der-City-Bus in Frankfurt am Main, will develop what is claimed to be the first station in the world to utilise hydrogen fuel cells – with a battery buffer – in this performance class, to compensate for a lack of charging power from the grid for battery electric buses. The NEXUS-fc concept avoids expensive grid expansion and balances out the energy received during the course of a day, while buffering power peaks.

The other partners in this two-year project – funded by the Federal Ministry of Education and Research (BMBF) to January 2023 – are Schaefer Elektronik GmbH, with expertise in power supply systems for industrial applications, and Karlsruhe Institute of Technology, with associate partner fischer Power Solutions GmbH supplying a high-performance lithium-ion battery. Proton Motor [*see the feature in FCB, May 2015*] and Schaefer Elektronik announced their NEXUS-e GmbH joint venture two years ago, to develop and market fuel cell powered fast-charging stations for electric vehicles [*October 2019, p13*].

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

Schaefer Elektronik GmbH: www.schaeferpower.de/?lang=en

fischer Power Solutions GmbH: www.fischer-group.com/en

NEXUS-e GmbH: www.nexus-e.de

LARGE STATIONARY

Doosan FC joins 100 MW project in Korea

Doosan Fuel Cell has signed a Memorandum of Understanding with local government and five companies to join the 100 MW fuel cell power plant project in Chuncheon, Gangwon Province in South Korea.

Doosan Fuel Cell will supply 240 units of its 440 kW phosphoric acid fuel cell systems – for a total capacity of 105.6 MW – to the Dongchuncheon General Industrial Complex in Chuncheon, and provide long-term maintenance services. The project is expected to mitigate the intermittent output of local hydro power plants, which are heavily affected by the amount of rainfall and water storage in the city.

The project partners include POSCO Engineering & Construction (E&C), consulting firm Nexia Samduk, and East Chuncheon Green Energy. Construction will begin at the end of 2022, with commercial operation starting in 2025. Overall the project is expected to see an investment of KRW700 billion (US$600 million) over the next 20 years.

Doosan FC previously supplied the 50 MW Daesan Hydrogen Fuel Cell Power Plant in Seosan, Chungnam Province, claimed to be the world's first large fuel cell power plant running on by-product hydrogen [*FCB, August 2020, p7*]. The company plans to ramp up production capacity to 275 MW in 2022, to fulfil growing demand for hydrogen-based energy and diversifying its portfolio to include natural gas (NG), liquefied petroleum gas (LPG)/NG and hydrogen models.

Doosan FC has also joined a Korean industry-academic consortium of 36 institutes, companies and local governments that are collaborating on green shipping vessel R&D, adoption and commercialisation.

Doosan Fuel Cell: www.doosanfuelcell.com

PORTABLE & MICRO

Hyundai Motor links with Hyundai Electric for fuel cell power gen

South Korean automaker Hyundai Motor Company has signed a Memorandum of Understanding with Hyundai Electric & Energy Systems, to develop a hydrogen fuel cell package for mobile power generation, based on its proven automotive fuel cell technology.

The partnership combines Hyundai Motor's fuel cell experience with Hyundai Electric's expertise in power equipment. They will jointly develop a hydrogen fuel cell package dedicated for mobile power generators and alternative maritime power (AMP) supply solutions, based on Hyundai Motor's PEM fuel cell system used in its fuel cell electric vehicles, including the NEXO car [*FCB, January 2018, p2*] and

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The project partners include POSCO Engineering & Construction (E&C), consulting firm Nexia Samduk, and East Chuncheon Green Energy. Construction will begin at the end of 2022, with commercial operation starting in 2025. Overall the project is expected to see an investment of KRW700 billion (US$600 million) over the next 20 years.

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PORTABLE & MICRO

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Under the agreement, Hyundai Motor will supply fuel cell systems and technical support, while Hyundai Electric will develop and commercialise a fuel cell-based power generation package for mobile generators and AMP supply systems, and explore various business models for marketing it in Korea and beyond.

In other news, Hyundai Motor has become a shareholder in the German hydrogen infrastructure company **H_2 Mobility Deutschland GmbH**, as the first shareholder beyond the founding members [*November 2015, p6*].

Hyundai Motor Company: www.hyundai.com/worldwide

Hyundai Electric & Energy Systems: www.hyundai-electric.com

H_2 Mobility Deutschland: www.h2.live/en

FUELING

Nel wins station order for taxi fleet in Aarhus

Nel Hydrogen Fueling – a subsidiary of Norway-based Nel ASA – has received a purchase order from Danish company Everfuel, to deliver an H2Station® hydrogen refueling station to serve a fleet of taxis in Aarhus, Denmark.

The H2Station will be installed in Aarhus – Denmark's second-largest city – during 2022, and used as a prototype for a movable station solution to serve light-duty fuel cell electric vehicles and as a demonstration for refueling heavy-duty vehicles. Everful says that the mobile station prototype is an important step towards reducing installation time and cost, to make hydrogen commercially competitive. The parties have agreed not to disclose the value of the contract.

Everfuel plans to roll out hydrogen stations at up to 19 key locations in Denmark by the end of 2023 [*FCB, June 2021, p7*], as part of its overarching strategy to connect the main traffic corridors in Scandinavia [*e.g. August 2021, p10, and see the next item*]. Nel Hydrogen Fueling – in its former guise as H2 Logic [*see the H2Station feature in May 2013*] – commissioned the first hydrogen station in Aarhus in 2016 [*February 2016, p5*].

Nel Hydrogen Fueling: www.nelhydrogen.com

Everfuel: www.everfuel.com

Everfuel expands plans for Sweden, Norway

Denmark-based Everfuel has signed its first contract to roll out hydrogen refueling stations in Sweden, in Trelleborg. Everfuel is also partnering with ASKO to apply for funding to support heavy-duty truck procurement and building green hydrogen infrastructure in Norway.

