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Plug Power secures Carrefour as new customer in France, expands FM Logistic deployment

US-based Plug Power has just announced two major contracts in France that highlight its continuing traction with European materials handling customers. Carrefour is the company's newest European retail customer, purchasing more than 150 GenDrive® hydrogen PEM fuel cell units for deployment at a new distribution centre in Vendin-lès-Béthune. Plug Power has also received a new GenDrive order from existing customer FM Logistic, for deployment at its logistics facility in Neuville-aux-Bois. Both projects are supported by the EU-funded Fuel Cells and Hydrogen Joint Undertaking (FCH JU).

The **Carrefour Group,** headquartered just outside Paris, is the leading retailer in Europe and the second-largest in the world, with more than 12 300 stores in 30 countries. Securing Carrefour as a GenDrive customer is a significant milestone for Plug Power in building its business in Europe, and provides critical validation for hydrogen and fuel cells across the continent.

Carrefour will purchase more than 150 GenDrive units, to be deployed in STILL Class 2 and Class 3 electric lift trucks at its brand new distribution centre in Vendin-lès-Béthune, near Lille in northern France.

The agreement is part of a significant rollout of Plug Power's GenDrive fuel cell solution in European countries, where many firms are seeking new technologies that can deliver higher productivity and better environmental sustainability [*see the Plug Power feature in FCB, December 2011*]. This supports Carrefour's commitments to responsible retailing, including reducing energy consumption by 30% and greenhouse gas emissions by 40% by 2025.

In new facilities, like Carrefour's Vendin distribution centre, the use of hydrogen allows companies to avoid the high costs of building a battery room and related upgrades to electrical infrastructure, and instead apply that budget to more cost-effective hydrogen infrastructure. Carrefour's hydrogen infrastructure will be completed in the coming months, enabling the project to be commissioned before the end of 2016.

Plug Power has also received a new GenDrive purchase order from existing customer **FM Logistic,** for deployment in Toyota Material Handling and Crown pallet jacks and reach trucks at its 90 000 m^2 (970 000 sq ft) logistics facility in Neuville-aux-Bois, near Orléans, southwest of Paris [*FCB*, April 2015, p10]. Plug Power's European GenCare team will support the GenDrive fleet.

FM Logistic is an international leader in warehousing, transport, and packing. It operates in 13 countries including Russia, Brazil, China and India, with approximately 60% of its revenues coming from outside France.

'Plug Power continues to add new customer names to our résumé, and we look forward to helping FM Logistic continue to grow its business through the use of GenDrive fuel cells,' says Andy Marsh, CEO of Plug Power. 'Our expanded partnership with FM Logistics further strengthens our value proposition that GenDrive applies not just for our core large distribution centre markets, but also in extending to smaller-size distribution centres and to the European logistics operations.'

Another French logistics company, Prelocentre, is operating the first European all-hydrogen logistics platform in Saint-Cyr-en-Val, also near Orléans, equipped with forklifts powered by Plug Power fuel cells that are now being refueled by a new Air Liquide hydrogen station [*see page 8*]. Plug Power is also partnering with HyGear in the Netherlands to supply the latter's hydrogen generation technology to Plug Power fuel cell customers worldwide [*see page 9*].

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Carrefour Group: www.carrefour.com

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

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

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ROAD VEHICLES

Riversimple launches first UK trial of Rasa hydrogen fuel cell cars

Welsh car company Riversimple has agreed the first trial of its hydrogen-powered cars in the UK. The company is partnering with Monmouthshire County Council to run a 12-month trial of the Rasa hydrogen fuel cell electric vehicle, which has a range of 300 miles, refuels in five minutes, and has 'no cost premium' compared with a conventional car.

In early 2017, Riversimple will supply 20 hand-built Rasa cars on three- or six-month contracts, to be driven by 60–80 residents in the county. The short distances between towns in Monmouthshire are described as ideal for testing the cars, which are designed for local non-motorway use, with a top speed of 60 mph (100 km/h). Riversimple will cover the running costs of the cars, the temporary building of an 'experience centre', and provide customer relations. As part of the initiative, a self-service, mobile refueling point is planned for the council car parks at Abergavenny or Monmouth.

The trial marks the start of Riversimple's ambitious plans to kickstart hydrogen infrastructure in the UK, by developing a community of users around a single hydrogen refueling station. Over the next 20 years, the company plans to build a distributed network of compact and efficient local manufacturing plants that will regenerate communities and create thousands of jobs.

At the recent London Motor Show, company founder Hugo Spowers unveiled two new concept vehicles based on Riversimple's two-seater Rasa – a light goods vehicle and a four-seater car – both styled by renowned auto designer Chris Reitz. The designs form part of Riversimple's plans to bring affordable, cutting-edge technology to everyday road-users with a unique, all-inclusive, sale-of-service offering. The company says that this eliminates built-in obsolescence, and flips sustainability from a cost into a competitive advantage.

Riversimple launched the Rasa in the spring, and started crowdfunding in April to match a €2 million (US$2.2 million) EU grant [FCB, March 2016, p2]. It also received £2 million ($2.6 million) from the Welsh government in 2015 [July 2015, p3]. The company plans commercially available cars in 2018, with the concept vehicles developed at a later stage, following initial rollout.

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Nissan SOFC powered vehicle system runs on bioethanol

Japanese automaker Nissan Motor Company is developing a solid oxide fuel cell (SOFC) powered system that runs on bioethanol reformed onboard the vehicle. The new system – which Nissan says is a world first for automotive use – features an e-Bio Fuel Cell with an SOFC power generator.

Unlike conventional automotive fuel cell drive systems, the e-Bio Fuel Cell features an SOFC as its power source, which generates electric power more efficiently to give the vehicle a cruising range of more than 600 km (370 miles), similar to gasoline-powered cars. The e-Bio Fuel Cell car's electric-drive features include the near-silent operation, linear startup, and brisk acceleration of an electric vehicle (EV).

Bioethanol fuels, including those sourced from sugarcane and corn, are widely available in North and South America, and Asia. The e-Bio Fuel Cell, using bioethanol, can therefore offer eco-friendly transportation and create opportunities in regional energy production, while supporting existing infrastructure.

The use of bioethanol results in a carbon-neutral cycle, with minimal CO_2 increase. Ethanol blended with water is easier and safer to handle than most other fuels. As this will remove limits on creating a totally new infrastructure, it has great potential for market growth.

Nissan says that running costs will be remarkably low, on a par with today's EVs, ultimately benefitting the public as well as businesses. The e-Bio Fuel Cell is an ideal fit for wider customer needs because of the short refueling time and ample power supply, which can support a range of services such as refrigerated delivery.

It is not clear whether Nissan developed this SOFC system in-house, but the company's UK subsidiary is working with SOFC developer Ceres Power to

trial an SOFC stack module as a range-extender in commercial electric vehicles [*FCB*, April 2016, *p3, and see page 4*]. The same subsidiary is participating in the two Hydrogen Mobility Europe projects [June 2016, p1], while in Japan Nissan is collaborating with other automakers to support the rollout of further hydrogen refueling stations [February 2015, p1 and June 2016, p11]. In 2013 Nissan signed a hydrogen fuel cell development agreement with Daimler and Ford, in an effort to bring affordable FCEVs to market by 2017 [February 2013, p2].

Nissan, Running on e-Bio: http://blog.nissan-global.com/EN/?p=14144

Dutch regions commit to scale up rollout of fuel cell electric buses

The Dutch provinces of Groningen, South-Holland, and the Rotterdam–The Hague Metropolitan Region signed a Letter of Intent during the recent TEN-T Days 2016 meeting in Rotterdam, expressing their commitment for the upscaling of fuel cell electric buses in their regions.

The collaboration between these public transport authorities (PTOs) is in line with the agreement signed in April between the Dutch government and the 14 PTOs in the Netherlands, which says that all new buses in 2025 must be zero-emission (tank-to-wheel). Fuel cell buses are considered to be one of the most promising zero-emission solutions, especially for long-distance routes outside cities.

The PTOs' statement comes as a follow up to the Letter of Intent signed by PTOs and cities across Europe at the TEN-T Days 2015 in Riga last summer, showcasing their readiness to integrate hundreds of buses in their bus fleets. The Trans-European Transport Network (TEN-T) is a network of roads, railway lines, inland waterways, inland and maritime ports, airports and rail-road terminals throughout the 28 EU Member States.

With the support of the Dutch ministry of infrastructure and environment, the PTOs will request financial support from the European Union for the deployment of 100 buses. By focusing on the purchase of a larger number of fuel cell buses, the PTOs expect to reduce the initial investment costs for the buses and hydrogen infrastructure. This should stimulate the market development of this type of bus in Europe and the Netherlands. It is expected that in 2017, the EU will provide approximately €30 million (US$33 million) through the Fuel Cells and Hydrogen Joint Undertaking (FCH JU).

This initiative takes place in the framework of a pan-European joint activity, coordinating project development activities in five clusters. These clusters aim to unlock the market potential of fuel cell buses by bringing down the costs, looking in detail at matching funding, technical specifications, and joint procurement.

The FCH JU is already funding the Giantleap project, which aims to increase PEM fuel cell system lifetime and reliability for bus applications [*see page 11*]. The FCH JU has contributed €61 million ($68 million) so far for several projects to deploy buses in across Europe: CHIC [*FCB*, September 2013, p2], HyTransit [*News Feature in March 2015*], High V.LO-City [February 2014, p3], and 3Emotion [February 2015, p1].

TEN-T Days 2016: www.tentdays.eu/2016

Hydrogenics partners with Chinese vehicle tech firm SinoHytec

Canadian-based Hydrogenics has entered into a strategic partnership agreement with SinoHytec, a vehicle propulsion technology company based in Beijing, for the delivery of fuel cells in China. The deal sees Hydrogenics – a leading developer and manufacturer of hydrogen generation technology and fuel cell power modules – move into volume manufacturing of fuel cell systems for world-class vehicle OEMs.

The agreement consists of fuel cell power module co-development and the supply of power systems specifically designed for the Chinese market. The power systems will be integrated into buses and trucks from several leading vehicle manufacturers in China during 2016 and 2017; the total value of the contract is approximately US$13.5 million.

'China's strong commitment and leadership in tackling air quality continues to drive interest in hydrogen zero-emission transportation for its leading cities today,' says Hydrogenics CEO Daryl Wilson. 'Hydrogenics is the only 'one stop shop' providing the full scope of applications needed to meet China's requirements – from

EDITORIAL

Brexit will be the new reality in Europe, following the recent national referendum that voted for the UK to leave the European Union, in the next two or three years. The result surprised many 'Leave' and 'Remain' voters, but negotiations will get under way shortly to extract the UK from the many EU arrangements and organisations.

The scientific community in Britain is particularly concerned that **UK researchers may lose out in participation in EU-funded projects**, such as those supported by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU, www.fch.europa.eu). Many UK-based organisations play key roles in FCH JU-funded initiatives, such as the new Giantleap project [*see page 11*] and the INSPIRE programme [*see the News Feature on pages 14–15*].

Indeed, Professor Sir Venki Ramakrishnan – president of the Royal Society, one of the world's oldest and most prestigious learned societies – has called for the UK government to underwrite the research of all UK-based researchers who apply for EU funding now. He told the BBC *Newsnight* TV programme that post-Brexit uncertainty needs to be 'nipped in the bud', adding that EU researchers based in the UK also need to be given assurances that they will be able to stay indefinitely.

For its part, the FCH JU has reiterated a European Council statement that until the UK leaves the EU, its organisations can still participate in and receive funding for Horizon 2020 actions. That said, these projects often include organisations from non-EU countries – such as Switzerland, Norway, Iceland et al. – so it may well be that UK-based organisations will continue much as before. Top-level negotiations will be needed to work out the details over the next few years.

The first News Feature this month [*pages 12–13*] reports on a recent **road trip challenge across Europe**, in which a small fleet of Hyundai ix35 Fuel Cell cars were driven from Bergen in western Norway across Denmark, Germany, and Austria to finally arrive in Bolzano in northern Italy. The cars demonstrated their endurance and practicality on the 2300 km (1430 mile) journey, which also highlighted the growing European hydrogen infrastructure through refueling stops at several hydrogen stations en route.

The second News Feature [*pages 14–15*] describes the new **EU-funded INSPIRE project** to validate the next generation of automotive PEM fuel cell stack technology, accelerating commercialisation of high-performance FCEVs. This three-year project will develop higher-performance, longer-lifetime MEAs for integration into new, high-power stack technology. The consortium is being coordinated by UK-based Johnson Matthey…

Steve Barrett

Power-to-Gas energy storage to fueling stations and vehicle propulsion systems.'

Over the past few years Hydrogenics has supplied multiple fuel cell systems to SinoHytec for vehicle prototypes, including buses and trucks for various Chinese OEMs. These manufacturers are moving forward with fuel cell mobility programmes with SinoHytec as the chosen system integrator.

'We have worked with Hydrogenics for several years now, and thoroughly assessed their technology advantages,' says Min Yu, VP of sales and marketing for SinoHytec. 'SinoHytec also understands the Chinese fuel cell mobility customers' requirements. Through a strong co-development effort, SinoHytec and Hydrogenics can deliver a new commercial fuel cell power system product especially designed for our valued customers in China.'

Last autumn Hydrogenics signed separate supply agreements with several Chinese electric vehicle integrators, to bring its fuel cell and fueling station technology to China as part of the country's strategy to solve prevalent air quality issues [*FCB*, November 2015, p1]. The deals cover more than 2000 vehicles over the next three to five years. Staged rollouts will follow typical engineering milestones from prototyping, manufacturing, vehicle certification, and infrastructure build-out. Based on Chinese proposals, vehicle fuel cell requirements alone over a five-year period are forecast to be above $100 million.

