



H2 INTERNATIONAL NEWSLETTER FOR HYDROGEN AND FUEL CELLS **international**

H2-international – e-Journal

December 2015

H2-international started very successful in its first year. More than 1300 newsletter subscribers could be gathered in the first weeks and the e-journal got a lot of positive reply.

The list of companies is still growing and growing so that we are absolutely sure now – H2-international can keep you informed in the future, in 2016 and hopefully for many years after.

Thanks to you all for your interest and your support.

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BMW Presents New 5 Series Boasting Fuel-Cell Engine



Fill it up, please! © BMW

This summer car manufacturer BMW presented a new vehicle driven by a fuel cell. In Miramar in the south of France, the Bavarian company revealed their new BMW 5 Series Gran Turismo (GT) on the first of July 2015. The car is a showcase vehicle, which was developed in cooperation with Toyota and is planned for mass production by 2020.

Based on the already available GT model, it is the first vehicle from Munich's car manufacturer that generates engine power only by the use of a fuel cell. Until 2006, BMW had focused almost entirely on H₂ combustion engines and equipped eight generations of cars with an Otto engine and a liquid hydrogen tank, before halting development work altogether. In 2013, BMW and Toyota announced their cooperation, during which the Bavarian car manufacturer has benefitted from Toyota's experiences with fuel-cells, and Toyota had the favor returned by BMW sharing their diesel expertise with the Japanese producer.

"We will continue to explore all avenues of development, but the combination of fuel cell and hydrogen seems to be another possible drive system from around 2020 on. [...] The fuel cell is a key part of our strategy for the future," BMW's Head of Development, Klaus Fröhlich, explained. The target was to design a fuel cell as compact as an internal combustion engine, so that the same chassis could be used for both fossil-fuel and electric cars. Additionally, high-pressure carbon fiber tanks should be shaped similar to battery units, in order to allow replacing one by the other.

When asked by *H2-international*, a company spokesperson said: "The fuel cell incorporated into the BMW 5 Series Gran Turismo is a result of our cooperation with Toyota, and it is basically the same one that is being used in Toyota's Mirai. Some peripheral units share the same design too. However, the car itself was developed by

BMW on its own. For instance, the powertrain is based on BMW-i technology.” The gaseous hydrogen is stored between front and rear axle either in a 700-bar tank or a two-meter long, 350-bar tunnel tank patented by the BMW Group. Ten showcase vehicles were built to allow testing both storage technologies, the 700 bar version as well as the cryo-pressure tank one. BMW said that the same amount of resources were going into developing the two technologies further.

In the second case, the cryogenic version, the container made of aluminum and carbon fiber weighs 160 kg. Its heat insulation guarantees that the tank’s interior remains at between -210 to -230°C (over several weeks). Car refueling uses the new cryogenic pressure technology (CCH₂), which was first tested at the new public H₂ filling station in Munich. The 7.1 kg of H₂ gas stored this way (at a capacity of 237 kWh) enables a range of 500 km. But if requested, the cryogenic pressure tank can also be filled at 700 bar. The container will then only hold 2.1 kg, which will obviously result in a lower range.

“As it is BMW’s belief that the ideal use of hydrogen fuel-cell technology will be for medium to large cars – meaning usually long-range vehicles – the typical space requirement to install the technology will be today’s tunnel version.”

The H₂ 5 Series is driven by an electric engine with a power of 180 kW. As an addition to the fuel cell, electricity is supplied by a high-voltage battery for intermittent storage (1 kWh). In contrast to common electric cars, this sports vehicle offers a two-gear automatic, which shifts once at around 80 to 90 km/h. This technology could be the foundation for a hydrogen-powered BMW race car participation in the *24 Hours of Le Mans* from 2018 on.



© BMW

BMW did not want to confirm any rumors circulating of a fuel-cell i5 complementing BMW’s current model offerings of *i3* and *i8*. Instead, the company made the following statement: “The aim of our cooperation with Toyota is to have components available for future hydrogen fuel-cell vehicles and ready for mass production by 2020.” Asked

about the market entry of future H2 cars, Fröhlich recently told the *Süddeutsche Zeitung*: “I think 2025 is more of a realistic time frame.”

Besides the 5 Series, the Bavarian engineers also equipped an *i8* with a fuel cell for testing (see above). “The matte black prototype was developed by BMW on its own until 2012. Thus, it was designed and built before the cooperation with Toyota and was based on other technologies. The car is no longer in use today.”

Ballard: Big vision for China



P200i back-up system, © Protonex

Second quarter figures certainly fell short of expectations. All segments reported decreasing revenues. Still: The second half of 2015 should bring forth many positive developments in several areas, according to Ballard’s CEO, Randall MacEwen. FuelCell Energy would be “extremely busy.” This means: I assume that the takeover of Protonex will soon become reality, as over 50% of preliminary votes by Protonex’s shareholders were in favor of the deal. Ballard’s share price, who had been dropping quite considerably in the meantime, could have triggered re-negotiations. I believe that Protonex’s shareholders will already have taken precautionary measures by selling short Ballard shares before any takeover would occur. This could even be a key reason for Ballard’s low stock price.