The agreement with Trelleborg Municipality and Trelleborg Energy AB is the first signed contract in Everfuel's plan to deploy hydrogen stations in **Sweden** [*FCB, May 2021, p7, and see the item above*]. The agreement is the first of eight potential stations in the Nordic Hydrogen Corridor project. Trelleborg Municipality, at the southernmost tip of Sweden, aims to implement a fleet of hydrogen vehicles, paving the way to establishing a hydrogen station in the city. It has committed to a hydrogen offtake increasing to 120 kg/day, and the partners aim to increase this to 500 kg/day within five years of operation.

Meanwhile, Everfuel and ASKO have signed a Letter of Intent to develop a joint coordinated plan for applying to the Enova clean energy innovation agency in **Norway**, for support for vehicle procurement and establishing green hydrogen infrastructure to decarbonise heavy-duty, long-haul trucking. ASKO is the country's largest grocery and catering wholesaler, and a leading cargo transporter. It is already testing hydrogen as a fuel in Trondheim using Scania trucks [*January 2020, p1*], and will apply its experience to developing infrastructure for the Oslo-Trondheim corridor.

Everfuel: www.everfuel.com

ASKO: www.asko.no/en

H2B2 completes tests for FM Logistic station

Spanish electrolyser manufacturer H2B2 has completed initial testing of the first hydrogen refueling station for a logistics operator in Spain, ahead of delivery to FM Logistic in Illescas, in the central province of Toledo.

FM Logistic and H2B2 signed the deal to design and develop the green hydrogen station earlier this year [*FCB, April 2021, p11*], for installation at the headquarters of FM Logistic in Illescas, where it will supply hydrogen for forklifts and vans. French-based FM Logistic is a leading international operator in storage, transport, co-packing and urban logistics.

H2B2 conducted the Factory Acceptance Test (FAT) at its facility in Seville at the end of July, in the presence of FM Logistic staff. This testing stage is carried out at the manufacturing location to ensure that once the equipment is moved, everything will work correctly at the destination. The station has now been delivered to FM Logistic, where the Site Acceptance Test (SAT) is scheduled to take place in early September. This will verify that the PEM electrolyser produces hydrogen at 20 bar and compresses it to the required specification, ready to dispense up to 6 kg/day at 350 bar. H2B2 technical managers will be present at these tests, supervising assembly and final commissioning.

H2B2: www.h2b2.es

FM Logistic: www.fmlogistic.com/eng-gb

Air Liquide completes hydrogen station for Incheon airport buses

Air Liquide, Hyundai Motor Company and Hydrogen Energy Network (HyNet) have commissioned a hydrogen refueling station for buses at Seoul Incheon International Airport in South Korea [*FCB, June 2020, p6*].

The Incheon Airport T2 Hydrogen Refueling Station is the 100th hydrogen facility in Korea. It features Air Liquide's high-capacity hydrogen refueling equipment, and the company will supply hydrogen under a long-term contract, while Hyundai will provide fuel cell electric buses. HyNet will operate the station, primarily serving buses, but it will also be open to fuel cell passenger cars.

This station, with a dispensing capacity of 1 tonne/day of hydrogen, is at least four times larger than existing hydrogen stations in Korea, and capable of serving 40 buses – two at a time – or 180 fuel cell electric passenger cars per day. Incheon International Airport plans to gradually upgrade its current fleet of shuttle buses with fuel cell electric buses.

Air Liquide and Hyundai Motor are founding members of the HyNet joint venture, which aims to install 100 hydrogen stations in Korea by 2022 [*April 2019, p8 and September 2019, p9*], and the KOHYGEN (Korea Hydrogen Green Energy Network) joint

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FUELING

Nel wins station order for taxi fleet in Aarhus

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The H2Station will be installed in Aarhus – Denmark's second-largest city – during 2022, and used as a prototype for a movable station solution to serve light-duty fuel cell electric vehicles and as a demonstration for refueling heavy-duty vehicles. Everful says that the mobile station prototype is an important step towards reducing installation time and cost, to make hydrogen commercially competitive. The parties have agreed not to disclose the value of the contract.

Everfuel plans to roll out hydrogen stations at up to 19 key locations in Denmark by the end of 2023 [*FCB, June 2021, p7*], as part of its overarching strategy to connect the main traffic corridors in Scandinavia [*e.g. August 2021, p10, and see the next item*]. Nel Hydrogen Fueling – in its former guise as H2 Logic [*see the H2Station feature in May 2013*] – commissioned the first hydrogen station in Aarhus in 2016 [*February 2016, p5*].

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The station – built, owned and operated by Air Products, and a joint effort with the local government – is located in Huantai County of Zibo City, and features two dispensers, with hydrogen supplied by the company's production facility in Zibo. The station can refuel several fleets of public buses and trucks used for logistics.

The 'Hydrogen into Ten Thousand Homes' demonstration project is a high-level programme initiated by the Chinese Ministry of Science and Technology in cooperation with Shandong provincial government, to promote the comprehensive utilisation of hydrogen energy and demonstrate hydrogen applications in industrial parks, community buildings and transportation applications.

The Shandong provincial government has laid out a 10-year plan to realise breakthrough developments in the hydrogen energy industry and build a 'China Hydrogen Valley' and 'Oriental Hydrogen Island'. Shandong is the first – and currently only – province selected by the central government to implement the 'Hydrogen into Ten Thousand Homes' project.

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Hydrogen supply chain well-to-tank emissions

UK-based Zemo Partnership has published a new study and well-to-tank (WTT) model for emerging low-carbon hydrogen supply chains, identifying a range of pathways for the production, distribution and dispensing of low-carbon hydrogen to transport end-users. The full report and an executive summary are available from the Zemo website.

The study, prepared by Element Energy – recently acquired by ERM [*FCB, August 2021, p5*] – details the energy requirements and greenhouse gas (GHG) emissions resulting from each potential pathway, and the related infrastructure requirements. The research looks at a combination of six production configurations, three distribution pathways and two dispensing options, for a total of 32 potential pathway combinations. The work identifies the GHG emissions associated with each hydrogen supply chain pathway, based on technologies available today, as well as those expected to be commercialised in the medium term such as offshore electrolysis, gas reformation with carbon capture and storage (CCS), and waste gasification with CCS.