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Beijing SinoHytec Co Ltd: www.sinohytec.com [in Chinese]

MOBILE APPLICATIONS

Ceres to demo SOFC stack tech for Nissan in EV range-extender

UK-based Ceres Power has finalised all the required agreements to begin its new relationship with Nissan Motor Manufacturing (UK) Ltd, to develop a compact, onboard solid oxide fuel cell stack for range extension of electric vehicles.

Ceres is leading a consortium with Nissan and M-Solv, which specialises in micromachining and microdeposition equipment, as part of the funding arrangement from Innovate UK and the Office for Low Emission Vehicles (OLEV) announced in March [*FCB*, April 2016, p3].

The SOFC stack is based on Ceres Power's unique Steel Cell intermediate-temperature SOFC technology, which is able to work with a variety of high-efficiency fuel types (including biofuels) applicable to the automotive sector. This offers a potential path to significantly accelerate the take-up of electric vehicles, reducing CO_2 and other emissions, and making significant progress towards the UK's low carbon energy targets.

'We are delighted to be working with Nissan and M-Solv to enable an all-electric vehicle with a longer range and shorter refueling time, and to help cut vehicle emissions globally,' says Ceres CEO Phil Caldwell. 'In addition, this project broadens the applications for Ceres Power's Steel Cell into the automotive industry as well using alternative fuels such as biofuels.'

In January, Ceres signed a joint development agreement with Honda R&D in Japan, to jointly develop IT-SOFC stacks for a range of potential power equipment applications [*FCB*, January 2016, p1]. Ceres has subsequently completed a manufacturing scale-up project to enable high-volume production capability on its new high-speed print line [March 2016, p9].

Nissan has just unveiled an SOFC powered system that runs on bioethanol reformed onboard a vehicle [*see page 2*]. The new system features an e-Bio Fuel Cell with an SOFC power generator, although it is not clear whether Ceres supplied the stack.

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M-Solv Ltd: www.m-solv.com

Innovate UK: www.gov.uk/innovateuk

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

GM, US Navy partner on fuel cell powered underwater vehicles

General Motors, the Office of Naval Research (ONR), and the US Naval Research Laboratory (NRL) are cooperating to incorporate automotive hydrogen fuel cell systems into the next generation of Navy unmanned undersea vehicles (UUVs).

Under ONR's Innovative Naval Prototype programme for Large Displacement UUVs, energy is a core technology in the Navy's goals for vehicles with more than 60 days endurance. The UUV project partners anticipate that hydrogen PEM fuel cell technology could augment ships and submarines on patrol [*see the feature on marine fuel cells in FCB, May 2010*]. Other fuel cell developers that have worked with the US Navy include NexTech Materials [June 2012, p4], FuelCell Energy [August 2012, p4], and UTC Aerospace [June 2014, p4].

NRL recently concluded an evaluation of a prototype UUV, equipped with a GM fuel cell at the heart of the vessel's powertrain. The tests, a key step in the development of an at-sea prototype, were conducted in pools at the Naval Surface Warfare Center in Carderock, Maryland.

'Our in-water experiments with an integrated prototype show that fuel cells can be game changers for autonomous underwater systems,' says Frank Herr, ONR's department head for Ocean Battlespace Sensing. 'Reliability, high energy, and cost-effectiveness – all brought to us via GM's partnering – are particularly important as Navy looks to use UUVs as force multipliers.'

GM's fuel cells are compact and lightweight, and have high reliability and performance. Lower cost is achievable through volume production. These attributes match the goals of the Navy to develop reliable, affordable systems.

'The collaboration with the Navy leveraged what we learned in amassing more than 3 million miles of real-world experience with our Project Driveway fuel cell programme [*FCB*, June 2014, p2],' says Charlie Freese, executive director of GM Global Fuel Cell Activities. 'Our customers will benefit from additional lessons we learn about the performance of fuel cells in non-automotive applications, that will be useful in GM's drive to offer fuel cells across consumer markets.'

Last autumn GM and the US Army Tank Automotive Research, Development & Engineering Center (TARDEC) modified a Chevrolet Colorado pickup truck to run on a commercial hydrogen fuel cell propulsion system, and are trialing the truck in the extremes of daily military use for 12 months [*FCB*, December 2015, p2].

General Motors, Technology: http://tinyurl.com/gm-emerging-tech

US Naval Research Laboratory: www.nrl.navy.mil

Office of Naval Research: www.onr.navy.mil

SMALL STATIONARY

Dantherm rebrands FCgen-H2PM backup power product

Denmark-based Dantherm Power, which provides fuel cell backup power to critical infrastructure in

the IT and telecom industries, has rebranded its hydrogen power module product line – formerly known as the ElectraGen™-H2 – as the FCgen®-H2PM.

The FCgen-H2PM is a PEM fuel cell system designed to provide backup power for markets with reliable grids, but which are vulnerable to extended power outages in crisis situations such as extreme weather conditions.

Dantherm Power – a subsidiary of Canadian-based Ballard Power Systems since 2010 [*FCB*, February 2010, p8] – has developed and deployed FCgen-H2PM backup power systems to a number of IT and telecom operators in Denmark. More recently, its market focus has shifted to the more critical infrastructures for both IT and telecom sites, taking full advantage of the product's reliability, robustness, and environmentally friendly characteristics. The new product name is in alignment with the entire FCgen fuel cell product line offered by Ballard.

'Thanks to great interest from our Danish customers, the FCgen-H2PM has demonstrated its value as a viable substitute for lead-acid batteries,' says Jesper Themsen, CEO of Dantherm Power. 'The name change to FCgen-H2PM represents a beginning to the next era of the product's life. We will initially focus sales efforts on the Scandinavian market to provide backup power for critical infrastructure.'

At the end of May, Ballard sold certain of its *methanol* telecom backup power business assets (including the ElectraGen trademark) to Chung-Hsin Electric & Machinery Manufacturing Corporation, a major Taiwanese power equipment company [*FCB*, May 2016, p1]. Ballard acquired the ElectraGen product line and other key assets in 2012 from IdaTech [August 2012, p10].

Dantherm Power is targeting two business areas: backup power, with the primary focus on critical infrastructure for the IT and telecom industries; and technology solutions. The latter focus on enabling customers to solve their technical and business challenges and accelerate their fuel cell programmes by delivering customised, high-value, bundled technology solutions. This includes Dantherm Power's participation in the new HyFlexDrive project in Denmark, to develop next-generation PEM fuel cells for powering materials handling vehicles [*FCB*, January 2016, p3].

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Ballard Power Systems, Burnaby, BC, Canada. Tel: +1 604 454 0900, www.ballard.com

SFC gets largest Asian single order for EFOY Pro from Innoverde

German fuel cell manufacturer SFC Energy has received a major order from its Singapore sales & marketing partner Innoverde, serving its prime customer Oneberry Technologies, a Singaporean IT solutions provider. The contract is the largest single order yet from an Asian customer for SFC's EFOY Pro fuel cells.

Innoverde will procure several hundred units of the EFOY Pro 2400 direct methanol fuel cell – and the requisite EFOY methanol fuel cartridges – over the next 24 months, with the first deliveries expected imminently. These fuel cells will be used to provide reliable off-grid power for security and surveillance equipment in Singapore; some of the fuel cells will be hybridised with a solar module in a weatherproof system by Oneberry Technologies. The contract award builds on the success of five years of extensive business development between SFC Energy and Oneberry [*FCB*, May 2014, p3].

EFOY Pro fuel cells are well established in Singapore. They power off-grid equipment, ensuring the integrity of infrastructure and environmental needs, such as flood watch warning systems in underground canals, solutions for littering, or waste water quality monitoring.

'The EFOY Pro fuel cell is not only a very eco-friendly power generator, but also an extremely reliable one: it provides power at any time and in any weather to critical infrastructure and environmental equipment, to ensure 24/7 system readiness,' says Ken Pereira, CEO of Oneberry Technologies. 'In hybrid operation with the solar module the fuel cell covers the module's power gap in bad weather and at night.'

'After the success story of our EFOY Pro fuel cells in Japan, this order is another important milestone in our expansion into the Asian markets, where we see tremendous business opportunities,' adds Dr Peter Podesser, CEO of SFC Energy [*see the SFC feature in FCB, January 2013*]. 'Our clean, sustainable, and silent products are fast becoming the power source of choice for ensuring off-grid power availability to state and civilian security & surveillance equipment all across Asia.'

Last summer SFC signed a partner agreement with Toyota Tsusho Corporation in Japan, under which Toyota Tsusho will become an official representative of SFC in the Japanese market [*FCB*, October 2015, p11].

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Innoverde Pte Ltd, Singapore. www.innoverde.com.sg

IN BRIEF

Implats targets fuel cell power to drive underground vehicles at platinum mine

Impala Platinum (Implats, www.implats.co.za) in South Africa plans to roll out fuel cell powered load haul dumpers at its base metals refinery in Springs, serving the 14 Shaft at its Rustenburg Platinum Mine, according to a report in *MiningWeekly.com*.

The first prototype fuel cell forklifts and hydrogen refueling station have been operating in the nickel dispatch area of Implats' base metals refinery in Springs since October [*FCB*, April 2016, p4]. They utilise a novel metal hydride material that allows the fuel cell and refueling system to be operated at just 180 bar (2610 psi), rather than the 350 bar (5000 psi) required for internationally certified systems. The report says that the prototype refueling station cost R2 million (US$140 000), much less than the €500 000 ($553 000) cost of an off-the-shelf 350 bar European system.

Implats fuel cell coordinator Fahmida Smith says that detailed design has also been completed for a 1.2 MW stationary hydrogen fuel cell system and an 8 MW natural gas system, to demonstrate the different fuels that can be used [*FCB*, April 2015, p8].

India maps road to hydrogen, fuel cells

The Indian Ministry of New and Renewable Energy has released a draft report that lays down a road map for the use of hydrogen energy and fuel cell technology in the transport sector, according to *LiveMint.com*. The report recommends an overall budget allocation of Rs.2765 crore (US$410 million) until 2022 for the adoption of hydrogen energy.

The draft report *Hydrogen Energy and Fuel Cells in India – A Way Forward* [PDF: http://tinyurl.com/h2fc-india-draft] calls for industry participation in projects that will help commercialise technology to use hydrogen energy, and for strengthening R&D. In the initial phase, compressed natural gas (CNG) buses should be converted to hydrogen-CNG, and a fleet of 10 passenger cars, SUVs, two-wheelers, three-wheelers, and buses operating on fuel cell technology should be developed.

Ten years ago India established a National Hydrogen Energy Board, and prepared a National Hydrogen Energy Road Map to accelerate the development of the hydrogen energy sector [*FCB*, March 2006, p3, and *see the India feature in July 2009*]. The Road Map covered all aspects of hydrogen energy – such as production, storage, transport, delivery, application, codes & standards, public awareness, and capacity building – and formed the basis of the Indian hydrogen energy programme.

Oneberry Technologies, Singapore. Tel: +65 6692 6760, www.oneberry.com

Waterloo hydrogen microgrid system wins student design contest

The University of Waterloo in Ontario, Canada was the Grand Prize Winner of the Hydrogen Education Foundation's 2016 Hydrogen Student Design Contest, announced at a session of the US Department of Energy's recent Annual Merit Review and Peer Evaluation Meeting (AMR) in Washington, DC [*see page 11*]. This is the third time that Waterloo has won the Grand Prize.

This year's contest required student teams to design a hydrogen powered microgrid with the capability of solely supporting a community, facility, or military base for two days, and the ability to handle at least 10% of peak demand while the 'macrogrid' is active, as well as provide grid support during peak times. The contest is sponsored by DOE, its National Renewable Energy Laboratory (NREL), and Air Liquide.

The Waterloo team's design used Cornwall, Ontario as the location of its renewable hydrogen-powered microgrid design. Hydrogen is used as an energy storage medium, to be converted back into electricity using PEM fuel cells. The system is designed to supply hydrogen to 100 forklifts used at a food distribution centre, and for more than 30 fuel cell electric vehicles used in the residential community. Wind, solar, and hydrogen power continuously supply 10% of the energy demand of the community, as well as the full demand for two days in the event of a blackout. The key to meeting these criteria is the vehicle-to-grid (V2G) concept used in the design, where FCEVs can be connected to charging stations to supply power back to the grid during peak demand or emergency scenarios.

As part of their award, the University of Waterloo team received a travel stipend to DOE's AMR meeting, to present their design in front of industry representatives. The winning team will also have their design submitted for publication in an issue of the *International Journal for Hydrogen Energy*.

Sixteen teams participated in the 2016 contest: Arizona State University, California State University – Los Angeles, Farmingdale State College, Stanford University, University of California – San Diego, University of South Florida, and West Texas A&M University in the US; University of Waterloo and University of British Columbia in Canada; University of Manchester in the UK; Kyushu University in Japan; Bogor Agricultural University in Indonesia; North-West University in South Africa; and three teams from Universidad de Ingeniería y Tecnología (UTEC) in Peru.

Hydrogen Student Design Contest: www.HydrogenContest.org

Hydrogen Education Foundation: www.HydrogenEducationFoundation.org

PORTABLE & MICRO

myFC delivers first order of JAQ fuel cell chargers to 3 Sweden

Swedish company myFC has delivered the first order of its JAQ fuel cell charger – claimed to be the world's smallest – for testing and evaluation with cellular phone operator 3 Sweden. IEC certification of the JAQ charger has been completed, and with the first delivery being evaluated by the operator, the next step will be to bring the products to the final consumer.