According to company information, Protonex will already be contributing US\$ 5 million in 2015 and over US\$ 15 million in 2016 to Ballard’s total turnover. The company is considered to have high growth potential, and it will expand Ballard’s portfolio by introducing the company to new markets and products – such as military drones. At the same time, Ballard raised its capital, which ranked in another US\$ 15 million. One can only shake one’s head about the way the capital increase was

handled, as it was done at US\$ 1.60 per share, whereas back then the stock was quoted at over US\$ 2.20. It seems likely that this was a hedge as well, during which underwriters may have short-sold shares and the company would buy them back at US\$ 1.60 (not uncommon, although no-one would want to admit it). The result was quite “unfortunate” and could have only been implemented with much better conditions for Ballard if there had been any good news (orders, collaborations, projects in China) at the same time. But what’s done is done.

Ballard is exploring many avenues in China: The company seems to be negotiating with several bus manufacturers about various kinds of collaborations, from the supply of fuel-cell stacks and R&D agreements to licensed fuel-cell production and more. Here, one can still expect breakthroughs in 2015 (contracts, upfront payments, orders). Even the project where 48 Chinese cities are looking to acquire 1,000 e-buses each (battery-driven, fuel-cell hybrid, etc.) could lead to follow-up orders from time to time. Two of the cities already ordered 33 fuel-cell buses (totaling US\$ 10 million). It could – at least, that is what I believe – turn into as many as 1,000+ buses, which Ballard will supply and/or for which Ballard’s partners will set up a licensed fuel-cell stack production line.

Regarding railway vehicles (streetcars, trains), Ballard has already been in business with the two biggest companies on the market. It collaborates with CRRC (a merger of CNR & CSR to become the world’s largest railway vehicle company) on a project to build a prototype of a hydrogen-driven train (to be realized in 2016) and already delivered an H2-driven streetcar prototype to CSR (see [Alstom and Ballard approach the railroads](#)). It should be expected that the signed framework agreement will be followed by contracts detailing everything from upfront payments to R&D collaboration and fuel-cell stack orders. Such a deal alone could generate high interest in Ballard’s shares.

In China, Ballard said it made, and I quote, “rapid progress” and could very well imagine that the country will give fuel cells & H2 a massive push that would greatly outpace market development even in Japan, Germany, or the US (California’s industry, in particular). My expectations/thoughts: A bill, regulation, or CP draft might lead to a network of 10,000 H2 gas stations within three to five years – certainly not unachievable. German carmakers, such as BMW, Daimler and VW, could then be forced to give the fuel cell a more prominent place more quickly, as China has become the world’s largest car market.

In short: Globally, Ballard occupies exactly the right spot in the fuel-cell market. The company is extremely healthy, has about US\$ 60 million on the bank (including a payment to be made in 2016, no debt = 1/3 of the stock exchange rating!), has various orders in the pipeline (backup power systems, fuel-cell stacks for buses, etc.), creates revenue through a framework agreement with VW (order potential of around US\$ 20 million per year up to 2019/2020), and should be interested in further acquisitions that could be a perfect supplement to Ballard’s IP portfolio.

Additionally, more OEM deals (such as with automotive parts suppliers) seem likely. Last but not least, I believe that the cooperation with and the fuel-cell supply of Plug Power will increase again in the second half of this year. Plug, however, does aim at its own fuel-cell stack production, which means Ballard will be inclined to establish collaborations with other companies in the material handling segment, in order to

become more independent of Plug. In some way, the low share price is self-inflicted (capital increase, Protonex financing) and is based even on “psychological” grounds on an oil price in free fall. Whoever has the time should take advantage of the greatly underwhelming stock prices, because fuel cells and H2 are clearly forward-looking technologies, which will even inspire a megatrend, as clean energy has become a global issue.

This post was written in September 2015 by Sven Jösting.

Note on risk

When investing in shares, every investor must make their own risk assessment, and ensure an appropriate spreading of the risk. The FC companies and/or shares stated here come from the area of small and mid-caps, which means that they do not constitute standard values and their volatility is far higher. This report does not provide purchasing recommendations – and no guarantees are made. All of the details are based on publicly accessible sources, and in terms of the forecasts they only represent the personal opinion of the author.

DOE Chooses FuelCell Energy for New Project



59-MW-fuel-cell-park, © FuelCell Energy

FuelCell Energy specializes in large-scale projects using fuel-cell technology to generate clean energy (electricity and heat). It is also leading in technologies such as CO2 capture and storage. The company recently secured a contract award by the American Department of Energy for a scalable CO2 capturing project (e.g., for coal-fired power plants) potentially worth around US\$ 24 million. The system used in the project is a *DFC3000*, which is based on a fuel cell. Such prototype efforts show the great future potential of fuel-cell technology.