It shows that fundamental choices exist in terms of the production of green hydrogen using electrolysis powered by renewable electricity, or blue hydrogen primarily produced by reforming fossil natural gas combined with CCS [*see the hydrogen spectrum feature in November 2020*]. It also looks at the implications of using biomethane in place of fossil gas, and hydrogen derived entirely from biogenic waste.

Zemo Partnership: www.zemo.org.uk

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GREEN HYDROGEN

UK unveils hydrogen strategy to 2030 at ITM's new gigafactory

The UK government's new Hydrogen Strategy aims to create a thriving low-carbon hydrogen sector over the next decade and beyond, building a hydrogen economy worth £900 million (US$1.2 billion) and creating more than 9000 jobs by 2030. The strategy was announced by Business & Energy Secretary Kwasi Kwarteng at the official opening of ITM Power's new gigafactory in Sheffield.

The government has launched a public consultation on a preferred hydrogen business model, based on the successful offshore wind Contracts for Difference (CfD) scheme, and is consulting on the design of the £240 million ($330 million) Net Zero Hydrogen Fund, which aims to support the commercial deployment of new low-carbon hydrogen production plants.

Other measures in the strategy include a twin-track approach to supporting multiple technologies including 'green' electrolytic and 'blue' carbon capture-enabled hydrogen

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The Shandong provincial government has laid out a 10-year plan to realise breakthrough developments in the hydrogen energy industry and build a 'China Hydrogen Valley' and 'Oriental Hydrogen Island'. Shandong is the first – and currently only – province selected by the central government to implement the 'Hydrogen into Ten Thousand Homes' project.

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

Hydrogen supply chain well-to-tank emissions

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The study, prepared by Element Energy – recently acquired by ERM [*FCB, August 2021, p5*] – details the energy requirements and greenhouse gas (GHG) emissions resulting from each potential pathway, and the related infrastructure requirements. The research looks at a combination of six production configurations, three distribution pathways and two dispensing options, for a total of 32 potential pathway combinations. The work identifies the GHG emissions associated with each hydrogen supply chain pathway, based on technologies available today, as well as those expected to be commercialised in the medium term such as offshore electrolysis, gas reformation with carbon capture and storage (CCS), and waste gasification with CCS.

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Zemo Partnership: www.zemo.org.uk

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The government has launched a public consultation on a preferred hydrogen business model, based on the successful offshore wind Contracts for Difference (CfD) scheme, and is consulting on the design of the £240 million ($330 million) Net Zero Hydrogen Fund, which aims to support the commercial deployment of new low-carbon hydrogen production plants.

Other measures in the strategy include a twin-track approach to supporting multiple technologies including 'green' electrolytic and 'blue' carbon capture-enabled hydrogen

venture, created to build and operate heavy-duty hydrogen stations in order to accelerate heavy-duty vehicle deployment.

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

Incheon Airport: www.airport.kr/co/en/index.do

KOHYGEN: www.kohygen.co.kr

PDC, Ivys to deliver SimpleFuelFast station to CSIRO in Australia

US-based PDC Machines and Ivys Energy Solutions are collaborating with Australian partner ENGV to deliver a SimpleFuelFast hydrogen refueling station to the Victorian Hydrogen Hub in Melbourne, established by the Commonwealth Scientific and Industrial Research Organisation (CSIRO).

PDC and Ivys jointly design and manufacture hydrogen refueling solutions [*e.g. FCB, March 2020, p8*]. Earlier this year they collaborated with ENGV to bring the first retail hydrogen station to Australia, supporting a fleet of Hyundai NEXO fuel cell electric vehicles for use by the Government of the Australian Capital Territory in Canberra [*April 2021, p12*].

The compact SimpleFuelFast station for CSIRO includes 20 kg/day production through PEM electrolysis, compression, cascade storage up to 1000 bar, chilling for fast-fills, 700 bar dispensing, controls, safeties, and factory certification. The station is a key milestone for CSIRO's Hydrogen Industry Mission as it to supports Australia's clean hydrogen industry development. ENGV will provide local integration, installation and ongoing operational services for the station.

In other news, **ENGV** has signed an agreement with **PowerCell Sweden**, as its distribution and service provider for Australia and New Zealand. Last year ENGV ordered an MS-100 fuel cell system from PowerCell for use in Australia's first hydrogen stationary power demonstration plant in Denham, in Western Australia [*January 2021, p14*].

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CSIRO, Hydrogen Industry Mission: www.csiro.au/en/about/challenges-missions/hydrogen

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Air Products has commissioned its first hydrogen refueling station in Shandong Province, serving buses and trucks to support China's 'Hydrogen into Ten Thousand Homes' demonstration project and green transportation. The company has accelerated several hydrogen production and application projects in the province in support of this national initiative.

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Phase I of HySynergy is expected to be in operation by mid-2022, and will be the largest electrolyser in Europe. Everfuel plans to expand this to 300 MW of electrolyser capacity in Phase II by late 2024 [*June 2021, p8*].

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Linde will build, own and operate a 2 MW electrolyser plant at Infineon's Villach site in Austria. The semiconductor fabrication plant will produce green hydrogen using PEM electrolyser technology supplied by UK-based ITM Power, which Linde will then purify to meet the rigorous specifications required in Infineon's manufacturing process. The use of this high-purity green hydrogen is part of Infineon's plans to reduce greenhouse gas emissions at the Villach site. Linde will also build, own and operate a compact air separation unit at the site to deliver a reliable supply of nitrogen, in addition to a bulk storage system to supply additional industrial gases. The new Linde facilities are expected to start up in 2022.

Linde is a global leader in the production, processing, storage and distribution of hydrogen, with nearly 200 refueling stations and 80 electrolysis plants installed worldwide [*e.g. FCB, May 2021, p8, and see the feature in September 2014*]. The company offers the latest electrolysis technology through the joint venture ITM Linde Electrolysis GmbH [*October 2019, p1*].