3 Sweden is the first to receive JAQ units, and will shortly be providing them to customers so they can charge their mobile devices – in particular smartphones – with 'green' energy, completely independently from an electrical outlet. JAQ utilises charge cards filled with water and salt, allowing the user to produce their own electricity.

'The delivery is a historic moment for the fuel cell world: this is a technological breakthrough, since no one has yet taken the dream of a water-based integrated fuel to reality in the form of a finished product, even though there have been multiple attempts,' says Björn Westerholm, CEO of myFC. 'Optimisation and tuning of all components is ongoing, with the focus now being set on the user's experience.'

'We have achieved a breakthrough in solving a number of difficult problems, and can now begin the integration with our robotic production line,' he adds. 'Moreover, we begin to build the foundation for the expansion of production in the markets where we need to be close to the customer.'

Westerholm continues: 'Today, we have some 30 operators waiting to begin the testing and evaluation of our patented technology and products, so we expect to eventually go into a pure commercial phase with these customer relationships.'

myFC unveiled the JAQ charger in early 2015 [*FCB*, March 2015, p6]. It recently signed an exclusive agreement with the 'du' mobile network carrier to distribute and market it in the United Arab Emirates, and a distribution agreement with Mobileistic for the American market [January 2016, p6]. It is also setting up a joint venture with investment company Novel Unicorn in Hong Kong, to market and sell the JAQ in one of the world's fastest-growing mobile telephony markets [May 2016, p6]. myFC is using new robot technology from ABB to produce the PowerCards, in a collaboration that will build myFC's first factory in Sweden [December 2015, p7].

myFC AB, Stockholm, Sweden.
Tel: +46 8 5000 0200, www.myfcpower.com

FUELING

Air Products licenses its hydrogen fueling protocol to Air Liquide

Pennsylvania-based Air Products has agreed to provide a technology licence that allows Air Liquide Advanced Technologies US LLC to practise the patented Air Products technology incorporated in the Society of Automotive Engineers (SAE) J2601 hydrogen fueling protocol.

Air Products will provide licences to anyone seeking to use the patented technology as part of a fueling station project employing the SAE J2601 protocol. The company makes such hydrogen fueling technology licences available for use around the world under fair, reasonable, and non-discriminatory (FRAND) terms.

'We are very proud of our accomplishments in the hydrogen fueling and infrastructure marketplace, and believe this licence is recognition of our capabilities,' says Ed Kiczek, global business director for hydrogen energy systems at Air Products. 'We will accommodate additional licences for our technology as the hydrogen fueling network in the United States and around the world continues to expand.'

Air Products uses its patented hydrogen fueling technology in conjunction with the SAE J2601 protocol in its own SmartFuel® stations, and also those built for other customers. SmartFuel stations worldwide provide hydrogen fueling at 700 bar (10 000 psi). Air Products has available several SmartFuel stations incorporating modular and expandable technology, and a global patent portfolio, related to the advances to be deployed under this protocol. This supply system can also be cost-effectively deployed anywhere in the US, to rapidly jumpstart new markets that need a hydrogen fueling infrastructure.

Air Products is a leading installer of hydrogen fueling stations worldwide, including a significant contribution to the rapidly expanding network in California [*FCB*, November 2015, p7]. At the

end of 2015 Air Products partnered with Bohlen & Doyen to support the further development of Europe's burgeoning hydrogen fueling market [January 2016, p7, *and see the Air Products Europe feature in February 2013*], and recently opened its first retail hydrogen fueling station in Japan [June 2016, p8].

French-based Air Liquide is also busy building hydrogen stations, including a new one now refueling fuel cell powered forklifts for Prelocentre in Saint-Cyr-en-Val, the first European all-hydrogen logistics platform [*see page 8*]. Air Liquide has also just announced that it is collaborating with automaker Hyundai, to increase the number of hydrogen stations and FCEV fleets in both Europe and Korea [*see In Brief, page 11*].

Air Products, SmartFuel Hydrogen Energy: www.airproducts.com/h2energy

Air Liquide US, Hydrogen: https://industry.airliquide.us/hydrogen

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

H2 Logic delivers 10th station for Denmark, NEL order in Sweden

A new hydrogen refueling station, supplied by H2 Logic, was inaugurated recently in Esbjerg, becoming the 10th station in Denmark. And NEL Hydrogen Solutions – formerly branded as part of H2 Logic – has entered into an agreement with the City of Mariestad in southern Sweden, for the sale and construction of an H2Station®.

The new **hydrogen station in Esbjerg**, the western-most and fifth-largest city in Denmark, further strengthens the world's first nationwide hydrogen refueling network. The hydrogen station is located at a conventional fueling station operated by OK in the city centre, right next to the highway connecting Esbjerg with eastern Denmark. The station will be used by fuel cell electric vehicles delivered to various local users, including the City of Esbjerg.

The Esbjerg station is operated by Danish Hydrogen Fuel A/S (DHF), a joint venture between OK, gas company Strandmøllen, and H2 Logic [*FCB*, March 2015, p8]. DHF now operates four hydrogen stations in Denmark [April 2016, p7]. Hydrogen for the station is delivered from a central electrolyser plant operated by Strandmøllen, based on technology from H2 Logic's sister company NEL Hydrogen. The entire Danish hydrogen station network is based on 100% sustainable and zero-emission hydrogen produced from electrolysis and electricity procured with CO_2 certificates.

The Esbjerg station – like the rest of the Danish network – is based on H2Station technology from H2 Logic, which provides 700 bar fast fueling [*see the H2 Logic feature in FCB, May 2013*]. The station is supported by the Danish Energy Agency in the H2DK project.

Meanwhile, NEL Hydrogen Solutions will supply an **H2Station for Mariestad**, completing the strategic connection between Copenhagen in Denmark and Stockholm in Sweden. The project includes turnkey installation of an H2Station, including service & maintenance, and will be owned by the City of Mariestad. The contract value is more than €1 million (US$1.1 million), and will be delivered in Q4 of 2016.

The hydrogen station in Mariestad is part of the recently announced €106 million ($118 million) Hydrogen Mobility Europe 2 (H2ME 2) project, a new pan-European deployment of hydrogen refueling infrastructure alongside passenger and commercial FCEVs [*FCB*, June 2016, p1].

H2 Logic, Herning, Denmark. Tel: +45 9627 5600, www.h2logic.com

H2 Logic station network: http://h2logic.com/products-services/track-record

NEL ASA, Oslo, Norway. Tel: +47 2324 8950, www.nel-asa.com or www.nel-hydrogen.com

ITM sells integrated refueling station to Hydrogène de France

UK-based ITM Power has sold an integrated hydrogen refueling station with onsite generation to Hydrogène de France (HDF), for deployment in France, with commissioning scheduled for mid-2017. The contract is worth €1.5 million (US$1.7 million) to ITM Power, before follow-on contracts such as maintenance agreements.

HDF chose the electrolyser-based hydrogen station through its competitive tender process. The station will serve both local captive fleets of fuel cell range-extender electric vans with a 350 bar refueling technology, and fuel cell electric vehicles with 700 bar refueling technology [*FCB*, July 2015, p2].

HDF is working to exploit the potential of hydrogen as an energy carrier, and is deploying hydrogen refueling assets in France to prepare for future large-scale rollouts of FCEVs and fuel cell buses. This is part of the H2 Mobilité France consortium strategy to create and then interlink regional hydrogen station clusters across France [*FCB*, August 2013, p2]. HDF will be responsible for the purchase, installation, operation, and maintenance of the station, as well as site preparation.

The station will be partly funded by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) as part of the Hydrogen Mobility Europe 2 (H2ME 2) initiative [*FCB*, June 2016, p1]. As part of this project, HDF will be able to test the operation of the electrolyser in a live market to provide grid balancing services.

'ITM Power's skills in systems management were essential in our choice,' says Damien Havard, CEO of HDF. 'This equipment is not only the first step in our deployment of hydrogen mobility, but also a key component in our offer of grid balancing services.'

Earlier this year HDF organised the transfer of a 1 MW PEM fuel cell power plant, manufactured by Dutch-based Nedstack [*see page 10*], which had previously been in service at a chlorine plant in Belgium, to the Caribbean island of Martinique [*FCB*, February 2016, p5]. And last summer it signed an agreement with Canadian-based Ballard Power Systems to provide a 1 MW fuel cell distributed generation system for an AkzoNobel sodium chlorate plant in Bordeaux [August 2015, p4].

ITM Power's electrolyser technology is also utilised in Power-to-Gas (P2G) systems, such as the system in service with Thüga Group in Germany [*see page 9*].

Hydrogène de France, Lormont, France. Tel: +33 5 5677 1111, www.hdf-energy.com

ITM Power, Sheffield, UK. Tel: +44 114 244 5111, www.itm-power.com

H_2 Mobility station in Wuppertal marks German series launch

The first standard H_2 Mobility Station has opened in Germany, at the Shell site at the Wuppertal-North motorway junction. This station is a model for the company's further expansion of the German hydrogen refueling station network, which will initially create 100 stations, and up to 400 nationwide by 2023.

H_2 Mobility Deutschland – a joint venture of Air Liquide, Daimler, Linde, OMV, Shell, and Total – was launched in 2013, with the aim of constructing and operating up to 400 hydrogen stations across Germany by 2023 [*FCB*, October

2013, p6]. H_2 Mobility was a founding partner in the original Hydrogen Mobility Europe project, a collaboration between national hydrogen mobility initiatives from across Europe that started last year [*see the News Feature in October 2015*], and is part of the recently launched Hydrogen Mobility Europe 2 (H2ME 2) project [June 2016, p1].

The first German hydrogen stations have already been operating for several years. Shell started operation of the world's then-largest hydrogen station in Berlin in 2011 [*FCB*, July 2011, p8], and also operates facilities in Hamburg [April 2015, p10]. There are currently 20 completed hydrogen stations in Germany, funded by the federal government through the National Innovation Programme Hydrogen and Fuel Cell Technology (NIP). The federal government has also participated in the construction of the new Wuppertal hydrogen station, with funding totalling €670 000 (US$740 000), as part of the 50 station programme of the Clean Energy Partnership [*see the CEP feature in June 2011*].

The state-of-the-art station constructed by Linde in Wuppertal uses mostly standardised components for storage, compression and refueling, and can be adapted to the basic layout of the station onsite in a space-saving and flexible way. The new station in Wuppertal serves as a model for the planned deployment of further stations. Three-quarters of the hydrogen refueling stations in Germany are currently equipped with Linde technology [*see the Linde feature in FCB, September 2014*].

The Shell hydrogen station at Wuppertal-Schmiedestrasse is located close to the A1, A43 and A46 motorways. It improves logistics in the Rhine-Ruhr metropolitan region, and also serves long-haul traffic. More Shell stations under H_2 Mobility will be built later this year in Hesse, Baden-Württemberg, and Bremen.

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

Shell Deutschland, Wasserstoff: http://tinyurl.com/shell-wasserstoff [in German]

H_2 Mobility Deutschland GmbH: www.h2-mobility.de/en

Clean Energy Partnership: www.cleanenergypartnership.de/en

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

Air Liquide station for first all-hydrogen warehouse in Europe

In France, Air Liquide has supplied and is now operating a hydrogen station that refuels the onsite forklifts at Prelocentre, a logistics company in Saint-Cyr-en-Val, near Orléans. This site is the first European all-hydrogen logistics platform, and is already equipped with 46 forklifts powered by fuel cells supplied by US-based Plug Power [*FCB*, October 2015, p3, *and see page 1*].

This Prelodis facility, operated by its subsidiary Prelocentre, prepares fruit and vegetables for delivery to all Grand Frais stores located west of the Toulouse–Lille axis. The Air Liquide hydrogen station allows a forklift to be refueled in just 3 min, for an average 8 h operating shift. This installation – co-financed by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) as part of the HyLIFT-Europe project [*FCB*, July 2013, p2] – aims to showcase the use of hydrogen-powered forklifts in European warehouses and airports.

Hydrogen energy offers a sustainable alternative to conventional diesel or lead-acid battery powered forklifts, and meets key logistics challenges by combining increased flexibility and improved productivity. It provides an extended range for forklifts, reduced refueling time, and increased safety for forklift operators who no longer have to handle heavy batteries.

This new implementation of hydrogen energy in Europe demonstrates this solution's competitiveness for forklifts. The use of hydrogen in logistics platforms is increasingly widespread in the US and Canada, with already more than 10 000 fuel cell forklifts powered with hydrogen.

Meanwhile, Air Liquide's US subsidiary has signed a technology licence with Pennsylvania-based Air Products, that allows it to practise the patented Air Products technology incorporated in the SAE J2601 hydrogen fueling protocol [*see page 6*]. Air Liquide has also just announced that it is collaborating with automaker Hyundai, to increase the number of hydrogen stations and FCEV fleets in both Europe and Korea [*see In Brief, page 11*].

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

HyLIFT-Europe project: www.hylift-europe.eu

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

H_2 Energy to generate green hydrogen from hydropower in Aarau

Swiss companies H_2 Energy and IBAarau plan to construct a hydrogen production plant at the latter's hydropower station in Aarau. The hydrogen generated will be dispensed from the first public hydrogen refueling station in Switzerland.

Local energy supplier IBAarau has submitted a building application for the project at the hydropower station on the river Aare, which will provide renewable electricity for hydrogen production. The refueling station will be operated by Coop Mineralöl AG in nearby Hunzenschwil.