To sum it up: With around US\$ 0.90, the stock quote was below the US\$ 1.00 threshold required to keep FuelCell Energy listed on the Nasdaq. Shares that are traded below US\$ 1.00 for some time can result in a company's delisting, meaning the transfer to another exchange. In my opinion, short sellers (around 43 million shares were sold short) have, of course, a high interest in such a development, because a further decline in the share price would make a transfer a likely scenario. But: FuelCell Energy continues to hold high cash reserves of over US\$ 80 million, has a line of credit worth US\$ 40 million guaranteed by a major shareholder (NRG), has outstanding orders valued at above US\$ 300 million, and is the uncontested market leader in its segment. One has to know, however, that large projects such as the one in South Korea are subject to great quarterly fluctuations (because of billing, etc.), so that finished projects involve great capital costs before being settled or sold. I believe that the share price dilemma will be solved in one way or another to keep FuelCell Energy listed on the Nasdaq. This means that either the share price will rise above US\$ 1.00 or there will be a reverse stock split (to reduce the number of shares). The company is seen as having great potential because it operates globally in large growth markets, has a very good reputation (regarding ongoing and completed projects) and is committed to being a technology leader (see [website](#)).

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South Africa Promotes H2 and Fuel-Cell Technologies

South Africa is the biggest economy on the African continent, and since the end of apartheid more than 20 years ago, the country has been viewed as a role model by many of its neighbors. Because of its very healthy economic development, the nation at the Cape of Good Hope has become part of the BRICS group of countries. There is, however, the issue of unstable energy supply as well as the uneven spread of wealth among the population, which has meanwhile begun to hamper South Africa's progress and is posing great challenges to the government. The use of hydrogen and fuel-cell technology is thus not only viewed as an opportunity for economic growth, but also – and most importantly – as a chance to right the wrongs in energy policy.

There are two main drivers behind the use of H2 and fuel-cell technology in South Africa today: One is mining, South Africa's most important industry sector. Besides chrome, vanadium and manganese, the country is rich in platinum (more precisely, platinum group metals or PGMs). Its use in fuel cells offers new opportunities for incorporating another process into the platinum value chain and establish a new industry.



TriGeneration-System, © N2telligence

The second one is the big problem of secure power supply. South Africa's power grid is outdated and ailing. Power outages and shutdowns are the rule rather than the exception, which is placing a burden on businesses as well. Additionally, the grid does by no means cover the entire country. Up to 600,000 households, especially in underdeveloped rural areas, still have no access to it. For many South-Africans, growth and wealth remain out of reach, which fuels widespread dissatisfaction.

As early as 2008 did the South-African government establish the *Hydrogen South Africa (HySA)* program, which is to run over 15 years as part of a research, development and innovation strategy. Originally thought up to strengthen the platinum industry, the program is now seen by the government as an opportunity to improve energy supply primarily in telecommunications as well as network-independent electricity generation through the use of hydrogen and fuel-cell technology. Moreover, the technology is viewed as helping to meet the CO₂ targets stipulated in the National Development Plan as well as to support the climate policies of the government.

Whereas in early years, the focus of the program used to be gathering and expanding the knowledge about the technology, the past three have seen the realization of different demonstration projects, which were intended to showcase the technology's benefits to the public:

In 2014, Anglo American Platinum, one of the biggest mining companies in South Africa, had fuel-cell systems set up as part of a pilot project at the rural Naledi Trust community near Kroonstad. In a first step, 34 households were connected to a small, independent power grid. If the initial stage proves successful, the network is planned to be expanded to include a total of 200 to 300 households.

Since the end of last year, the University of the Western Cape has been testing a fuel-cell unit at its nature reservoir in Cape Town. The unit is intended to supply power for the lighting of the administration building. Since the beginning of this year, the electricity for the building of the Chamber of Mines in Johannesburg has been generated by a 100-kW fuel-cell system. The phosphoric acidic fuel cell (PAFC, see photo) by Fuji Electronics is powered by natural gas and covers the building's basic load.

A 5-kW emergency power supply system by Intelligent Energy was recently set up in Bhisho, the capital of the Eastern Cape province. It cools vaccine supplies, which had to be regularly disposed of before because of power outages. There are also plans to equip up to 20 agricultural parks in remote rural areas in South Africa with fuel-cell systems over the next two to three years. Three schools in Cofimvaba in the Eastern Cape province were chosen to serve as pilot projects. There, charging stations for PCs and faxes are said to run based on fuel-cell energy.

The South-African mining companies see hydrogen and fuel-cell applications as more than an opportunity to generate increased demand for platinum. They also want to use these technologies to enhance their own production processes and refineries. Five fuel-cell trains powered by natural gas have already been running through the mine shafts of Anglo American Platinum. A cost comparison between trains running on diesel and the ones driven by fuel cells concluded that the costs for diesel use were between 4 and 6 rand (0.3 to 0.45 euro) per kilowatt hour, whereas – depending on the natural gas price – fuel-cell costs ranged from 2.7 to 3 rand per kilowatt hour (0.2 to 0.3 euro).

Platinum giant Impala announced that it would install a power supply based on fuel cells at its refinery in Springs, Gauteng province. The system is planned to be supplied by the excess hydrogen from the refinery's metal reduction process and would thus contribute to plant operations becoming independent of the national power grid.

The government recently carried out an evaluation of the *HySA* program after half-time: There is still too little awareness of hydrogen and fuel cells and their potential throughout the country. Now, the government wants to advance the issue on all fronts and continue offering financial support for relevant projects. This is all the more important when it comes to establishing a hydrogen infrastructure. The government identified the electrification of rural areas, the use in mining and the employment in telecommunications as the top-priority H2 and fuel-cell markets in South Africa. There is also a call for greater involvement of small to medium enterprises. Additionally, the government is deliberating the establishment of special economic zones to develop hydrogen and fuel-cell technology. These zones would be designed with low taxes in mind, in order to accelerate market deployment.