Linde, Clean Hydrogen: www.linde.com/clean-hydrogen

ITM Power: www.itm-power.com

ITM Linde Electrolysis GmbH: www.itm-linde.com

Everfuel under way on HySynergy electrolyser

Everfuel has received the building permit for the HySynergy Phase I electrolyser in Fredericia, Denmark, and selected facility construction specialist CJ A/S as the contractor, with construction now under way.

Everfuel and Crossbridge Energy, which owns the adjacent Fredericia refinery, hosted a sod-turning ceremony at the site on 18 August, to mark the official start of construction for the HySynergy Phase I electrolyser [*FCB, December 2019, p9, and January 2021, p10*]. US company Postlane Partners acquired Danske Shell – the oil giant's Danish subsidiary – and the Fredericia refinery on 1 July, with the new business now called Crossbridge Energy Fredericia.

The HySynergy development will establish large-scale production and storage of green hydrogen. The facility will produce about 8 tonnes/day of green hydrogen, utilising renewable energy, and offer 10 tonnes of storage capacity. Everfuel is responsible for engineering, procurement and construction (EPC), including hydrogen storage and distribution facilities, while CJ has extensive experience in large-scale construction of fueling and industrial facilities and refineries.

Phase I of HySynergy is expected to be in operation by mid-2022, and will be the largest electrolyser in Europe. Everfuel plans to expand this to 300 MW of electrolyser capacity in Phase II by late 2024 [*June 2021, p8*].

Everfuel: www.everfuel.com

Crossbridge Energy Fredericia: www.crossbridge.dk/en

Nel PEM electrolyser to produce hydrogen at nuclear plant in US

Nel Hydrogen US has received a $2.6 million contract for a 1.25 MW containerised PEM electrolyser from a leading utility, for installation in 2022 at a nuclear power plant in a project for zero-carbon hydrogen production.

Exelon Generation has received a Department of Energy grant to explore the potential benefits of onsite hydrogen production at Nine Mile Point Nuclear Generating Station in Oswego, New York. Exelon is partnering with Nel Hydrogen, Argonne National Laboratory, Idaho National Laboratory and National Renewable Energy Laboratory to demonstrate integrated production, storage and normal usage at the station. The project will generate an economic supply of hydrogen, as a natural by-product of nuclear energy, to be captured, stored and potentially taken to market as a zero-carbon source of power for other purposes, such as transportation. The initiative is funded by DOE's Hydrogen and Fuel Cell Technologies Office, through the H2@Scale Program [*FCB, September 2019, p14*].

Nel Hydrogen US – formerly Proton OnSite, now a subsidiary of Nel ASA [*May 2017, p11*] – will deliver an MC250 electrolyser to supply hydrogen to meet the nuclear plant's turbine cooling and chemistry control requirements, using the site's existing hydrogen storage system and supporting infrastructure. This will be the first PEM electrolyser at a nuclear generating plant in the US configured for dynamic despatch, and demonstrate the economic feasibility of hydrogen production at nuclear facilities.

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DOE, H2@Scale Program: www.energy.gov/eere/fuelcells/h2scale

Air Liquide, Siemens plan German 30 MW green hydrogen plant

Air Liquide and Siemens Energy plan to build a renewable hydrogen production plant utilising PEM electrolysis in Oberhausen,

production [*see ITM Power's hydrogen spectrum feature in FCB, November 2020, and the features in October 2020 and March and June 2021*]. The government will collaborate with industry to develop a UK standard for low-carbon hydrogen – based on a report prepared by E4tech and Ludwig-Bölkow-Systemtechnik (LBST) – and undertake a review to support development of the necessary network and storage infrastructure, including mixing 20% hydrogen into the existing natural gas supply. And in early 2022 it will launch a hydrogen sector development action plan to support companies in securing supply chain opportunities, skills and jobs.

The government has also announced a £105 million ($144 million) funding package, through its Net Zero Innovation Portfolio, that will act as a first step to build up the low-carbon hydrogen economy. The investment will help industries to develop low-carbon alternatives for industrial fuels including hydrogen.

ITM Power's gigafactory, with an annual production capacity of 1 GW of electrolysis equipment, commenced operation in January [*January 2021, p12, and see the next item*]. The site already employs some 320 people, with further staff additions planned as the facility ramps up to capacity.

UK Hydrogen Strategy: www.gov.uk/government/publications/uk-hydrogen-strategy

ITM Power: www.itm-power.com

E4tech/LBST report: www.gov.uk/government/publications/options-for-a-uk-low-carbon-hydrogen-standard-report

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The AquaSector project is seen as a 'proof of concept' for realising the broader AquaVentus vision of producing up to 10 GW of green hydrogen offshore by 2035, transported via an extended pipeline to mainland Germany [*FCB,*

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Hyzon will provide offtake through its heavy-duty fuel cell electric truck customers. Last summer Hyzon and Raven agreed to jointly develop clean mobility projects [*FCB, June 2020, p11*], and recently announced plans to build up to 250 hydrogen hubs across the US and beyond, utilising waste feedstocks at landfill sites [*May 2021, p9*].

Raven SR has also announced a $20 million **strategic investment** from Chevron USA, Itochu Corporation, Hyzon Motors and Ascent Hydrogen Fund, to support its plans to build modular waste-to-hydrogen production units and renewable synthetic fuel facilities, initially in California and then worldwide.

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Hyzon Motors: www.hyzonmotors.com

AquaSector offshore hydrogen park project in German North Sea

German electric utility RWE, energy giant Shell and natural gas infrastructure operator Gasunie in the Netherlands, and Norwegian energy company Equinor will intensify their collaboration in the AquaSector large-scale offshore hydrogen park project in the German part of the North Sea.

The AquaSector project aims to install approximately 300 MW of electrolyser capacity to produce up to 20,000 tonnes per annum of green hydrogen offshore. This would be transported via the AquaDuctus pipeline to Heligoland, starting in 2028.