The planned H_2 Energy electrolysis plant, combined with a compressor station, is the first facility in Switzerland directly connected to a hydraulic power station. The plant is based on 100% renewable energy, and is being used to supply hydrogen refueling stations. The electrolysis plant will be able to meet the annual hydrogen demand of up to 170 fuel cell electric vehicles.

The use of hydropower with electrolysis is an ideal combination, with the potential to match power production with power demand and increase the flexibility of the hydropower station. This combination thus offers a great opportunity to increase the value of renewable hydropower in a deregulated energy market.

Zürich-based H_2 Energy, which specialises in tailor-made hydrogen solutions, is the prime investor in the hydrogen production plant in Aarau, and is responsible for the timely launch of FCEVs for Coop Mineralöl. It will operate the electrolyser and manage the logistics to the hydrogen refueling station in cooperation with IBAarau.

The hydropower station in Aarau generates an average power output of 12.5 MW, but it can't store water or respond to demand-driven peak loads. The anticipated hydrogen production will take about 2% of the total power production of the hydropower station. The hydrogen will be stored in large pressurised tanks, then transported to the Coop refueling station in Hunzenschwil.

H_2 Energy AG, Zürich, Switzerland. Tel: +41 43 343 9000, www.h2energy.ch

IBAarau AG: www.ibaarau.ch

Plug Power, HyGear to provide reformer tech to fuel cell users

US-based Plug Power is partnering with HyGear in the Netherlands to supply the latter's hydrogen generation technology to Plug Power fuel cell customers worldwide. The first deployments will be installed in Q4 of 2016, at a new site for one of Plug Power's existing customers.

HyGear's Hy.GEN® hydrogen generation technology is based on small-scale reforming, and provides an onsite, low-cost, efficient, and flexible alternative to conventional hydrogen supplies. These systems allow users flexibility in fuel generation and consumption, including the option to use biogas for a 'green' hydrogen solution. Distributed generation of hydrogen eliminates the need to transport the fuel, further improving the sustainability of the overall GenKey solution that Plug Power provides to its customers [*FCB*, January 2014, p1].

HyGear's advanced reformer solution allows Plug Power to address a more diverse set of customers, including small materials handling fleets and a broader base of tethered fleet vehicles. Plug Power will offer the Hy.GEN reformer technology as an option under its GenFuel platform to materials handling and stationary power customers worldwide.

Plug Power has more than 7000 hydrogen fuel cell products deployed in the North American materials handling sector [*see the Plug Power feature in FCB, December 2011*]. The company is also expanding into the $20 billion European electric lift truck market, especially since it took full control of its European joint venture HyPulsion [July 2015, p1]. Its European customers include Colruyt in Belgium [December 2015, p3] and Prelodis in France [October 2015, p3, *and see page 8*], with new orders just received from Carrefour and FM Logistic [*see page 1*].

HyGear partners with its clients to design and implement efficient and cost-effective gas supply solutions utilising its advanced onsite generation technologies. It also participates in European projects such as NEMESIS2+, led by the DLR in Germany, which developed a new method for producing hydrogen from diesel and biodiesel [*FCB*, October 2015, p12].

Plug Power, Latham, New York, USA. Tel: +1 518 782 7700, www.plugpower.com

HyGear, Arnhem, The Netherlands. Tel: +31 88 9494 300, www.hygear.nl

ENERGY STORAGE

DTU Energy boosts Chinese collaboration on solid oxide cells

Researchers from DTU Energy – the Department of Energy Conversion and Storage at the Technical University of Denmark – have co-organised a Sino-Danish forum on solid oxide fuel cells and electrolysis, to strengthen their collaboration with the Chinese research community in a technology area of great importance for both nations.

China and Denmark both have ambitious plans to increase the fraction of renewable energy supply over the coming years. This creates the need for large-scale energy storage, as electricity from fluctuating sources such as wind and solar power needs to be stored for later use.

One of the most promising options for such energy storage is solid oxide electrolysis cells (SOECs), in which electricity is converted into chemical energy stored in compounds such as hydrogen or CO, later to be reconverted to electricity using solid oxide fuel cells (SOFCs). In recognition of the potential importance of the technology, Denmark and China both have major research efforts on such solid oxide cells. Now, to move the development further ahead, researchers from the two countries are strengthening their collaboration.

The first steps were taken at a three-day Sino-Denmark Bilateral Forum: Possibilities and Challenges of Solid Oxide Cells in Energy Transition, which included a scientific workshop and a panel discussion. This event was co-organised in April by DTU Energy and the Department of Thermal Engineering at Tsinghua University in Beijing. The workshop took place in Kunshan City, 50 km from Shanghai, and attracted nearly 70 participants despite the short notice, including more than half of the Chinese research groups working in SOECs/SOFCs. The workshop provided a unique opportunity for the Chinese and Danish researchers to present their latest research, exchange new ideas, and explore collaboration opportunities.

The panel discussion took place at the Innovation Centre Denmark in Shanghai, with participants from academia as well as several Chinese energy companies. The discussion focused on how to facilitate research collaboration and joint projects, and how to attract Chinese and Danish industry for the commercialisation of solid oxide fuel cell and electrolysis technology. As a follow-up, a Chinese delegation of researchers, industry representatives and potential investors will visit DTU Energy in October 2016 to further consolidate the proposed collaboration.

Contact: Dr Ming Chen, Senior Scientist, DTU Energy, Roskilde, Denmark. Tel: +45 46 77 57 57, Email: minc@dtu.dk, Web: www.energy.dtu.dk/english

ITM Power's P2G unit at Thüga successful in primary grid balancing

Thüga Group in Germany reports that the Power-to-Gas (P2G) plant purchased from UK-based ITM Power [*FCB*, October 2013, p8] is proving the suitability of P2G technology in the primary electric grid balancing market. The plant has successfully concluded two years of rigorous testing for primary grid balancing, demonstrating economic operation through the higher revenues accessible in this market.

In 2013, Thüga's P2G plant in Frankfurt am Main was the first in Germany to use electrolysis to convert electricity into hydrogen, and feed this into the gas distribution network [*FCB*, January 2014, p8]; this was also a novel use of a PEM electrolyser. Two months ago Thüga successfully subjected its P2G plant to the prequalification profile for primary balancing – the so-called 'duel bump test' – to see if it meets the necessary dynamic response requirements and accuracy. The plant was prequalified for *secondary* balancing last summer [September 2015, p8].

To take part in the primary balancing market, the entire load being offered must be reached within 30 s, and be continuously available for at least 15 min. The system was programmed and operated according to a load profile in 1 s resolution that reflects the frequency fluctuations in a real electricity distribution network. This operation simulated practical conditions, to compensate for frequency variations in the electrical grid.

A comprehensive stress test undertaken last year verified the system efficiency of over 70% (based on the higher heating value), exceeding the expectations of the 13 project partners in the Thüga Group. Moreover, the plant is compatible with smart grids. With the help of a newly

developed real-time control unit, working within a virtual network connecting other plants, the system intelligently modulated the differences between electricity generation and consumption. This capability is essential for the deployment of P2G technology in storing large amounts of energy.

In early 2015, ITM Power delivered the first of its second-generation P2G PEM electrolyser systems to RWE Deutschland in Germany [*FCB*, March 2015, p9], and it recently sold a 1 MW electrolyser system to ZEAG Energie in Baden-Württemberg [April 2016, p7]. ITM's PEM electrolyser technology is also utilised in hydrogen refueling stations, such as the one just ordered by Hydrogène de France [*see page 7*].

ITM Power, Sheffield, UK. Tel: +44 114 244 5111, www.itm-power.com

ITM Power GmbH, Frankfurt am Main, Germany. Tel: +49 6084 950012.

Thüga Group: www.thuega.de [in German]

COMMERCIALISATION

Arcola, IMS Ecubes partner to address grid stability, transport

UK-based Arcola Energy has created a new joint venture with Norwegian grid specialist IMS Ecubes, to develop whole-system energy and mobility solutions for market opportunities in Europe and South Asia.

The JV – to be based in Denmark – will offer an energy infrastructure with market opportunities for grid stability systems enabled by the shift to renewable power in countries like Denmark, and the requirement for clean power generation in developing economies such as Indonesia. The JV was launched at a meeting in Copenhagen with the Governor of South Sumatra province, who has committed to use only zero-emission vehicles for the 2018 Asian Games in Jakarta and the provincial capital Palembang.

IMS Ecubes has comprehensive knowledge and understanding of transmission system operations, with a special emphasis on electric grid balancing. Its know-how and competences allow it to develop and implement innovative services and business models for exploiting the flexibility offered by emerging technologies.

Arcola Energy works with a network of technology developers and mass-market manufacturers to develop and deliver integrated energy systems to support grid stability and enable hydrogen mobility. Last autumn it linked up with ITM Power and Symbio FCell to provide zero-emission commercial vehicles, fueling, and support for UK commercial fleet operators [*FCB*, November 2015, p7].

Denmark's EnergiNet framework for electricity and gas network management offers opportunities to work with energy network operators on developing robust grid balancing services at a system level [*FCB*, March 2016, p8]. This grid balancing requirement drives the business case for the hydrogen refueling infrastructure needed for zero-emission transport.

IMS Ecubes and Arcola will launch their latest fuel cell-based product, and present developments in the new joint venture, at the European Utility Week conference in Barcelona, Spain in November.

Arcola Energy, London, UK. Tel: +44 20 7503 1386, www.arcolaenergy.com

IMS Ecubes AS, Akland, Norway. Web: www.ecubes.eu

IMS Group: www.imsgroup.no

Nedstack collaborates with HySA Systems, AGET in South Africa

Cape Town-based HySA Systems has entered into a collaborative agreement with Nedstack BV in the Netherlands and a local small business, Africa Green Energy Technologies (AGET), to manufacture PEM fuel cell components and systems in South Africa.

HySA Systems – hosted by the South African Institute for Advanced Materials Chemistry, at the University of the Western Cape – will design and manufacture membrane-electrode assemblies (MEAs) as well as other components and systems. Nedstack will integrate the MEAs into its PEM fuel cells, which will be jointly integrated into final products for the African market. HySA Systems and Nedstack will collaborate closely with AGET to develop fuel cell market opportunities in South Africa and the broader African continent.

HySA Systems director Dr Cordellia Sita says that since its inception, the centre has generated sufficient intellectual capital and developed a number of prototypes which have been tested in the field by industry partners [*FCB*, December 2014, p5 and April 2016, p4]. The next step is to ensure that these products are commercialised. The collaboration with Nedstack, she says, provides the required momentum to establish a commercially viable fuel cell manufacturing industry that will enable HySA Systems to reach its mandated commercialisation goals.

Nedstack CEO Arnoud Van De Bree adds that this collaboration will create a profound basis for both local South African added value and Nedstack's expertise and activities in potentially the whole of Africa. It will also contribute to one of South Africa's main business segments, the platinum mining industry [*see In Brief, page 5*], through beneficiation, i.e. bringing greater economic benefit from further along the value chain.

The SA Department of Trade and Industry is working with the Hydrogen South Africa (HySA) programme to develop a fuel cell roadmap [*see the HySA features in FCB in June, October and November 2013*]. Earlier this year Isondo Precious Metals secured a licence from US-based Chemours Technology to manufacture, market and sell platinum-based PEM fuel cell components [March 2016, p10], and HyPlat was recently launched to manufacture high-quality components for the international hydrogen fuel cell industry [May 2016, p10].

HySA Systems, SAIAMC, University of the Western Cape, Cape Town, South Africa. Tel: +27 21 959 2158, www.hysasystems.com

Nedstack fuel cell technology BV, Arnhem, The Netherlands. Tel: +31 26 319 7600, www.nedstack.com

RESEARCH

DOE funding small businesses for clean energy innovation

The US Department of Energy has announced $23 million in funding for 23 new projects led by small businesses, to further develop clean energy technologies with strong potential for commercialisation and job creation. One of the successful projects focuses on manufacturing of polymer electrolyte membranes, another on hydrogen contamination detection, and another on a plasma-based fuel reformer.

These Small Business Innovation and Research (SBIR) Phase II awards, for $1 million each over the next two years, will help the selected companies advance their innovative concepts into prototype technologies.

Among the 23 projects selected for awards are:

- **Mainstream Engineering Corporation** (www.mainstream-engr.com) in Rockledge, Florida is developing a real-time, in-line, cross-polarised near-UV/Vis optical detector for the simultaneous determination of PEM thickness and defect detection. This quality control device will help drive down the costs of fuel cells by reducing waste and improving the efficiency of roll-to-roll manufacturing of fuel cell PEM and other specialised membranes. The company was awarded Phase I funding last year [*FCB*, June 2015, p11].
- **Sustainable Innovations LLC** (www.sustainableinnov.com) in East Hartford, Connecticut has teamed with the University of Connecticut to develop an innovative

multichannel hydrogen fuel quality monitor, to detect multiple impurities at low levels in hydrogen. Successful development of a low-cost hydrogen contaminant sensor is critically important in expanding markets for hydrogen used in industrial and fueling applications.

- **Advanced Cooling Technologies Inc** (www.1-act.com) in Lancaster, Pennsylvania will develop and demonstrate an efficient non-catalytic, plasma-based fuel reformer for converting natural gas to hydrogen-rich syngas. Partners include Drexel Plasma Institute, Air Products, the Gas Technology Institute, and FuelCell Energy.

DOE Fuel Cell Technologies Office:
http://energy.gov/eere/fuelcells/fuel-cell-technologies-office

DOE Office of Energy Efficiency and Renewable Energy, SBIR/STTR:
www.energy.gov/eere/sbir

Giantleap project aims to extend PEM fuel cell lifetime for buses

The new Giantleap project – funded by the European Fuel Cells and Hydrogen Joint Undertaking – aims to increase the availability and reduce the total cost of ownership of fuel cell electric buses, by increasing PEM fuel cell system lifetime and reliability.