Author: Alexandra Huss

Michael Seehuber Heads H-Tec Systems



Michael Seehuber, © H-Tec

Since August 1, there has been a new CEO at the helm of H-Tec's electrolysis division: Michael Seehuber, who is now managing H-Tec Systems. Seehuber will take over the responsibilities previously held by Uwe Küter, who founded H-Tec in 1997 together with Stefan Höller and left the company in 2014. The company's former Head of Sales, Ake Johnson, will manage the training division, H-Tec Education. For seven years, Michael Seehuber was CEO of REFUsol, a specialist in inverters, which was bought up by AEI Power in 2013. In August 2014, the electrical engineer established PV4Life, a consultancy for power electronics. Ove Petersen, CEO of GP Joule, had the following to say about him: "Not only does he possess the technical expertise, he also has the necessary management experience." According to GP Joule, the new director will manage H-Tec Systems from Bittenwiesen in Bavaria to be able to use "as many synergy effects with the R&D department of GP Joule at this location as possible." The subsidiary of GP Joule, which still employs around 30 employees in Lübeck, focuses on PEM electrolysis systems and the related power-to-gas technology. Currently, the company is testing its "power gap filler" design with a 200-kW demonstration plant in Reußenköge near Husum.

Fraunhofer ISE Inaugurates New Testing Site



Fraunhofer ISE Lab Inauguration, © Fraunhofer ISE

The energy transformation needs efficient storage solutions and technologies for heat conversion. One of the institutions playing an important role in advancing the transformation of the energy sector is the Fraunhofer Institute for Solar Energy Systems, ISE, in Freiburg. Increasing interest in energy storage technologies as well as efficient heating and cooling processes has led to an expansion of ISE's research and development capacities and the construction of a new facility in the Auerstraße. The new building was officially inaugurated on July 2 this year.

During the inauguration festivities, Professor Hans-Martin Henning from Fraunhofer ISE announced: "Now, we take the next big step – integrating 'green' energies into the system." Up to now, the use of renewable energy sources has neither significantly impacted the energy network, nor has the production of greenhouse gases been reduced by a considerable margin. In terms of network expansion and supply security, capacity management is of paramount importance, as renewable energy generation has to deal with high fluctuations. Countering those will be one of the main challenges over the coming years.

If reorganization of the network and the integration of renewables is successful, Henning estimates that CO₂ emissions could be reduced by at least 80 percent.

This requires a new concept of managing the so-called residual load. In simple terms, the residual load is the electric power in networks not covered by renewable sources. The more flexible the consumer and producer of energy are, the better they can be aligned with renewable energy use – the simpler their system integration.

According to Henning, integral components are the convergence of the heat and power sector, an intelligent management of consumers (demand side management),

and an increased use of storage units. Fraunhofer ISE places particular emphasis on energy-saving technologies and efficient processes for heating and cooling supply.

Work on these issues has now been moved to the institute's new location in Freiburg's Auerstraße, a site with which Fraunhofer notably expanded the size of its research and development facilities. At the beginning of July, the institute's staff officially inaugurated the new center for storage and heat transfer technologies.

One of the key research targets at the newbuild is the "Model of a cost-optimal transformation of the German energy network in line with the country's political climate change objectives." Among other things, the model specifies the technologies required to transform the energy sector: heat pumps, stationary battery storage and electrolysis systems.

According to Fraunhofer, the electric heat pump will play a crucial role over the next years. Currently, there are around one million units installed across Germany. In the next years, the scientists expect a dramatic increase in installations of these pumps as well as of stationary battery storage units. The latter are said to amount to around ten million kilowatt hours of installed capacity already in 2025. Until then, the first electrolysis systems will have come into operation too.

During stage three, which starts between 2025 and 2030, ISE's scenario anticipates a rise in renewable energy use for synthetic fuel production. At this stage, the experts already expect significant negative residual loads. This means that the electricity generated by renewable energy sources will outpace demand by consumers.

By 2040, the Fraunhofer model predicts electric and gas heat pumps to supply most of the required space heating in Germany. Then, the capacity of stationary battery storage could be at more than 25 GWh, and electrolysis systems could already have an output performance of between 30 and 45 GW.

With the last stage from around 2040 on, the scientists from Freiburg offer an outlook on the complete replacement of fossil resources in all application areas and a subsequent reduction of CO₂ emissions to almost zero. They also expect the import of electricity (e.g., from sunny regions) to reach significant magnitude.

CO₂ targets

Germany's political climate change targets include a staggered reduction of CO₂ emissions compared to the 1990 reference value: by 40 percent by 2020, by 55 percent by 2030, by 70 percent by 2040, and by 80 to 95 percent by 2050. "If we take these climate protection targets seriously, we will need a significant amount of power conversion into chemical storage through electrolysis," Henning is convinced. Which chemical substances will turn out to be the most popular the scientist does not want to predict at this point.

One of the technologies that could very likely increase on a massive scale until the middle of this century is the use of electrolysis systems. They may reach a total capacity of up to 70 GW. Most essential to making such a scenario happen, however, is that renewable energy use will be increasing and the transformation of the energy network will be implemented as planned.