The AquaSector project is seen as a 'proof of concept' for realising the broader AquaVentus vision of producing up to 10 GW of green hydrogen offshore by 2035, transported via an extended pipeline to mainland Germany [*FCB,*

Germany. The first phase of the project is expected to be operational with 20 MW capacity by early 2023, with subsequent expansion to 30 MW.

The new PEM electrolyser, to be built by Air Liquide, will produce green hydrogen using renewable electricity. The technological solution for the project is being developed in the framework of the partnership between Air Liquide and Siemens Energy [*FCB, March 2021, p8*]. By 2023, the partners will implement a 20 MW electrolyser plant producing renewable hydrogen and oxygen, and in a second phase the plant's capacity will be increased to 30 MW.

The electrolyser will be the first large-scale green hydrogen production plant connected to existing hydrogen and oxygen pipelines, with nearly 15 large industrial sites currently served. This will support the decarbonisation of sectors such as steel, chemicals, refining and mobility in North Rhine-Westphalia (NRW) by accelerating the availability of gases produced using renewable electricity.

To accelerate project implementation, public funding has been granted by the Federal Ministry for Economic Affairs and Energy (BMWi).

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

Siemens Energy, Hydrogen Solutions: www.siemens-energy.com/global/en/offerings/renewable-energy/hydrogen-solutions.html

Plug Power starts on Georgia hydrogen site

Plug Power has broken ground on the site of a green hydrogen production plant in Camden County, Georgia, which will produce 15 tons (US, 13.6 metric tonnes) per day of liquid (cryogenic) green hydrogen.

The company is investing $84 million in the facility, as it works to establish the first North American green hydrogen supply network. The plant, which will serve customers in the southeastern US, will produce liquid hydrogen using renewable energy, with the help of at least 24 local employees [*FCB, July 2021, p12*]. The plant is expected to be completed by the end of this year.

The Camden County plant joins Plug Power's previously announced green hydrogen facilities in south central Pennsylvania [*April 2021, p12*] and western New York state [*March 2021, p9*], as well as the Tennessee facility it acquired last summer [*July 2020, p14*]. The company is already the world's largest buyer of liquid hydrogen, and aims to produce more than 500 tons (450 tonnes) per day of green hydrogen by 2025.

Plug Power: www.plugpower.com

GHS electrolysers for UK, Norway projects

Danish company Green Hydrogen Systems has signed agreements with Octopus Hydrogen to deliver alkaline electrolysis equipment for a project in the UK, and with Liquiline for a project in Norway.

GHS manufactures pressurised alkaline electrolyers for onsite hydrogen production using renewable electricity [*FCB, April 2021, p15*]. The order for **Octopus Hydrogen** – a new arm of Octopus Energy – includes the supply of two GHS HyProvide™ A90 electrolysers with a combined capacity of 0.9 MW for production of green hydrogen from solar energy. The electrolysers will be deployed in a 40 ft (12 m) container as a complete green hydrogen plant. When fully operational during Q2 of 2022, the electrolysers will produce 389 kg/day of green hydrogen.

The order for Norwegian gas technology company **Liquiline** also includes two GHS HyProvide A90 electrolysers with a combined capacity of 0.9 MW. The end customer is Energy House, part of the Sustainable Energy Norwegian Catapult Centre at Stord. This will be the first GHS HyProvide electrolyser in Norway, and is also expected to be operational in Q2 of 2022.

Earlier this year Liquiline and hydroelectric company SKL established the Hydrogen Solutions AS (HYDS) joint venture, to develop, build and operate plants for local green hydrogen production, and handle dispensing and bunkering (ship fueling). The project at Stord will be HYDS's first green hydrogen production site in Norway, operated with Alltec Services and Greenstat.

Green Hydrogen Systems: www.greenhydrogen.dk

Octopus Hydrogen: www.octohydrogen.com

Liquiline: www.liquiline.no

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'This second-generation fuel cell system is necessary for a carbon-neutral future,' says David Rosier, powertrain head at Toyota Kentucky. 'It delivers over 300 miles [480 km] of range at a full load weight of 80,000 lb [36 tonnes], all while demonstrating exceptional drivability, quiet operation and zero harmful emissions.'

Toyota Motor North America designed and built the fuel cell electric power system for the Kenworth Class 8 trucks in a demonstration project at the Port of Los Angeles [*FCB, July 2021, p4*].

Toyota Motor Manufacturing Kentucky: www.toyotageorgetown.com

Proton Motor plans series production of fuel cells with Aumann

Proton Motor Fuel Cell GmbH in Germany is collaborating with Aumann AG, a specialist in automated production lines, in an exclusive agreement to expand series production of hydrogen fuel cells.

Since 2017 Proton Motor has been working with Aumann and others as part of the Fit-4-AMandA (Fit for Automatic Manufacturing and Assembly) project, with funding from the EU-supported Fuel Cells and Hydrogen Joint Undertaking (FCH JU) [*FCB, May 2017, p13 and June 2019, p14*]. The new 'stack robot' is expected to boost production capacity up to 2500 fuel cell units per annum, with graphite bipolar plate stacks embedded in a module.

For the next four years after the end of the funded project, it has been agreed that Aumann will exclusively convert the Fit-4-AMandA machine prototype into an automatic fuel cell stack production plant for series production of hydrogen fuel cells at Proton Motor's facility in Puchheim, near Munich. Proton Motor will also give preferential consideration to Aumann in relevant future tenders.

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

Aumann: www.aumann.com/en

Vitesco develops truck fuel cell control unit

German company Vitesco Technologies is developing a Fuel Cell Control Unit (FCCU) for a German fuel cell manufacturer, which will serve as the central control unit of a fuel cell system. Series production of the FCCU will commence in the second half of this decade.

Vitesco has already demonstrated its electric drive systems expertise in battery electric vehicles, and is now employing this electronics know-how in drive technologies and electrification solutions for hydrogen fuel cell systems for heavy-duty trucks and off-highway applications. The company says that its production experience was a decisive factor in winning the order to develop the FCCU for the unnamed customer. It has built up comprehensive expertise in industrialisation over more than a decade, giving it the ability to implement volume production with the same speed and quality as the development work.