Fuel cell buses have been deployed in several demonstrations in Europe [e.g. FCB, September 2013, p2, *and see page 3*], but they still suffer from high costs and low availability. The latter has almost always been due to control issues and hybridisation strategies, rather than problems in the fuel cells themselves.

The three-year Giantleap project will develop advanced online diagnostics of the fuel cells and balance-of-plant system components, coupled with prognostics methods to calculate system residual useful life, and advanced control algorithms able to exploit this information to maximise system life. The control system will also be engineered for robustness, to increase availability to the level of diesel buses or better.

A similar initiative, the recently completed Sapphire project, focused on micro combined heat and power (mCHP) stationary units; Giantleap will apply similar methods to a more challenging automotive application.

Giantleap includes the demonstration of a prototype in a relevant environment, allowing the project to reach Technology Readiness Level 6. The prototype will be a trailer-mounted, fuel cell-based range-extender intended for battery electric city buses. The ability to swap out the range-extender in the case of malfunctions greatly increases bus availability. The large battery capacity allows the bus to complete its route should malfunctions occur during use, and gives the control system ample opportunity to optimise fuel cell usage via hybridisation management strategies.

The €3.26 million (US$3.6 million) project is coordinated by SINTEF in Norway, which is also responsible for control synthesis and data management; the University of Split (FESB) in Croatia will cover diagnostics, laboratory tests, and fuel cell degradation; the Université de Franche-Comté in France is responsible for prognostics and dissemination (through its FCLAB Federation for Fuel Cell Research, with partners IFSSTAR and ENSMM); ElringKlinger in Germany will supply fuel cell stacks; Bosch Engineering in Germany will focus on fuel cell systems and exploitation of the project's results; and VDL Bus & Coach in the Netherlands will produce fuel cell range-extenders for city buses.

The FCH JU is supporting the market deployment of fuel cell buses in Europe, having contributed €61 million ($68 million) so far for projects deploying 67 buses in 12 locations: CHIC [*FCB*, September 2013, p2], HyTransit [*News Feature in March 2015*], High V.LO-City [February 2014, p3], and 3Emotion [February 2015, p1].

Giantleap project: www.giantleap.eu

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

DOE 2016 Hydrogen and Fuel Cells Annual Merit Review papers

The US Department of Energy's Annual Merit Review and Peer Evaluation Meeting (AMR) was held in Washington, DC in early June. The full proceedings are now available.

Former Senator Byron L. Dorgan and the Acting Assistant Secretary for the Office of Energy Efficiency and Renewable Energy (EERE) David Friedman delivered remarks on the opening day, followed by presentations by the Fuel Cell Technologies Office and Vehicle Technologies Office. More than 1880 people registered, representing 19 countries; some 125 presentations were reviewed by 160 experts, with a total of 800 expert reviews being provided. Annual Merit Awards were also presented.

The **2017 AMR** will take place **5–9 June 2017** in Washington, DC.

2016 AMR Proceedings:
http://tinyurl.com/doe-amr2016

Video recordings from plenary session:
http://tinyurl.com/doe-amr2016-video

IN BRIEF

Hyundai, Air Liquide to push FCEV and hydrogen station rollout in Korea, Europe

The French-based industrial gases giant Air Liquide has signed a memorandum of understanding with Korean automaker Hyundai, to collaborate on accelerating the deployment of hydrogen infrastructure and fuel cell electric vehicles in both Korea and Europe. The partnership was announced when South Korean President Park Geun-hye recently visited Air Liquide's new energy and advanced technologies facility in Grenoble.

In Korea, in line with the national Green Car Roadmap ambitions, Hyundai and Air Liquide will collaborate on the faster deployment of hydrogen stations, to enable the successful rollout of Hyundai FCEVs. In Europe, the companies intend to further develop FCEV fleet projects such as taxis or municipal fleets. In France last autumn, Air Liquide installed the first hydrogen station in central Paris [*FCB*, January 2016, p7], ahead of the 2015 UN Climate Change Conference (COP21), to serve the initial five Hyundai ix35 Fuel Cell cars in the 'Hype' taxi fleet [January 2016, p2]. The objective is to increase this taxi fleet to 70 vehicles.

A small fleet of Hyundai ix35 Fuel Cell cars were recently driven on a road trip challenge across Europe, which also highlighted the growing European hydrogen infrastructure [*see the News Feature on pages 12–13*]. For its part, Air Liquide has just installed a hydrogen station to refuel fuel cell powered forklifts at the first all-hydrogen logistics platform in Europe [*see page 8*].

New FCHEA guides showcase breadth of fuel cell and hydrogen energy industry

The Fuel Cell and Hydrogen Energy Association (www.fchea.org) in Washington, DC has released two new resources that confirm the impact these technologies are making on today's energy landscape. FCHEA members include fuel cell manufacturers, fuel providers, automakers, component suppliers, national labs and other organisations in the US, Canada, UK, France, Germany, Sweden, South Africa, and Japan.

The *FCHEA Member Product Guide 2016* highlights the range of commercially available products, covering the entire fuel cell and hydrogen supply chain – from components to complete fuel cell systems and fuel cell electric vehicles, as well as the necessary hydrogen generation, delivery and storage technologies. The guide also features other services provided by members, including lab space, R&D, testing, certification, and engineering.

The *FCHEA Members and Media Contacts 2016* guide provides a detailed overview of association members, including media contact information for each organisation.

PDF downloads: www.fchea.org/media-kit

Hyundai ix35 Fuel Cell cars driven from Bergen to Bolzano

A small fleet of Hyundai ix35 Fuel Cell cars were recently driven on a road trip challenge across Europe, travelling from Bergen in Norway across Denmark, Germany, and Austria to finally arrive in Bolzano, Italy. The cars demonstrated their endurance and practicality on the 2300 km (1430 mile) journey, which also highlighted the growing European hydrogen infrastructure.

Technology milestones

Hyundai Motor Europe recently sent a number of ix35 Fuel Cell cars on a pan-European road trip. In five days (12–16 June) participants travelled from Bergen on the western coast of Norway across Denmark, Germany, and Austria across the Alps to finally arrive in Bolzano, in northern Italy.

Nine of the Korean automaker's ix35 Fuel Cell SUVs started the journey in Norway, with more vehicles joining along the way, reaching a total of 15 FCEVs by the time the fleet reached its Italian destination. Two conventional vehicles travelled with the fleet to support the logistical effort. The FCEVs refueled with hydrogen at stations in Porsgrunn (Norway), Aarhus (Denmark), Hamburg, Düsseldorf, Geiselwind and Munich (Germany), Innsbruck (Austria), and Bolzano (Italy).

European infrastructure

The road trip also served to demonstrate the growing hydrogen infrastructure across Europe, and promote its further development. Bergen, where the trip started, will shortly open a new hydrogen refueling station, connecting the Oslo region with the Norwegian south and west coast [FCB, June 2016, p8]. And Denmark is the first European country with a nationwide hydrogen refueling network, with nine hydrogen stations already in service [April 2016, p7, *and see page 7 in this issue*].

Germany is also on track to install a nationwide network of hydrogen refueling stations over the next few years, as the H_2 Mobility Deutschland joint venture aims to roll out up to 400 hydrogen stations across Germany by 2023 [FCB, October 2013, p6, *and see page 7*]. Hamburg, Düsseldorf, and Munich are already equipped with stations, and therefore served as refueling stops along the way. An additional hydrogen station is currently under construction at Hyundai Motor's European headquarters in Offenbach, near Frankfurt am Main.

Linde supports Hyundai

In Munich the tour was joined and co-hosted by hydrogen technology company The Linde Group. Its new subsidiary, Linde Hydrogen Concepts, is about to offer the world's first car-sharing service to exclusively use hydrogen fuel cell cars, under the BeeZero brand [FCB, April 2016, p1]. Linde took delivery of the 50 ix35 Fuel Cell cars for BeeZero just a few days before the road trip began, with the vehicles now available to car-sharing customers in several Munich districts.

Linde is a leading supplier of hydrogen refueling solutions [*see the Linde feature in FCB, September 2014*], and has built or equipped many of the hydrogen stations along the route of this pan-European road trip. Last summer it inaugurated a hydrogen station in Innsbruck, on a key transit route across the Alps from Germany to Italy [June 2015, p9]. Linde expects to gain valuable information from day-to-day fleet operations, which it will use to further develop its hydrogen technologies and help expand the hydrogen infrastructure.

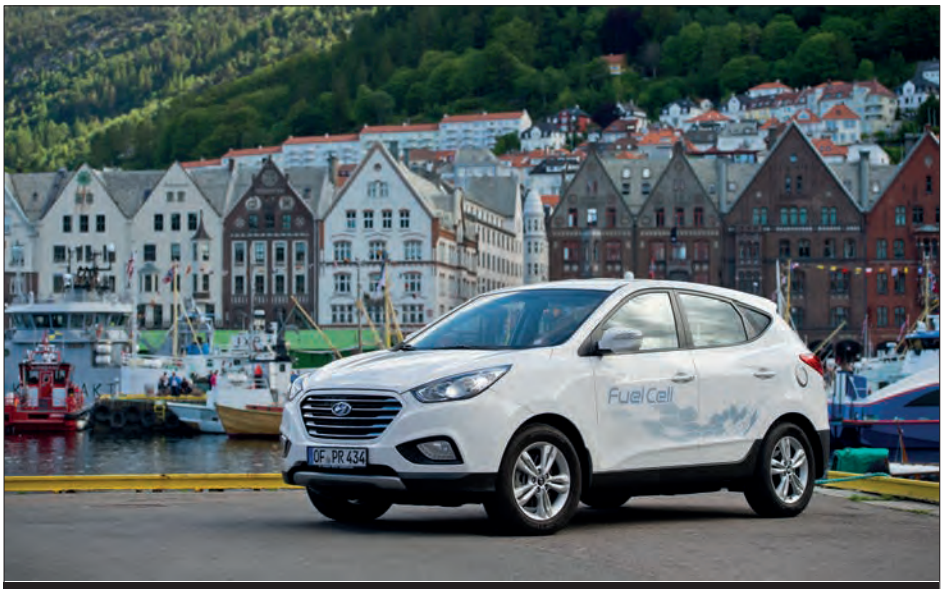
The wider community

On 16 June the convoy arrived in Innsbruck, Austria for the opening of the Green Energy Center. This project office and information centre is working towards a more sustainable future, by exploring and developing electric and hydrogen powered mobility based on the philosophies of global and regional companies.

At the final tour stop in Bolzano, participants visited the Institute for Innovative Technologies. The institute runs the first Italian fleet of Hyundai ix35 Fuel Cell cars, and since 2014 has been renting 10 of the vehicles to the people of Bolzano [FCB, April 2014, p1].

Connected journey

During the road trip, the safety of the people on board the FCEVs was ensured by Hyundai's new Remote Diagnostics Function, which permitted remote tracking of all cars during the tour [*see box on page 13*]. The Remote Diagnostics Function records distance, speed and hydrogen used, and is therefore able to send drivers helpful notifications in real time. It can also gain



The fleet of Hyundai ix35 Fuel Cell cars set off from Bergen – the second-largest city in Norway, on its rugged west coast – on a 2300 km road trip across Europe.

valuable information and insights that will be used to promote the further development of hydrogen technology and infrastructure worldwide, and making a substantial contribution to ongoing innovation in fuel cell technology.

To coordinate refueling, drivers on this trip were using Hyundai's new Fuel Cell mobile app, which has just been launched for iOS and Android [*see box*]. This is the first app to include live information on the availability of all hydrogen refueling stations across Europe.

In order to capture the journey from Bergen to Bolzano and make the impressions accessible across Europe, Hyundai Motor partnered with the German creative agency INSCALE, which developed an exclusive Fuel Cell 360 augmented reality app. Users of the app could follow the trip through location-based, three-dimensional, 360° video content produced with the camera technology of partner GoPro.

The fleet of Hyundai ix35 Fuel Cell SUVs set off from Bergen in Norway, refueling in Porsgrunn en route to Larvik, where the cars boarded the ferry for the crossing to Hirtshals in northern Denmark. (The 'HY' prefix on Norwegian vehicle plates denotes hydrogen-powered vehicles.)

Alternative powertrains

The Hyundai ix35 Fuel Cell – known as the Tucson Fuel Cell in South Korea and North America – has been commercially available since 2013 [FCB, March 2013, p2]. There are now some 300 Hyundai ix35 Fuel Cell cars on European roads [January 2016, p2], with the model now available to buy or lease in 13 European countries [December 2015, p11].