Chemical energy carriers offer the potential to store energy chemically in large quantities even over long periods of time. For instance, hydrogen can be used to power fuel-cell cars, but also to reverse-power stationary fuel-cell units or gas engines.

The scientists believe that utilities or grid providers will employ water electrolysis systems to gain more flexibility in production. These systems can help align power generation with demand, stabilizing the line frequency.



Prof. Hans-Martin Henning, © Fraunhofer ISE

Henning assumes that over the years, there will be a more or less close network of H₂ filling stations. “Hydrogen can be transported without any complications when it has been compressed to almost 1,000 bar. And, for example, filling systems for cars with their 700 bar do have their practical applications and have already been in use.” How dense the network will be and whether hydrogen can become a popular replacement for fossil fuels depends on many factors: from the development of the market for hydrogen-driven cars to total costs and to the future availability of feasible business models.

At least the heavy-duty and the aviation industry of the future will not be able to do without other synthetic energy carriers, such as methane, methanol, polymers, or ester. In terms of chemical processing, however, the first step is always the creation of hydrogen. For instance, to produce methane (CH₄), one needs hydrogen and carbon-dioxide (CO₂), which could be filtered out of the atmosphere over the long term. “In the case of methane, we can already use available structures, such as storage space in underground caverns.”

The liquid energy carrier methanol (CH₃OH) could be another imaginable alternative. But like all synthesized energy carriers created from hydrogen and CO or CO₂, it has the disadvantage of requiring an additional production step that causes energy

losses. As a sustainably produced base substance for the chemical industry, however, methanol is indeed a perfect match. “It will be the task of R&D to assess the options offered by synthetic energy carriers and explore the relevant cost-reduction potential. It is important that energy generation is strongly dynamical to lessen as well as offset the supply fluctuations of renewable energies.”

One of the tasks of the new *Center for Storage and Heat Conversion Technologies* at Fraunhofer ISE will be to do thorough research on large-scale industrial hydrogen production. “If you look at the extent of the energy transformation, you’re soon to reach megawatt figures. For instance, our tests aim to determine how to guarantee gas purity and to explore how the aging process of electrolytes looks like as well as which consequences this has for efficient production.”

Besides electrolysis systems, battery units could also pervade many application areas – from individual transport to stationary storage in private households or at commercial premises to wind and solar power plants as well as battery storage for grid stabilization. “In the medium-term, such plants will use large battery storage units. Additionally, there will be variable power pricing to support the use of batteries – you will store electricity when it is cheap and use it when getting it from the grid would be expensive.”

In short: The scientific and technical challenges of the energy transformation are – for the most part – issues already known. And if one is to believe the experts from Fraunhofer, they can be solved too. The Gordian knot apparently shows up in another field: the one of politics and lobbyism. It remains to be seen when one can announce a breakthrough there as well.

Decentralized structures

Professor Dr. Michael Weinhold, CTO of the Energy Management Division at Siemens, sees the challenge of the “dramatic change in the energy world” in altering existing structures. Instead of centralized energy supply, there will be a “mix of decentralized, distributed and conventional energy systems, which keep the balance in both directions.” He listed as the most important fields of innovation:

- Changes in the energy mix and integration of new energy sources: The high variability of renewables requires investing in stability and availability.
- Bridging the gap between decentralized energy sources and concentrations of consumers: “We will require DC lines that can transport large electricity loads across great distances while keeping energy losses at a minimum. Additionally, we will require more flexible AC transmission systems.”
- Establishing digital smart-grid technologies: As intelligent structures, small, distributed energy systems (e.g., battery swarms) will become part of markets such as the energy imbalance market.
- Power-to-X: Besides Power-to-Heat and lithium-ion batteries, chemical conversion (Power-to-Value) will gain in importance.
- Enhancements: Existing structures and technologies must be improved upon to be able to meet the new challenges and allow the best possible as well as the most sustainable use of infrastructures.

Author: Herbert Grab

H2 Info Truck Tours Europe



© H2U, Sergio Ferraris

The Hydrogen Information Truck H2M, a tractor-trailer, began its road tour through Europe in Italy in spring 2015. The tour's starting location on April 20 was the Italian parliament; the final destination was Paris at the end of 2015. There, the truck advertises for sustainable environmental policies during the UN Climate Conference (COP 21).

The specially configured truck is thought to explain what the future holds for the hydrogen segment. Its roof and the top-hinged sidewalls were equipped with solar panels (80 m²), with the generated power being used to create hydrogen on the run. This hydrogen will then be compressed in the laboratory and stored away in 20 pressure cylinders of 50 l each, so that it can either generate electricity through fuel cells or be used as an on-the-road refueling option. The trailer with its top-hinged sidewalls contains a presentation room that provides sufficient space for around 50 people and whose electricity demand is covered exclusively by the energy system on board. The 15-meter long truck is powered by an internal combustion engine that has been modified to allow the consumption of methane and hydrogen in addition to diesel. There are already plans to replace the engine by an electric one combined with a fuel cell.