Vitesco Technologies: www.vitesco-technologies.com

Symbio launches unit to enter US market

French fuel cell stack and system manufacturer Symbio has launched Symbio North America, to target the US market. The new business unit, headed

January 2021, p10]. The partners believe that this approach offers clear economic advantages compared to the transfer of electricity generated offshore. The pipeline could replace five High Voltage Direct Current (HVDC) transmission systems that would otherwise need to be built.

The first step in AquaSector is for the partners to carry out a detailed feasibility study. This will provide important initial indications of the conditions under which the large-scale offshore hydrogen park can be realised, and the technical and commercial challenges that would need to be overcome.

RWE, Hydrogen: www.rwe.com/hydrogen

Shell, Hydrogen: www.shell.com/hydrogen

Gasunie, Hydrogen: www.gasunie.nl/en/hydrogen

Equinor, Hydrogen: www.equinor.com/hydrogen

COMMERCIALISATION

Nel partners with SFC for integrated system

Nel ASA in Norway is partnering with German-based SFC Energy to jointly develop what they say will be the world's first integrated electrolyser and hydrogen fuel cell system for decentralised energy generation and storage. The accelerated development of the integrated offering will be based on using mature products and proven technology from both parties.

The partnership will focus on developing industrial solutions to replace diesel generators with more efficient systems based on hydrogen fuel cells in combination with green hydrogen production through water electrolysis. Initially, SFC Energy and Nel will address applications in a power range up to 50 kW with a daily operating time of 2–10 hours, which can be used as reliable emergency power generators for critical applications. In the medium term, the partners aim to develop systems in the power range up to 500 kW for the telecom, data centre and auxiliary power unit (APU) markets. They plan to introduce the first products to the market during the second half of 2022.

SFC Energy is a leading provider of hydrogen and methanol fuel cells for stationary and mobile hybrid power solutions, and has delivered more than 50,000 fuel cells to date [*see the SFC feature in FCB, January 2013*], while Nel has long experience in hydrogen technologies, including electrolysers and refueling stations [*e.g. see the other Nel items in this issue*].

Nel ASA: www.nelhydrogen.com

SFC Energy: www.sfc.com

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Symbio's H2Motive range, with power outputs from 40 kW to 300 kW, meet a wide range of duty cycles, power and durability requirements for the US transportation market. These solutions are compact, efficient, and easy to install within existing engine bays. The 150 kW product shown at ACT Expo 2021 is adapted for pick-ups as well as light-, medium- and heavy-duty vehicles.

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manufacturer of compressed natural gas and hydrogen systems for transit and coach buses, with its hydrogen fuel cell system featuring a fully integrated package of fuel cell module, cooling system and DC-DC power-conditioning equipment. The first order has already been placed, intended for initial testing and homologation of hydrogen electric transit buses being developed by NGVI and Ulsan Metropolitan City. Loop Energy is accelerating adoption of the eFlow platform in the transit bus market [*e.g. July 2021, p3*], and this order marks its entry into the South Korean zero-emission commercial vehicle market.

Loop Energy: www.loopenergy.com

Técnicas Reunidas: www.tecnicasreunidas.es

Van Hool delivers first bus for Brussels trial

Belgian bus manufacturer Van Hool has delivered an A330FC hydrogen fuel cell electric bus to STIB-MIVB, which operates public bus, metro and tram transport in Brussels. STIB-MIVB will test the vehicle over a two-year period on various bus lines, to thoroughly analyse performance in different weather conditions and topographies on its network.

The 12 m (40 ft) hydrogen powered bus is a fuel cell-battery hybrid vehicle, designed to carry 25 seated and 48 standing passengers. It is equipped with an FCvelocity®-HD85 PEM fuel cell module from Canadian company Ballard Power Systems, and a 210 kW Siemens electric traction motor. This hybrid approach means that the bus, with a tank capacity of 38.2 kg of hydrogen, can carry out a full day's schedule of up to 350 km (220 miles).

Van Hool has delivered 21 hydrogen buses to North American customers since 2005 [*e.g. FCB, August 2017, p3*], and 141 buses for the European market since 2007 [*e.g. July 2021, p8*].

Van Hool, Fuel Cell Buses: www.vanhool.be/en/public-transport/agamma/hybrid-fuel-cell

STIB-MIVB Brussels Intercommunal Transport Company: www.stib-mivb.be/?l=en

Solaris hydrogen bus trial in Upper Austria

The northern Austrian state of Upper Austria recently trialed a Solaris Urbino 12 hydrogen bus on several routes in the town of Wels. The week-long trial was part of the Hydro-Motion project, a collaboration between the state, Wels, Solaris Bus & Coach, hydrogen equipment manufacturer Fronius, and transport service providers Wels Linien, SAB Tours and OÖVV.

The trial was organised by Solaris Austria, which supplied the fuel cell electric bus and technical support during the test, while Fronius International provided access to its hydrogen refueling station in nearby Thalheim, site of its Hydrogen Competence Centre [*FCB, July 2020, p15*].

The Solaris Urbino 12 hydrogen bus was unveiled two years ago [*July 2019, p3*], with the first order from the Italian city of Bolzano, which recently took delivery [*May 2021, p1*]. Orders have also been received from Transdev Sverige in Sweden [*December 2020, p3*], Arriva Netherlands [*February 2021, p3*], In-der-City-Bus in Frankfurt, Germany [*June 2021, p3*], and MZK in Poland [*August 2021, p2*]. Earlier this year Austria's largest bus operator, Österreichische Postbus (ÖBB-Postbus), ordered 40 buses [*March 2021, p3*], and a bus was trialed in the southern province of Carinthia [*June 2021, p3*].