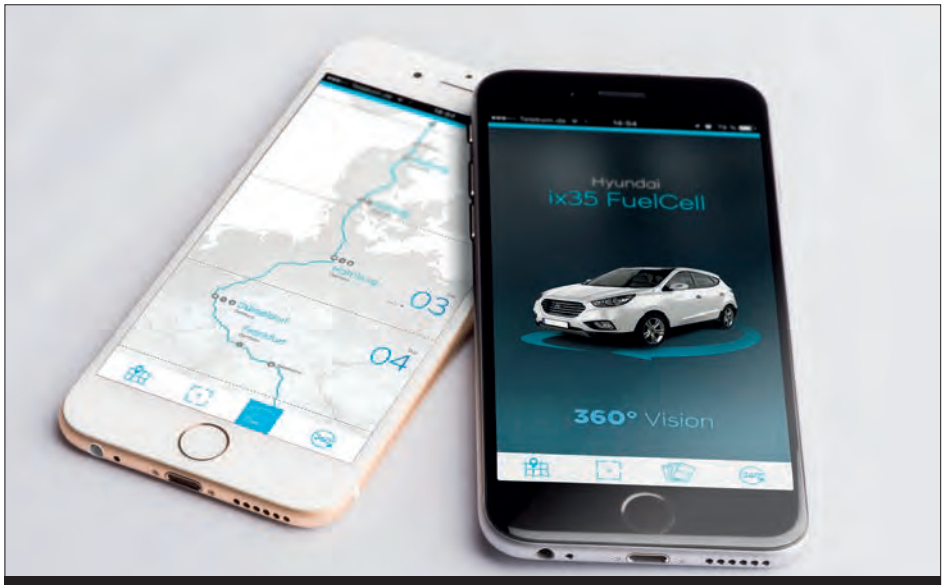
The ix35 Fuel Cell is being thoroughly tested on European roads. Last summer one of the vehicles was driven for 2383 km (1481 miles) in 24 hours on public roads in Germany, only stopping to refuel [FCB, September 2015, p2], and earlier this year another vehicle completed nearly 52 clockwise laps of the M25 London orbital motorway in five days and five nights of continuous driving, only pausing to refuel and swap drivers [March 2016, p1].

More information

Hyundai Motor Europe: www.hyundai-europe.com

Hyundai ix35 Fuel Cell: www.fuelcell.eu or www.hyundaiusa.com/tucsonfuelcell

Road trip videos: www.hyundai.news/eu/brand/video-diary-relive-hyundais-epic-fuel-cell-european-adventure



The Hyundai Fuel Cell App – inaugurated on the road trip from Bergen to Bolzano – shows ix35 Fuel Cell owners (and drivers of any other FCEV) the route to all hydrogen refueling stations across Europe, including live information on station availability.

Hyundai's hydrogen mobility app, and Remote Diagnostics Function for vehicles

Hyundai is taking the next step to advance hydrogen mobility, by releasing its new Hyundai Fuel Cell app, as well as a new Remote Diagnostics system. Both features were inaugurated on the recent European road trip from Bergen to Bolzano.

The Hyundai Fuel Cell app (available for iOS and Android devices) is the first of its kind. It shows ix35 Fuel Cell owners – and drivers of any other FCEV – the route to all hydrogen refueling stations across Europe, including live information on station availability. Also included are all European Hyundai-certified fuel cell car dealerships, and navigation via Google Maps. Users also have access to information about the Hyundai ix35 Fuel Cell car.

Hyundai's digital approach to promoting hydrogen technology and infrastructure further includes the new Remote Diagnostics Function. This feature – implemented in the ix35 Fuel Cell car – records distance, speed, and how much hydrogen has been used. This means it can send drivers helpful notifications in real time, and collect valuable information and insights to enhance the further development of hydrogen technology and infrastructure.

INSPIRE consortium validates automotive fuel cell stacks

The new EU-funded INSPIRE programme aims to validate the next generation of automotive PEM fuel cell stack technology, and thereby accelerate the commercialisation of high-performance fuel cell electric vehicles.

FCH JU project support

The three-year INSPIRE project, which began on 1 May, will develop higher-performance, longer-lifetime membrane-electrode assemblies (MEAs) for integration into new, high power output, fuel cell stack technology. The consortium, which is funded by a €6.9 million (US$7.6 million) grant from the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), is being coordinated by UK-based Johnson Matthey.

Inspiring collaboration

Johnson Matthey will work in close collaboration with its industrial and academic partners to bring forward materials and components that already show considerable promise in current FCH JU projects, integrate them for enhanced performance, and demonstrate their capability for volume manufacturing.

German fuel cell component developer SGL Carbon will work on the carbon-fibre gas diffusion layer (GDL) part of the MEA, while compatriot REINZ-Dichtungs-GmbH (a subsidiary of US-based Dana Holding Corporation) will develop an optimised metallic bipolar plate design that delivers the hydrogen and air to the MEA, and transmits the electricity generated to power the vehicle. BMW Group will set out the stack requirements, and assemble the MEAs and bipolar plates into new stack designs to achieve the cost, durability, and volumetric power density targets required for mass market exploitation.

Critical components

Johnson Matthey is a major global supplier of platinum-based catalyst layers, catalysed membranes, and fully integrated MEAs. In addition to the component developers, the project will involve partners working on next-generation catalysts, electrodes, and membranes from the Centre National de la Recherche Scientifique (CNRS) Montpellier in France, VTT Technical Research Centre of Finland, Technical University of Munich, Technical University of Berlin, and University of Freiburg in Germany. Project management support will be provided by French-based Pretexo.

Competitiveness boost

The three-year project kicked off with representatives from the partners and FCH JU gathering in early May at the Johnson Matthey Technology Centre, near Reading, to launch the project and develop detailed plans for its first phase. As well as realising the potential of advanced stack materials and components and validating them in the next generation of automotive fuel cell stacks, the project will consolidate a European supply chain for these critical stack components, and increase the competitiveness of the European fuel cell industry on the world stage.

'Fuel cell powered vehicles are anticipated to be a major application for MEA technology from the mid-2020s and beyond that will meet a growing consumer demand for full performance capable driving with zero tail-pipe emissions,' says Dr Jane Butcher, managing director of Johnson Matthey's Fuel Cells business.

'Projects like INSPIRE are essential to put European car OEMs in the starting blocks for the deployment of the next generation of fuel cell vehicles,' adds Bart Biebuyck, FCH JU executive director [FCB, June 2016, p5]. 'INSPIRE demonstrates that European labs have delivered mature and high-quality research solutions on hydrogen technologies, and these are now being transferred to the car industry in the manufacturing lines. This is a good signal for the decarbonisation of transport, for the economy in Europe, and for the job creations in our industries.'

Challenging objectives

The project objective is to develop and integrate the most advanced critical PEMFC stack components, many from recent FCH JU programmes, into an automotive stack showing beginning-of-life (BOL) performance of 1.5 W/cm2 at 0.6 V, <10% power degradation after 6000 h, with a technical and economic assessment showing a cost of less than €50/kW ($55/kW) on a production scale of 50 000 units per annum.

This will be achieved by industrial and academic partners with expertise in the design and manufacture of PEMFC stacks, components, and materials. The partners will select and build on components which can achieve key target metrics, e.g. catalyst materials showing mass activities of 0.44 A/mg Pt. There will be a focus on integration of the key components and optimisation of the interfaces regarding the electrochemistry, mass and heat transport, and mechanical interactions.

Several iterations of an advanced stack design will be evaluated. Work is organised to optimise the flow of development, which begins with catalysts being advanced and down-selected, scaled then fed into the design and development of catalyst layers, integration with membranes, and the demonstration of catalyst-coated membrane (CCM) performance. The CCMs feed into stack component development, where they will be integrated with GDLs to form MEAs, and bipolar plates will be designed and supplied with the MEAs for iterative stack design, assembly, and testing.

Performance and durability will be evaluated from small single cell to stack level using standardised test protocols. Degradation is addressed by stability testing, structural visualisation, and modelling. Interfaces and specification alignment are an important focus, integrated with the evaluation of new architectures and synthesis methods and informing balance-of-plant (BOP) component specifications. Dismantling and recycling for the recovery and reuse of all critical MEA components will be included in the costing evaluation.

FCH JU driving Europe

The Fuel Cells and Hydrogen Joint Undertaking is a unique public–private partnership to support research, technological development, and demonstration (RTD) activities in fuel cell and hydrogen energy technologies in Europe. Its three members are the European Commission, the fuel cell and hydrogen industries represented by

Hydrogen Europe, and the research community represented by Research Grouping N.ERGHY.

More information

Johnson Matthey: www.matthey.com
Johnson Matthey Fuel Cells: www.jmfuelcells.com
BMW Group: www.bmw.com
Dana Holding Corporation: www.dana.com
REINZ-Dichtungs-GmbH: www.reinz.com
SGL Carbon GmbH: www.sglgroup.com
CNRS Montpellier (Aggregates, Interfaces and Materials for Energy Team): www.aime.icgm.fr
Technical University of Munich (Electrochemical Research Group): www.ecrg.tum.de
Technical University of Berlin: www.tu-berlin.de
University of Freiburg, IMTEK (Department of Microsystems Engineering): www.imtek.de/en
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Pretexo: www.pretexo.com
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Research Trends

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Patents

Automotive SOFC module with thermally self-sustaining operation, faster and more stable startup

Assignee: **Honda Motor Co, Japan**
Inventor: T. Ogawa
Patent number: US 9318755
Published: 19 Apr. 2016 (Filed: 9 Feb. 2012)

Automotive SOFC module with reduced heat loss from combustor, smaller size and lower cost

Assignee: **Honda Motor Co, Japan**
Inventors: T. Ogawa et al.
Patent number: US 9318756
Published: 19 Apr. 2016 (Filed: 9 Feb. 2012)

Hydrogen supply unit for PEMFC power system on board an aircraft, and monitoring method

Assignee: **Airbus Deutschland, Germany**
Inventors: M. Koenig et al.
Patent number: US 9318757
Published: 19 Apr. 2016 (Filed: 14 Dec. 2007)

Automotive SOFC stack with temperature-adapted compression of different sections, and suppressed heat radiation

Assignee: **Honda Motor Co, Japan**
Inventors: M. Shinohara et al.
Patent number: US 9318758
Published: 19 Apr. 2016 (Filed: 26 June 2012)

Control of (PEMFC) MEA to avoid local membrane humidity cycling even when power demand is cycled

Assignee: **Audi AG, Germany**
Inventors: J. O'Neill et al. [UTC Power, USA]
Patent number: US 9318759
Published: 19 Apr. 2016 (Filed: 9 Dec. 2011)

Adjusting reactant gas humidity in automotive PEMFC, to minimise voltage differences between cells

Assignee: **Honda Motor Co, Japan**
Inventors: J. Uehara et al.
Patent number: US 9318760
Published: 19 Apr. 2016 (Filed: 27 Aug. 2013)

Cogeneration system comprising SOFC/reformer with ammonia absorption chiller to cool exhaust gas, water condensed from exhaust

Assignee: **Panasonic, Japan**
Inventor: S. Kobayashi
Patent number: US 9318761
Published: 19 Apr. 2016 (Filed: 5 Sep. 2012)

Conducting polymer-transition metal nanocatalyst compositions for PEM or DMFCs

Assignee: **Nanotek Instruments, USA**
Inventors: B.Z. Jang et al.
Patent number: US 9318762
Published: 19 Apr. 2016 (Filed: 12 Feb. 2007)

Ceramic porous substrate with controlled voids, reinforced composite electrolyte membrane, use in HT-PEM or DMFC MEA

Assignee: **Korea Research Institute of Chemical Technology, Korea**
Inventors: Y.T. Hong et al.
Patent number: US 9318763
Published: 19 Apr. 2016 (Filed: 26 June 2009)

Composite PEM made using resin with bis(perfluoroalkanesulfonyl) methide group, for superior proton conductivity without fuel crossover

Assignee: **Central Glass Company, Japan**
Inventors: T. Tanaka et al.
Patent number: US 9318764
Published: 19 Apr. 2016 (Filed: 13 Apr. 2012)

SOFC membrane with high OCV, has metal oxide such as $NaCo_2O_4$, high hydroxide ion conductivity

Assignees: **Santoku Corporation, Japan and Hokkaido University, Japan**
Inventors: M. Matsuda et al.
Patent number: US 9318765
Published: 19 Apr. 2016 (Filed: 1 Mar. 2011)

High-power IT-SOFC has CeCsSZ electrolyte, LSM-CeScSZ cathode

Assignee: **Korea Institute of Industrial Technology, Korea**
Inventors: H.S. Kim et al.
Patent number: US 9318766
Published: 19 Apr. 2016 (Filed: 20 Nov. 2012)

Laminate assembly pressurisation for fuel cell or electrolyser stack with improved sealing

Assignee: **Hamilton Sundstrand Space Systems International, USA**
Inventors: R.G. Barnett et al.
Patent number: US 9318767
Published: 19 Apr. 2016 (Filed: 2 Aug. 2013)

Two-layer PEMFC reaction coating with high moisture retention layer on electrolyte membrane, layer on GDL has high water discharge

Assignee: **Equos Research, Japan**
Inventors: M. Ohtsuka et al.
Patent number: US 9325015
Published: 26 Apr. 2016 (Filed: 29 June 2010)

Porous electrode substrate and production process, substrate precursor sheet, for PEMFC MEA

Assignee: **Mitsubishi Rayon Co Ltd, Japan**
Inventors: K. Sumioka et al.
Patent number: US 9325016
Published: 26 Apr. 2016 (Filed: 26 Oct. 2011)

Method to control ionomer and Pt distribution in PEMFC electrode

Assignee: **General Motors, USA**
Inventor: M.M. Fay
Patent number: US 9325017
Published: 26 Apr. 2016 (Filed: 28 July 2009)

Automotive PEMFC system operation, increasing efficiency by reducing stack power consumption if specific cell performance drops

Assignee: **Hyundai Motor Company, Korea**
Inventor: I.J. Son
Patent number: US 9325020
Published: 26 Apr. 2016 (Filed: 31 May 2013)

PEMFC GDL with scale-like, electrically conductive graphite in MPL, which improves electrical conductivity and gas permeability

Assignee: **Nissan Motor Co, Japan**
Inventors: Y. Okuyama et al.
Patent number: US 9325022
Published: 26 Apr. 2016 (Filed: 31 May 2012)

Hydrophilic solvent for lower PEM glass transition temperature, avoids membrane deterioration associated with conventional PEMFC MEAs

Assignee: **Korea Research Institute of Chemical Technology, Korea**
Inventors: Y.T. Hong et al.
Patent number: US 9325023
Published: 26 Apr. 2016 (Filed: 29 Mar. 2012)

Polyoxazole-based electrolyte membranes, for long-lifetime MEAs and HT-PEMFCs (180°C)

Assignee: **BASF, Germany**
Inventors: O. Gronwald et al.
Patent number: US 9325025
Published: 26 Apr. 2016 (Filed: 11 Apr. 2012)

Co(II)tetramethoxyphenylporphyrin additive to PFSA PEMs for improved fuel cell durability

Assignee: **General Motors, USA**
Inventors: M.R. Schoeneweiss et al.
Patent number: US 9325026
Published: 26 Apr. 2016 (Filed: 28 Mar. 2013)

Preparing fluorinated ion-exchange ionomer composite with excellent mechanical properties and gas impermeability, PEM and DMFCs

Assignee: **Shandong Huazia Shenzhou New Material Co Ltd, China**
Inventors: Y. Zhang et al.
Patent number: US 9325027
Published: 26 Apr. 2016 (Filed: 19 Mar. 2015)

Method and Pt-Pd/Cu-Mn catalyst system for removing CO, H_2 and CH_4 from anode waste gas in methane-fueled MCFC

Assignee: **Clariant Corporation, USA**
Inventors: G. Cullen et al.