According to Volker Krück from the Board of Directors of the Fondazione H2U, the Hydrogen Information Truck was designed by The Hydrogen University (H2U) foundation and is intended for teaching and learning purposes only. The onboard equipment is "not revolutionary," as Krück, who still wants to open another branch in Berlin in the second half of 2015, admitted. This is why he has been constantly looking for partners, for instance, which could contribute to the success of the Europe tour by providing the latest hardware. Up to now, several Italian universities have been supporters of the project. Users of the H2M could be schools and universities, but also enterprises.

www.unihydrogen.eu

International Comparison of E-Car Regions



J. Tomforde with F. Loogen and State Secretary N. Barthle (l. to r.)

What impact does the ongoing electrification of the automotive industry have? Which technology fields will be affected by the structural changes? What needs to be done not to lag behind? Questions like these are a concern especially to regions highly dependent on the car industry. In a search for answers, the State Agency for Electric Mobility and Fuel Cell Technology, e-mobil BW, commissioned the Fraunhofer Institute for System and Innovation Research (ISI) to conduct the study “Electric Mobility Worldwide– Baden-Wurtemberg in Global Comparison.” The results were presented in mid-April of 2015 during the tradeshow in Hanover.

Baden-Wurtemberg is home to many important, globally operating car makers, such as Daimler, Porsche and Audi. Work on electric vehicles (xEVs) has been going on for several years, but cars based on internal combustion engines will remain the manufacturers’ core business for years to come. Other companies in other regions of the country take a different approach, with some of them promoting electric vehicles on a much wider scale than Baden-Wurtemberg does. But what benefit did they reap from their initiatives? To assess the situation, e-mobil BW – which, according to President Frank Loogen, secured enough funding until the end of 2019 and intends to continue operations beyond this date – conducted the above-mentioned study. Its conclusion: Baden-Wurtemberg is at the risk of lagging behind.

“Regarding sustainable transport, particularly electric mobility, Baden-Wurtemberg is neither one of the world’s leading suppliers nor users, but assumes an average position at international level.”

The automotive sector is faced with fundamental structural changes. This concerns both the technology and the market. According to the Fraunhofer study, “stagnating car sales are to be expected” globally. For instance, the number of vehicles manufactured in Germany is said to level out at six million units per year. New structures and a changing attitude regarding the transportation system will lead to a shift away from the classic internal combustion engine towards electric drive designs and energy storage.

To allow the comparison of measures taken to meet such a challenge in different regions of the world, the study’s authors took a look at the most important electric car countries (China, Japan, Korea, US, and France) and identified the nine key regions that lead the ranking in each of these nations.

Afterwards, the scientists from Fraunhofer ISI used a multi-level approach by conducting interviews and patent analyses as well as comparisons of production figures and networks. According to Loogen, they reached the following conclusion from their research: “There is no region that is clearly the leader in all aspects of this new technology. The race is still open and the jury still out.” In his conversation with *H2-international*, he added: “We all have the chance to work our way to the top.”

“Against the backdrop of being the leader in conventional car technology, the imminent changes in the car market, and the sometimes high level of dependency of Baden-Wurttemberg on the automotive industry, this conclusion is to be met with genuine concern.”

What looms at large: Falling behind without a chance to catch up

The study’s authors credit the different regions with unique strengths. For instance,



Germany’s south-west offers important expertise in electronics, electric engines and high-voltage electronics. But there are deficits in terms of cell manufacturing. Cornelius Moll, who worked on the study project at the Fraunhofer ISI, said: “Our results show that Baden-Wurttemberg is currently not among the leading regions, neither in electric car supply nor technologies, nor in their use.” Moll sees notable deficits particularly in the research and the production of battery and fuel-cell technologies: “Baden-Wurttemberg has no manufacturing capacities for the mass-production of lithium-ion battery cells. As these are exactly the components with the highest innovative potential and the most promising value chain, the results prove to be greatly alarming.”

“In the meantime, even the research into a second-mover strategy – especially regarding battery and fuel cells – seems to be in danger. There is also the risk of having sustainable transportation standards negotiated and defined by other stakeholders outside of Baden-Wurttemberg, which would widen the gap.”

Fraunhofer ISI: “The wait-and-see attitude of many big companies in the automotive industry is undermining the development of electric mobility in general. Additionally, technology development by few pioneering businesses and their limited cooperation with small and medium enterprises when developing important key components could lead to many SMEs being outgrown internationally.” What loomed on the

horizon was Baden-Wurttemberg falling behind and having no chance to catch up, Moll added.

Baden-Wurttemberg's strengths lie in its well-established supplier and innovation networks, among them groups of world-class research facilities. The scientists also see a solid educational infrastructure at work in this German federal state, an infrastructure that could be tapped as a source of qualified employees and great expertise on system integration. Fraunhofer ISI said: "The federal state does possess the necessary potential and the requirements to be successful in the development, manufacture and use of electric cars – currently, however, Baden-Wurttemberg merely assumes an average position in the global market. [...] But closing the gap to the world's leading companies in the field can only succeed if there are profound changes to the local automotive industry."