Solaris Bus & Coach: www.solarisbus.com

Fronius International: www.fronius.com

UK hydrogen transport trials in Tees Valley

The UK government is funding several projects to accelerate the use of hydrogen transport in the Tees Valley region, including diesel buses retrofitted with hydrogen fuel cells, supermarket chains benefiting from hydrogen delivery vans, and the police and National Health Service using hydrogen vehicles.

Ricardo will collaborate with bus operator Stagecoach to retrofit a double-decker diesel bus with a hybrid fuel cell system. The one-off vehicle will be demonstrated in the Tees Valley Hydrogen Hub from February 2022, driven on local routes, with learnings from this project supporting fuel cell retrofit technologies in public transport across the UK. Ricardo will develop a scalable, modular solution, enabling it to be installed with minimal adaptation to single- and double-decker platforms.

Toyota will deliver several hydrogen vehicles, including a forklift for warehouse operations, a bus, and 10 fuel cell passenger cars. These will be deployed across local rapid-response services, including Cleveland Police and NHS patient support.

EDITORIAL

Crossover of fuel cell technologies developed for one application area being applied in a completely different field is becoming increasingly popular.

For example, we report on three good examples in this issue, with the newly announced relationship between **Hyzon Motors and ZeroAvia** making the front page. Hydrogen-electric aviation pioneer ZeroAvia has ordered a high power density PEM fuel cell stack from Hyzon, a leading manufacturer of heavy-duty fuel cell electric vehicles (i.e. trucks and buses) [*see also page 4*]. ZeroAvia will evaluate the lightweight, next-generation fuel cell for use in its hydrogen-powered aircraft development programme [*see also page 7*].

Another notable new partnership in South Korea is **Hyundai Motor Company** linking up with Hyundai Electric & Energy Systems, to develop a hydrogen fuel cell package for mobile power generators and alternative maritime power solutions, based on its proven automotive fuel cell technology [*page 9*]. Hyundai Motor is already well along the route to wider deployment of its fuel cell technology; in late 2018 the automaker announced its FCEV Vision 2030 roadmap, to leverage its automotive technologies beyond the transportation sector [*December 2018, p1*]. Its sister company Hyundai Mobis subsequently unveiled a power generation system for a building [*February 2019, p1*], and a year ago Hyundai Motor began shipping its fuel cell system technology to Europe for use by non-automotive companies [*October 2020, p14*].

Also in this issue, Swedish company **myFC** is working with a leading European OEM to develop fuel cell solutions for automated guided vehicles (AGVs) used as warehouse robots, powered by myFC's fuel cell-battery hybrid solution [*page 6*]. myFC originally developed its technology for consumer portable devices, but following a strategic review it switched to selling technology and know-how to companies planning fuel cell powered products [*July 2019, p11*], in particular for mobility [*e.g. July 2021, p14*].

Another crossover application – in a sense – is the use of fuel cell power sources to charge battery electric vehicles, and we report on two companies targeting this emerging sector in this issue. UK-based **AFC Energy** has delivered its first hydrogen-fueled alkaline fuel cell system to ABB, for operational integration with ABB's high-power, fast-charging system for EVs [*page 9*]. And **Proton Motor**'s NEXUS-fc network has been awarded EUR1.4 million in federal funding to develop and produce a grid-independent, fuel cell powered, fast-charging station for battery electric buses in Germany [*page 9*].

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eventually reaching 300 tons/day using steam methane reforming. The MOU anticipates that the LH_2 could be delivered by a fleet of Hyzon trucks, owned and operated by RenewH2.

Hyzon Motors: www.hyzonmotors.com

Total Transport Services Inc: www.ttsi.com

RenewH2: www.renew-h2.com

ULEMCo to develop hydrogen fuel cell power for fire engines

ULEMCo has been awarded UK government funding to work with Oxfordshire County Council and its Fire and Rescue Service to design a fuel cell electric powertrain configuration for zero-emission fire appliances.

The HySPERT project – Hydrogen Special Purpose Electric vehicle platform for Refuse collection and fire Trucks – is planned to take eight months, with funding from Innovate UK. The partners will first develop a deep understanding of the specific duty cycles for emergency service vehicles that need 24/7 readiness, and enough onboard energy for 4–40 hours of continuous running. Fire services use this type of vehicle in a variety of urban and rural scenarios.

This will build up a thorough understanding and detailed model of current energy requirements, including the energy needed to pump water for a minimum of four hours, as well as optimal range. The test process will gather real-world data based on the performance of an OEM-manufactured fuel cell over the course of the project. The council will also develop a plan for hydrogen refueling requirements across the Fire and Rescue Service, and how this fits with wider plans to develop the county's hydrogen infrastructure.

ULEMCo will design the optimised fuel cell electric powertrain for the Fire and Rescue Service, including a full specification and detailed engineered design for a prototype vehicle, as the precursor to prototype construction. The company is also leading a project to develop the first fuel cell electric ambulance, with a prototype vehicle scheduled for delivery soon to the London Ambulance Service NHS Trust [*FCB, March 2021, p2*].

ULEMCo: www.ulemco.com

Oxfordshire County Council: www.oxfordshiregov.uk

Nikola, Alta expand dealer network in US

Arizona-based Nikola Corporation is further expanding the sales and service dealer network for its Class 8 heavy-duty commercial battery and fuel cell electric trucks, with the addition of Alta Equipment Group.

Alta Equipment – a leading provider of construction and industrial equipment – plans to represent sales and service locations in New York, New Jersey, eastern Pennsylvania and other areas in New England with a growing opportunity for zero-emission Class 8 trucks. Nikola recently added five dealers covering key territories across the US [*FCB, August 2021, p4*].

'The Nikola partnership should complement Alta's history of battery electric and hydrogen fuel cell technology via their materials handling business, and add to its growing e-mobility vertical by fulfilling its long-term commitment to clean technologies,' says Pablo Koziner, President for Energy and Commercial at Nikola.