Patent number: US 9327238
Published: 3 May 2016 (Filed: 16 Nov. 2011)

Catalytic ink preparation for PEMFC electrode catalyst with most of catalyst surface covered with two ionomer layers

Assignee: **Nissan Motor Co, Japan**
Inventors: K. Toyoshima et al.
Patent number: US 9331340
Published: 3 May 2016 (Filed: 14 Aug. 2012)

Durable Pt/MWNT catalysts functionalised with citric acid, and synthesis, for PEM and DMFCs

Assignee: **Arizona State University, USA**
Inventors: A. Kannan et al.
Patent number: US 9331341
Published: 3 May 2016 (Filed: 17 Mar. 2011)

Hydrogen/bromine (tribromide) regenerative fuel cell system, high operational stability in harsh (e.g. acid or halogen ion) environments

Assignee: **Ramot at Tel-Aviv University Ltd, Israel**
Inventors: E. Peled et al.
Patent number: US 9331342
Published: 3 May 2016 (Filed: 24 Jan. 2011)

PEMFC separator has surface-modified stainless steel sheet matrix with Cr-rich passive film for corrosion resistance and durability

Assignee: **Hyundai Steel Company, Korea**
Inventors: Y.T. Jeon et al.
Patent number: US 9331343
Published: 3 May 2016 (Filed: 30 Apr. 2015)

Automotive PEMFC stack in which cathode flow-field has wavy flow grooves, improves water discharge

Assignee: **Honda Motor Co, Japan**
Inventors: Y. Asano et al.
Patent number: US 9331344
Published: 3 May 2016 (Filed: 11 Nov. 2014)

Suppressing bubble formation in sheet-member bonding process for PEMFC MEA gasket assembly

Assignee: **Nissan Motor Co, Japan**
Inventors: M. Yamamoto et al.
Patent number: US 9331345
Published: 3 May 2016 (Filed: 24 June 2013)

Resin frame equipped MEA for PEMFC, with improved adhesion of resin frame member to PEM

Assignee: **Honda Motor Co, Japan**
Inventors: Y. Tanaka et al.
Patent number: US 9331346
Published: 3 May 2016 (Filed: 9 Jan. 2013)

Control of automotive PEMFC system, for quick transitions to idling stop and reduced membrane degradation and cell voltage drop

Assignee: **Honda Motor Co, Japan**
Inventors: Y. Matsumoto et al.
Patent number: US 9331347
Published: 3 May 2016 (Filed: 18 Apr. 2012)

Control of ATR and steam reforming steps in SOFC reformer system, to suppress thermal runaway and extend service life

Assignee: **Toto Ltd, Japan**
Inventors: Y. Akagi et al.
Patent number: US 9331348
Published: 3 May 2016 (Filed: 17 July 2013)

Recovery of 'waste' heat from automotive PEMFC system, for vehicle interior heating or cooling

Assignee: **Honda Motor Co, Japan**
Inventors: K. Yamazaki et al.
Patent number: US 9331349
Published: 3 May 2016 (Filed: 27 May 2014)

SOFC fuel supply control during steam reforming, smooth transition from startup to power generation

Assignee: **Toto Ltd, Japan**
Inventors: K. Tsuchiya et al.
Patent number: US 9331351
Published: 3 May 2016 (Filed: 27 May 2010)

Sulfonated perfluorocyclopentenyl polymers, for significantly better PEMFC performance and lifetime

Assignee: **University of Texas System, USA [UT Dallas]**
Inventors: D.W. Smith et al.
Patent number: US 9331352
Published: 3 May 2016 (Filed: 20 July 2013)

Composite membrane has porous polyimide with interconnected macropores impregnated with proton-conducting ionic liquid, for HT-PEMFC (140°C)

Assignees: **Université de Rouen, France, Institut Polytechnique de Grenoble, France and CNRS, France**
Inventors: C. Chappey et al.
Patent number: US 9331353
Published: 3 May 2016 (Filed: 29 Nov. 2011)

PEM prepared from liquid composition comprising (tri- and/or tetravalent) Ce and/or (bi- and/or trivalent) Mn, use in PEMFC MEA

Assignee: **Asahi Glass Company, Japan**
Inventors: H. Kawazoe et al.
Patent number: US 9331354
Published: 3 May 2016 (Filed: 23 July 2013)

SOFC electrolyte sheet with less rough peripheral region, superior sealing, less damage in fabrication

Assignee: **Nippon Shokubai Co, Japan**
Inventor: K. Hata
Patent number: US 9331355
Published: 3 May 2016 (Filed: 29 Mar. 2011)

Metal-foam electrodes comprising non-reticulated, conductive metal foam, for increased power density in PEM or DMFCs, or batteries

Assignee: **HRL Laboratories, USA**
Inventors: A.F. Gross et al.
Patent number: US 9337493
Published: 10 May 2016 (Filed: 15 June 2014)

Ionic layer with oxygen evolution reaction catalyst containing IrO_2, to avoid PEMFC electrode corrosion

Assignee: **General Motors, USA**
Inventors: J. Zhang et al.
Patent number: US 9337494
Published: 10 May 2016 (Filed: 12 Jan. 2009)

Corrosion-resistant stainless steel PEMFC separator with coating of metal nitride, carbide or boride, or metal/metal nitride [two patents]

Assignee: **Hyundai Steel Company, Korea**
Inventors: Y.T. Jeon et al.
Patent numbers: US 9337495 and 9337496
Published: 10 May 2016
(Filed: 28 Aug. 2014 and 30 Apr. 2015)

Forming ceramic layer structure between Cr alloy interconnect and cathode in SOFC, to protect from corrosion and Cr vaporisation

Assignees: **Plansee, Austria and Fraunhofer-Gesellschaft, Germany [Fraunhofer IKTS]**
Inventors: M. Brandner et al.
Patent number: US 9337497
Published: 10 May 2016 (Filed: 14 Feb. 2012)

Automotive PEMFC stack with reactant gas manifolds to ensure uniform supply to channel surface

Assignee: **Honda Motor Co, Japan**
Inventors: M. Suzuki et al.
Patent number: US 9337498
Published: 10 May 2016 (Filed: 6 Dec. 2013)

PEMFC with improved thermal management to minimise heat imbalance between stacks, with coolant circuit thermostatic valves

Assignee: **CEA, France**
Inventors: D. Drouhault et al.
Patent number: US 9337500
Published: 10 May 2016 (Filed: 24 May 2012)

Control method for subzero startup of automotive PEMFC system, maintaining long-term durability

Assignee: **Toyota Motor Corporation, Japan**
Inventors: H. Tanaka et al.
Patent number: US 9337502
Published: 10 May 2016 (Filed: 22 June 2009)

System and method for managing

power flow in automotive PEMFC system, by offset estimation

Assignee: **General Motors, USA**
Inventors: J. Lenz et al.
Patent number: US 9337503
Published: 10 May 2016 (Filed: 11 Mar. 2013)

PEMFC status detection method, by monitoring cell voltage and current density of group of cells

Assignee: **Toyota Motor Corporation, Japan**
Inventor: Y. Araki
Patent number: US 9337504
Published: 10 May 2016 (Filed: 19 Aug. 2009)

Automotive SOFC module with combustion gas holes in partition plate, for improved heat efficiency, thermally self-sustaining operation

Assignee: **Honda Motor Co, Japan**
Inventors: T. Ogawa et al.
Patent number: US 9337506
Published: 10 May 2016 (Filed: 19 Dec. 2012)

Shared electrode hybrid NiMH battery-alkaline fuel cell system with solid-state hydrogen storage, for reliable energy storage

Assignee: **Ovonic Battery Company, USA**
Inventors: K.-H. Young et al.
Patent number: US 9343735
Published: 17 May 2016 (Filed: 14 Apr. 2014)

Multilayer IT-SOFC has electrolyte comprising ceria and bismuth oxide layers, cathodic TPB layer

Assignee: **University of Florida, USA**
Inventors: E.D. Wachsman et al.
Patent number: US 9343746
Published: 17 May 2016 (Filed: 14 Oct. 2009)

Electrocatalyst for PEM or DMFC, comprising Pt or Pt alloy particles highly dispersed on large surface area support, for larger active region

Assignee: **LG Chem Ltd, Korea**
Inventors: M.S. Kim et al.
Patent number: US 9343747
Published: 17 May 2016 (Filed: 13 Dec. 2013)

Bulk metallic glass nanowires (e.g. $Pt_{58}Cu_{15}Ni_5P_{22}$) for new class of high-performance nanowire catalysts for e.g. PEM or DMFCs

Assignee: **Yale University, USA**
Inventors: A.D. Taylor et al.
Patent number: US 9343748
Published: 17 May 2016 (Filed: 8 Aug. 2011)

Two-stage atomic layer deposition of ultrathin Pt films (1–10 atoms thick) on partially coated substrate for PEMFC electrodes

Assignee: **Ford, USA**
Inventors: P. Pietrasz et al.
Patent number: US 9343749
Published: 17 May 2016 (Filed: 29 May 2013)

PEM or DMFC electrode support comprising transition metal oxide coating layer covalently bonded with carbonaceous material

Assignee: **Samsung SDI, Korea**
Inventors: S.-C. Lee et al.
Patent number: US 9343750
Published: 17 May 2016 (Filed: 15 Oct. 2012)

High-performance porous electrode substrate for PEMFC, 3D entangled structure with short carbon fibres joined via mesh-like carbon fibres

Assignee: **Mitsubishi Rayon Co, Japan**
Inventors: K. Sumioka et al.
Patent number: US 9343751
Published: 17 May 2016 (Filed: 22 Nov. 2010)

Automotive PEMFC stack with separator back-support formed in insulator, avoiding need for special separator next to insulator

Assignee: **Honda Motor Co, Japan**
Inventors: E. Terada et al.
Patent number: US 9343752
Published: 17 May 2016 (Filed: 19 Feb. 2014)

Multilayer monolithic Fuel Cell Stick™, with sintered nanopowder on SOFC electrolyte to increase electrode surface area

Applicants/Inventors: **A. Devoe and L. Devoe, USA [Violet Fuel Cell Sticks]**
Patent number: US 9343753
Published: 17 May 2016 (Filed: 23 Feb. 2015)

High-pressure gas supply for stable automotive PEMFC operation from beginning of subzero startup

Assignee: **Toyota Motor Corporation, Japan**
Inventor: S. Inagi
Patent number: US 9343754
Published: 17 May 2016 (Filed: 23 Feb. 2011)

Cooling pressurised charge air for automotive PEMFC, and integrated three-fluid charge air cooler

Assignee: **Dana Canada Corp, Canada**
Inventors: D. Vanderwees et al.
Patent number: US 9343755
Published: 17 May 2016 (Filed: 26 Feb. 2013)

PEMFC separator to maintain high reactant gas utilisation and control water production under dynamic operation, and reactant gas control

Assignee: **Doosan Corporation, Korea**
Inventors: S.-J. Oh et al.
Patent number: US 9343756
Published: 17 May 2016 (Filed: 23 May 2007)

SOFC system hot zone with centre cathode air feed tube for improved reactant distribution, counter-flow heat-exchanger for heat retention

Assignee: **Protonex Technology Corp, USA**
Inventors: J.C. Poshusta et al.
Patent number: US 9343758
Published: 17 May 2016 (Filed: 19 Nov. 2013)

Improved automotive PEMFC system startup, by reducing pressure difference above/below shutoff valve in air supply

Assignee: **Toyota Motor Corporation, Japan**
Inventors: T. Yamanaka et al.
Patent number: US 9343759
Published: 17 May 2016 (Filed: 14 Oct. 2011)

Procedure to recondition PEMFC to recover stack voltage loss, operating stack in wet condition to provide water at cell electrodes

Assignee: **General Motors, USA**
Inventors: G.M. Robb et al.
Patent number: US 9343760
Published: 17 May 2016 (Filed: 16 Nov. 2012)

PEMFC with metal porous body as gas passage layer, supplies enough fuel or oxidant to electrode regardless of degree of clogging

Assignee: **Toyota Motor Corporation, Japan**
Inventor: K. Sato
Patent number: US 9343761
Published: 17 May 2016 (Filed: 5 Dec. 2011)

Controller for estimating RH and condensed water in automotive PEMFC, and method to control condensed water drain