["Almost all strengths are in conventional technologies. Baden-Wurttemberg is not a leader in any of the fields relevant to alternative engine technologies, but rather represents the average region of the study."](#)

The Fraunhofer ISI scientists recommend that "the path chosen by the automotive industry in Baden-Wurttemberg be questioned because of its future potential for success." They also suggest the establishment of innovation projects for a greater involvement of SMEs in research and innovation as well as an improvement in technology and knowledge transfer between all market stakeholders, such as SMEs, large corporations, and research institutions. Additionally, there should be long-term strategies and global innovative projects with technology leaders in other world regions, in order to tap the potential for learning. But the structural changes should also include extensive private-sector investments at Baden-Wurttemberg's car industry locations to create manufacturing capacities for new technologies such as batteries and fuel cells. And, finally, it would be important to further increase the acceptance of e-cars among the public, for instance, by implementing an extensive media campaign.

Despite all of the above, Loogen views the starting position of his federal state as a good one. He said: "We are pretty unique in the way we collaborate because we have a grown cluster in our industry. If we continue using our network like this, we will have a valid chance to become one of the relevant market players on the world stage."

["One thing that requires more attention is the involvement of SMEs in cooperative research projects. In consequence, this means that many businesses of subsequent value chain segments will be at the risk of lagging behind the technology leaders. This breeds the danger of not being able to meet market requirements as soon as the demand for xEVs increases by a considerable margin. The networks that are so successful today will then be at the risk of breaking up."](#)

In figures: The study determined that in Baden-Wurttemberg, "fewer than 700 xEVs left the factory gates of OEMs in 2013." In Aichi, Japan, the number was almost 630,000 during the same period. Moreover, Japan is setting global technology standards in creating electric and hybrid cars, whereas Korea's Seoul has proven expertise in battery development and manufacturing. California, on the other hand, is

the region with the most widespread use of electric vehicles (good charging infrastructure, high number of cars registered).

“The analyses suggest that the forces of the status quo are currently much stronger than the calls for transformation and renewal towards new drive systems. [...] The hesitation of important stakeholders is slowing down electric mobility in total.”

Quoted from the study

As the federal state in the southwest of Germany is an important manufacturing location for the automotive industry, the study focused on a detailed analysis of the industry and its production business. Naturally, even the limited scope of such a study cannot exclude the technology's application. Here, the scientists determined that California and its almost one million electric cars are the leaders in electric vehicle use. Baden-Württemberg does rank second, but only with 14,000 xEVs before Tokyo with nearly 10,000 xEVs. Accordingly, the conclusion about the effectiveness of electric mobility display is disillusioning. The result of the detailed analysis is: “The user and infrastructure side as well as the policies in place leave much to be desired despite the existence of demonstration and pilot projects.”

Roland Käppner Leaves for GKN



Roland Käppner, © GKN

Since summer of 2012, Roland Käppner had been President of McPhy Energy Germany. At the beginning of 2014, he also became Vice President of McPhy Energy S.A. In July of last year, the French company announced that it would collaborate with British corporation GKN on the development of solid-hydrogen storage systems.

This August, Käppner changed jobs and has since managed business development as Global Director Hydrogen at GKN Sinter Metals, a GKN subsidiary. Peter Oberparleiter, CEO of GKN Powder Metallurgy, said: “Clearly, hydrogen will be an important fuel of the future and its safe storage will be a key factor to its success.” Besides its business in the electrolysis industry, McPhy has been working on solid storage systems since 2008 and, for instance, installed one of its units at the airport Berlin-Schönefeld.

IAA 2015 – Where Electric Cars Bombed



The focus of the IAA was on hybrid models

Connectivity and digitalization – these were the main topics of the International Automobile Exhibition (IAA), which took place in Frankfurt a. M., Germany, from September 17 to 27, 2015. Both the media uplink to the entire globe and digital premium offers appeared much more important than clean engine technologies. The announcements did include much on electric cars, but there were mostly hybrid vehicles on-site; pure battery-driven vehicles were rare, and there were only two cars with fuel-cell technology.

The Association of the Automotive Industry (VDA) had not been completely wrong when saying that electric vehicles would indeed be a topic during the IAA. A closer look, however, quickly revealed how misunderstandings were willingly accepted to provide the car industry with a greener image. Traditional e-cars, which only possess a battery and an electric engine, were very hard to find.

The only exceptions seemed to be Audi and Porsche, which both showcased so-called “Tesla fighters.” Michael Müller, CEO of the latter company based in Zuffenhausen, presented a concept study, the Porsche *Mission E*, which intended to combine “the typical feel of driving a Porsche” and electric mobility. The range of the

440-kW sports car was given at a minimum of 500 kilometers, even with a more aggressive driving style. Charging the battery was said to take no longer than “a normal stop at a gas station for refill, espresso and handwashing” (around 15 minutes). This would be made possible by an 800-volt charge, which would be offered, “as soon as the technology will be developed enough – in less than five years.” Tesla’s boss, Elon Musk, will now have sufficient time to widen its lead.

Audi presented the e-tron quattro concept study, which is planned to compete with Tesla in terms of range, power (three electric engines with a combined total of 370 kW) and the “sporty feel,” but in form of an SUV. As an added benefit, the four-seater has been equipped with a solar roof. But this car will be commercially available at the earliest in 2018.