Nikola has also been awarded a **$2 million grant** by the US Department of Energy to develop an autonomous fueling system for heavy-duty fuel cell electric trucks. The project, funded through DOE's new Hydrogen Energy Earthshot initiative, will optimise the technology to ensure fast, efficient and safe fueling of >80 kg of hydrogen in 15 minutes. Nikola will work with the National Renewable Energy Laboratory to evaluate the integrated system (robotics, sensors and heavy-duty components) under weather conditions expected for widespread deployment across the continental US.

Nikola Corporation: www.nikolamotor.com

Alta Equipment Group: www.altg.com

DOE, Hydrogen Shot: www.energy.gov/eere/fuelcells/hydrogen-shot

MOBILE APPLICATIONS

Gaussin hydrogen yard trucks for Plug Power

French logistics vehicle manufacturer Gaussin has received an initial order from US-based Plug Power for 20 hydrogen powered yard trucks, for deployment with existing Plug Power customers in North America.

IN BRIEF

TECO and Greenstat cooperating to target green hydrogen value chain

Norwegian companies TECO 2030 (www.teco2030.no) and Greenstat (www.greenstat.no/en/) have signed a Letter of Intent to cooperate on relevant projects with the aim of developing a complete hydrogen value chain. Under the agreement, the partners will identify, evaluate and participate in relevant hydrogen infrastructure projects, in which Greenstat will provide green hydrogen to be used in TECO fuel cells. TECO has developed hydrogen PEM fuel cell systems, initially targeting marine applications [*FCB, July 2021, p7*] and construction sites [*August 2021, p15*].

Shell funded for heavy-duty multimodal hydrogen refueling station in California

Equilon Enterprises – which operates as Shell Oil Products US (www.shell.us) – has been awarded a $4 million grant by the California Energy Commission (www.energy.ca.gov) to develop and demonstrate the state's first 'multimodal' hydrogen refueling station, at the Port of West Sacramento. This facility will serve on-road heavy-duty fuel cell electric trucks (up to Class 8) at 350 bar on the public retail side of the station, and a fuel cell powered locomotive on the rail tracks on the other side (at 250 bar), supporting the Sierra Northern Hydrogen Locomotive Project [*FCB, April 2021, p6*].

Hyundai Motor invests in Pajarito Powder

US-based Pajarito Powder (www.pajaritopowder.com) has received a Series B investment from Hyundai Motor Company (www.hyundai.com/worldwide), which will allow the South Korean automaker to expand its portfolio in the hydrogen industry value chain and help establish a hydrogen ecosystem. Located in Albuquerque, New Mexico, Pajarito Powder develops advanced catalysts and supports for PEM and alkaline fuel cells and electrolysers.

Fortescue Future Industries to explore green hydrogen projects in India

Australian company Fortescue Future Industries (www.ffi.com.au) has entered into a framework agreement with JSW Future Energy Ltd in India, a subsidiary of JSW Energy (www.jsw.in/energy), to explore opportunities to develop green hydrogen projects in India. The partners will conduct scoping work on potential projects relating to green hydrogen production, and explore opportunities to utilise it for green steelmaking, hydrogen mobility, green ammonia and other industrial applications in India. FFI is the green energy subsidiary of Fortescue Metals Group Ltd (www.fmgl.com.au), focused on establishing a global portfolio of renewable green hydrogen and ammonia operations.

EVENTS CALENDAR

29 September 2021
Women in Green Hydrogen (WiGH) Third Networking Event: Finding a Work-Life Balance
Online
More information:
www.women-in-green-hydrogen.net/events

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 I01C: Polymer Electrolyte Fuel Cells & Electrolyzers 21, PEFC&E21
Now online only
More information: www.electrochem.org/240

13–14 October 2021
CANCELLED: 2021 Ohio Fuel Cell Symposium
North Canton, Ohio, USA
More information: www.fuelcellcorridor.com

14 October 2021
Plug Symposium 2021: Here Comes Green Hydrogen
Online
More information: www.plugpower.com/events

17–21 October 2021
Materials Science & Technology MS&T21, Technical Meeting & Exposition
Columbus, Ohio, USA and Online
More information: www.matscitech.org/MST21

20–21 October 2021
Hydrogen Technology Expo Europe: Technologies & Solutions for a Low-Carbon Hydrogen Future
Bremen, Germany
More information:
www.hydrogen-worldexpo.com

27–28 October 2021
HyVolution 2021: Energy, Industry, Mobility
Paris, France
More information:
www.hyvolution-event.com/en

7–10 November 2021
6th Asian SOFC Symposium & Exhibition
Jeju Island, South Korea
More information: www.2020asiansofc.or.kr

8–10 November 2021
HYPOTHESIS XVI Online 2021: HYdrogen POwer THeoretical & Engineering Solutions International Symposium
Online
More information: www.hypothesis.ws

16 November 2021
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

19–20 November 2021
4th International Symposium on Hydrogen Energy & Energy Technologies, HEET 2021
Osaka, Japan
More information: www.heet-18.org

22–23 November 2021
17th International Ulm ElectroChemical Talks, UECT 2021
Ulm, Germany and Online
More information: www.uect.de

23–24 November 2021
2nd Fuel Cell Conference Chemnitz FC^3: Clean Drives, Efficiently Produced
Chemnitz, Germany
More information: www.iwu.fraunhofer.de/en/trade-fairs-and-events/fc3-fuel-cell-conference-chemnitz1.html

24 November 2021
Hydrogen Ecosystem Slovenia Conference: Hydrogen & Flexibility (FCH JU and Ecubes)
Ljubljana, Slovenia
More information: www.ecubes.si/hydrogen-ecosystem-slovenia-conference-by-fch-ju-and-ecubes

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

8–10 December 2021 [rescheduled from 30 November–2 December]
2nd Annual Asia-Pacific Hydrogen Summit, organised by Sustainable Energy Council and Asia-Pacific Hydrogen Association
Online
More information:
www.asia-hydrogen-summit.com

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

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

2022

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

15–17 March 2022
International Renewable Energy Storage Conference, IRES 2022
Düsseldorf, Germany
More information: www.eurosolar.de/en/ires
Abstract deadline: 30 September 2021

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

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

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

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

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