Assignees: **Hyundai Motor Company, Korea and Kia Motors Corporation, Korea**
Inventors: S.I. Jeon et al.
Patent number: US 9343762
Published: 17 May 2016 (Filed: 6 June 2011)

Integration of MCFCs with processes for synthesis of nitrogen compounds, e.g. providing hydrogen for ammonia production

Assignee: **ExxonMobil Research and Engineering Company, USA**
Inventors: P.J. Berlowitz et al.
Patent number: US 9343763
Published: 17 May 2016 (Filed: 13 Mar. 2014)

Integration of MCFCs in methanol synthesis

Assignee: **ExxonMobil Research and Engineering Company, USA**
Inventors: P.J. Berlowitz et al.
Patent number: US 9343764
Published: 17 May 2016 (Filed: 13 Mar. 2014)

Automotive SOFC module with exhaust gas and startup combustors located coaxially in same space, for

thermally self-sustaining operation

Assignee: **Honda Motor Co, Japan**
Inventors: Y. Yoshimine et al.
Patent number: US 9343765
Published: 17 May 2016 (Filed: 19 Dec. 2012)

MCFC system with unified air intake line, minimises internal temperature variation of hot box caused by incoming cooler air

Assignee: **KyungDong Navien Co Ltd, Korea**
Inventor: D.J. Yang
Patent number: US 9343766
Published: 17 May 2016 (Filed: 28 Mar. 2013)

PEMFC activation method, by sweeping cell voltage to obtain a cyclic voltammogram

Assignee: **Honda Motor Co, Japan**
Inventors: T. Kato et al.
Patent number: US 9343768
Published: 17 May 2016 (Filed: 26 Dec. 2012)

Method for manufacturing ceramic SOFC with novel structure, where plate members may be circular, rectangular, square or hexagonal

Assignee: **LG Fuel Cell Systems Inc, USA**
Inventors: G.D. Agnew et al.
[Rolls-Royce Fuel Cell Systems, UK]
Patent number: US 9343769
Published: 17 May 2016 (Filed: 20 Mar. 2014)

Noble metal-free catalysts based on glucose-guanidine acetate, oxygen reduction on PEMFC cathodes

Assignees: **Università degli Studi di Milano, Italy and Fondazione Cassa di Risparmio delle Provincie Lombarde, Italy**
Inventors: L. Formaro et al.
Patent number: US 9346034
Published: 24 May 2016 (Filed: 28 June 2012)

PEMFC electrode catalyst with high specific surface area, for excellent reactivity using small quantity of metal catalyst

Assignee: **Samsung SDI, Korea**
Inventors: H.-G. Noh et al.
Patent number: US 9346673
Published: 24 May 2016 (Filed: 11 May 2005)

DMFC catalyst with good dispersion, containing Si, Al and/or Ti with catalytic metal Pt

Assignee: **Samsung SDI, Korea**
Inventors: M.-K. Min et al.
Patent number: US 9346674
Published: 24 May 2016 (Filed: 28 Oct. 2005)

Method for producing PEMFC cathode metal catalyst with excellent durability and high ORR

Assignee: **Showa Denko, Japan**
Inventors: R. Monden et al.
Patent number: US 9350025
Published: 24 May 2016 (Filed: 9 Aug. 2011)

Low-cost nanofibrous PEMFC cathode catalysts with transition metal compounds, e.g. MOFs, organometallics or inorganic salts

Assignee: **UChicago Argonne LLC, USA [Argonne National Lab]**
Inventors: D.-J. Liu et al.
Patent number: US 9350026
Published: 24 May 2016 (Filed: 28 Sep. 2012)

Low-cost PEMFC sealing structure with improved adhesion without multiple seal members

Assignee: **Nissan Motor Co, Japan**
Inventors: K. Kageyama et al.
Patent number: US 9350027
Published: 24 May 2016 (Filed: 30 Oct. 2009)

PEMFC MEA has carbon nanotube GDLs, improves reaction activity

Assignees: **Tsinghua University, China and Hon Hai Precision Industry Co Ltd, Taiwan**
Inventors: L.-N. Zhang et al.
Patent number: US 9350028
Published: 24 May 2016 (Filed: 24 July 2014)

Automotive PEMFC stack with asymmetrical triangular inlet buffer, to supply coolant uniformly and reliably to entire flow-field

Assignee: **Honda Motor Co, Japan**
Inventors: M. Suzuki et al.
Patent number: US 9350029
Published: 24 May 2016 (Filed: 18 Nov. 2013)

Compact SOFC module structure to reduce internal temperature variations, more stable activation

Assignees: **Murata Manufacturing Co Ltd, Japan and Tokyo Gas, Japan**
Inventors: Y. Tomoshige et al.
Patent number: US 9350030
Published: 24 May 2016 (Filed: 2 Dec. 2013)

SOFC stack module with integral features for connection to adjacent module, without additional spacers

Assignee: **LG Fuel Cell Systems Inc, USA**
Inventors: G. Wright et al.
[Rolls-Royce Fuel Cell Systems, UK]
Patent number: US 9350031
Published: 24 May 2016 (Filed: 23 Oct. 2013)

Method and system for stable DMFC operation under varying loads and at subzero temperatures

Assignee: **IRD Fuel Cells, Denmark**
Inventors: V. Andresen et al.
Patent number: US 9350032
Published: 24 May 2016 (Filed: 30 Jan. 2012)

Accurately estimating cathode gas flow rate in PEMFC system, to control power and prevent flooding

Assignee: **Nissan Motor Co, Japan**
Inventors: Y. Tomita et al.
Patent number: US 9350033
Published: 24 May 2016 (Filed: 10 Jan. 2013)

PEMFC GDL integrated gasket for improved sealing, precise assembly

Assignee: **NOK Corporation, Japan**
Inventors: H. Yui et al.
Patent number: US 9350034
Published: 24 May 2016 (Filed: 23 June 2010)

Crosslinked electrolyte membranes with very high acid content and strong polymer structure, for use in PEM, alkaline or DMFCs

Assignee: **Nissan North America, USA**
Inventor: R. Yadav
Patent number: US 9350035
Published: 24 May 2016 (Filed: 30 July 2014)

Fabrication of nanocomposite PEMs and AEMs from electrospun polymer multi-fibre/nanofibre mats

Assignee: **Vanderbilt University, USA**
Inventors: P.N. Pintauro et al.
Patent number: US 9350036
Published: 24 May 2016 (Filed: 6 Aug. 2012)

Manufacturing compact one-piece SOFC elements by layer-wise application of particulate ceramics

Assignee: **Airbus Operations, Germany**
Inventors: J. Steinwandel et al.
Patent number: US 9350037
Published: 24 May 2016 (Filed: 21 Oct. 2013)

EVENTS CALENDAR

6–7 August 2016
Gordon Research Seminar on Fuel Cells: From Fundamentals to Practical Applications of Fuel Cells
Stonehill College, Easton, Massachusetts, USA
More information:
www.grc.org/programs.aspx?id=16510

7–12 August 2016
Gordon Research Conference on Fuel Cells: The Next Generation of Durable, High-Performance Components and Fuel Cells, Including Modeling, Diagnostics, and Materials Development Advancements
Stonehill College, Easton, Massachusetts, USA
More information:
www.grc.org/programs.aspx?id=12882

15–19 August 2016
15th International Symposium on Polymer Electrolytes, ISPE-XV
Uppsala, Sweden
More information:
www.delegia.com/ispe2016

17–19 August 2016
21st Annual Electrochem Meeting, Electrochem 2016
University of Leicester, UK
More information:
www2.le.ac.uk/conference/electrochem2016

21–26 August 2016
67th Annual Meeting of the International Society of Electrochemistry, including Symposium 7 on Novel Materials and Devices for Energy Conversion and Storage
The Hague, The Netherlands
More information:
http://annual67.ise-online.org

7–9 September 2016
FC EXPO Osaka 2016, 1st International Hydrogen & Fuel Cell Expo Osaka (within World Smart Energy Week Osaka 2016)
Osaka, Japan
More information: www.fcexpo-kansai.jp/en

11–14 September 2016
4th International Symposium on Electrocatalysis, ECAT 2016: A Key of Sustainable Society
Shonan, Kanagawa, Japan
More information: www.cel.ynu.ac.jp/ecat2016

12–14 September 2016
2nd International Conference on Hydrogen Energy, alongside 1st International Conference on Advanced Energy Materials (AEM 2016)
University of Surrey, Guildford, UK
More information: www.aem2016.com

12–16 September 2016
11th European Fluid Mechanics Conference (EFMC11), including Symposium on Fluid Mechanics of Fuel Cells
Seville, Spain
More information: www.efmc11.org

14–15 September 2016
CENEX, 9th Annual Low Carbon Vehicle Event, LCV2016
Millbrook, Bedfordshire, UK
More information: www.cenex-lcv.co.uk

15–16 September 2016
HyResponse Final Workshop: European Hydrogen Emergency Response Training Program for First Responders
Aix-en-Provence, France
More information:
www.h2euro.org/2016/hyresponse-final-workshop

14–16 September 2016
2nd E3 Mediterranean Symposium: Electrochemistry for Environment and Energy
Gargnano, Italy
More information: http://users.unimi.it/E3_2016

19–21 September 2016
2nd International Workshop on Material Challenges for Fuel Cell and Hydrogen Technologies: From Innovation to Industry
Grenoble, France
More information: (FCH JU website):
http://tinyurl.com/material-challenges-workshop2

19–22 September 2016
European Materials Research Society, 2016 E-MRS Fall Meeting and Exhibit, including Symposium Q on Advanced Materials for Fuel Cells and Electrolyzers
Warsaw University of Technology, Poland
More information: www.european-mrs.com/advanced-materials-fuel-cells-and-electrolyzers-emrs

20–21 September 2016
LEVS – 1st World Light Electric Vehicle Summit
Barcelona, Spain
More information:
www.levs.mobi or www.electri-city.mobi

26–28 September 2016
Electrochemistry 2016, Gesellschaft Deutscher Chemiker
Goslar, Germany
More information:
www.gdch.de/index.php?id=2690

2–7 October 2016
Polymer Electrolyte Fuel Cells 16 Symposium (PEFC-16), at Electrochemical Society Pacific Rim Meeting on Electrochemical and Solid State Science (ECS PRiME 2016)
Honolulu, Hawaii, USA
More information: http://prime-intl.org

3–7 October 2016
11th European Space Power Conference, ESPC 2016: European Space Agency
Thessaloniki, Greece
More information: www.espc2016.com

4–5 October 2016
California Hydrogen & Fuel Cell Summit 2016
Cal EPA, Sacramento, California, USA
More information:
www.californiahydrogensummit.com

10–12 October 2016
World of Energy Solutions Trade Fair & Conference: Battery+Storage, f-cell, and e-mobility solutions
Stuttgart, Germany
More information:
www.world-of-energy-solutions.de/en

9–10 November 2016
Electric & Hybrid Aerospace Technology Symposium 2016 [and see below]
Cologne, Germany
More information:
www.electricandhybridaerospacetechnology.com

9–10 November 2016
Electric & Hybrid Industrial Vehicle Technology Symposium 2016 [and see above]
Cologne, Germany
More information:
www.electricandhybridivt.com

13–18 November 2016
2016 AIChE Annual Meeting (American Institute of Chemical Engineers), including several sessions on fuel cells and hydrogen
San Francisco, California, USA
More information:
www.aiche.org/conferences/aiche-annual-meeting/2016

21–23 November 2016
Fuel Cells and Hydrogen Joint Undertaking, Annual Programme Review Days (21–22 November) & Stakeholder Forum (23 November)
Brussels, Belgium
More information:
www.fch.europa.eu/event/programme-review-days-stakeholder-forum

2017

1–3 March 2017
FC EXPO 2017, 13th International Hydrogen & Fuel Cell Expo (within World Smart Energy Week 2017)
Tokyo, Japan
More information: www.fcexpo.jp/en

14 March 2017
13th International Hydrogen and Fuel Cell Conference: Hydrogen and Fuel Cells into the Mainstream – Powering Our Homes, Workplaces and Transport
Birmingham, UK
More information:
www.climate-change-solutions.co.uk

14–16 March 2017
11th International Renewable Energy Storage Conference, IRES 2017
Düsseldorf, Germany
More information: www.eurosolar.de/en
Abstract deadline: 15 September 2016

17–21 April 2017
Materials Research Society 2017 MRS Spring Meeting & Exhibit, including symposia on ES6 Mechanics of Energy Storage & Conversion, and ES13 Interfaces & Interphases in Electrochemical Energy Storage & Conversion
Phoenix, Arizona, USA
More information: www.mrs.org/spring2017
Abstract deadline: 13 October 2016

24–28 April 2017
Group Exhibit Hydrogen + Fuel Cells + Batteries, within Hannover Messe 2017
Hannover, Germany
More information: www.h2fc-fair.com

10–11 May 2017
All-Energy Exhibition & Conference 2017
Glasgow, Scotland, UK
More information: www.all-energy.co.uk

5–9 June 2017
2017 DOE Hydrogen and Fuel Cells Program, Annual Merit Review and Peer Evaluation Meeting
Washington, DC, USA
More information:
www.annualmeritreview.energy.gov

26–28 June 2017
5th Workshop on Ion Exchange Membranes for Energy Applications, EMEA 2017
Bad Zwischenahn, Germany
More information:
www.next-energy.de/EMEA2017.html

9–12 July 2017
7th World Hydrogen Technology Convention (WHTC 2017), together with Czech Hydrogen Days 2017
Prague, Czech Republic
More information: www.whtcprague2017.cz