One could not find any other new battery car developments at the tradeshow. Most of the other automotive manufacturers remained largely silent on the issue. When asked about e-cars, Opel’s short reply was, “Not this year.” Honda also said that there “won’t be anything this year.” Additionally, the usual practice of using emission-free electric cars to provide shuttle service on the tradeshow premises was not continued in 2015. Instead, the organizers employed fossil-fuel engines and from time to time, a hybrid version.

Lack of motivation

[Willi Diez from the Institute for the Automotive Industry \(IFA\) said about the transition from combustion engines to e-cars: “If oil prices continue to be as low as they are right now, then we’re rather talking about 2030 or 2040. This means that each company impacted by the transition will have more than enough time to adapt.”](#)

Nissan allotted at least a small space to its *e-NV200* and its Leaf showcases, even if the vehicle showcased at the tradeshow was a hybrid car study. Mitsubishi took a similar approach and did provide some green for its *i-MiEV*. BMW, on the other hand, had several *i3* and *i8* models set up inside and outside the halls. But it seemed like a bit of a half-hearted attempt, so that tradeshow visitors could at least try testing the seats in some e-cars.

Daimler’s current key issue is also not the electric vehicle, but rather autonomous driving. How the cars of the future are supposed to be powered seems to be less important at the moment, although Daimler’s official press conference did include the sentence: “Digitalization and electrification will completely change our industry.” What is currently more of a priority to the company based in Stuttgart than low-emission driving is their vehicles steering and braking fully automated as well as using the web to be linked to the entire globe.

In that sense, the research car *F 015*, which had already been shown at the *Consumer Electronics Show* in Las Vegas in January 2015, left more of an impression for its interior design. Everything inside revolved around large ultra-HD touchscreens, front seats that can be turned by 180 degrees, and lighting systems. That the luxury limousine could be powered by a fuel cell in 2030 seems both natural and hardly relevant. At the present stage, however, the *F 015* is still a thing of the future: The available showcase still houses a battery that supplies the electric engine, which should provide 200 kW at some future point in time.

New Mobility World

Instead of recreating the e-car hall that the VDA still had in 2013, the association organized a special exhibition this time, entitled *New Mobility World*. Besides alternative drive systems, it also presented hot topics, such as connected systems, automation and car-sharing.

With an eye on fuel-cell technology, Frankfurt's automotive tradeshow was one big disappointment. Only Toyota aggressively advertised its new fuel-cell car *Mirai* – both on its website as well as at its tradeshow booth and during its press conference. The new CEO of Toyota Motor Europe, Johan van Zyl, already mentioned the market entry of the *Mirai* in Europe during the beginning of the company presentation. And on the first day of the tradeshow, Germany's Chancellor, Angel Merkel, visited the Toyota booth to see how a mass-produced fuel-cell car looks like. Dirk Breuer, Spokesperson at Toyota Germany, voiced his hopes in his conversation with *H2-international*, that the prominent visit would encourage other car manufacturers to show some more commitment to this technology segment. From the carmaker's Japanese headquarters: "Toyota is convinced that different technologies can exist besides each other, from electric cars to hybrid versions to probably the most innovative solution, the fuel-cell car."

Hyundai's President, Hyung Cheong Kim, also referenced his company's fuel-cell car *ix 35* at the beginning of the IAA and announced that from 2016 on, hybrid, plug-in hybrid as well as purely battery-powered models will follow. Additionally, Hyundai revealed a concept study of a race car, which – at least, theoretically – combines the fuel-cell expertise of the Korean carmaker with the speed of a sports car: the Hyundai *N 2025 Vision Gran Turismo*. This car concept study, however, was only developed for the PlayStation® game *Gran Turismo®*.

According to the list of exhibitors, Hyundai was the only company to showcase hydrogen. Thankfully, fuel cells were presented by three other automotive industry companies as well: CeramTec, ElringKlinger and Woco.

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Events

- December 16th to 18th 2015, **European Fuel Cell Conference & Exhibition**, in Naples, Italy, www.europeanfuelcell.it
- February 4th to 5th 2016, **HyVolution**, in Paris, France, www.hyvolution.fr
- March 15th to 17th 2016, **International Renewable Energy Storage Conference (IRES 2016)**, Düsseldorf, Germany, www.eurosolar.de
- March 15th to 17th 2016, **Energy Storage Europe**, Düsseldorf, Germany, www.energy-storage-online.com
- April 13th to 14th 2016, **Grove Conference Fuel Cells Science and Technology**, in Glasgow, United Kingdom, organised by Elsevier, www.fuelcelladvances.com
- April 25th to 29th 2016, **Group Exhibit Hydrogen + Fuel Cells + Batteries**, in Hannover, Germany, www.h2fc-fair.com, www.hannovermesse.com
- June 13th to 16th 2016, **World Hydrogen Energy Conference 2016**, in Zaragoza, Spain, www.whec2016.com

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Companies

Electrolyzers

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- **AREVA H2Gen GmbH**, Maarweg 137, 50825 Cologne, Germany, Phone +49-(0)221-888244-88, Fax -67, www.arevah2gen.com



Diamond Lite SA

- **Diamond Lite S.A.**, Rheineckerstr. 12, PO Box 9, 9425 Thal, Switzerland, Phone +41-(0)71-880020-0, Fax -1, diamondlite@diamondlite.com, www.diamondlite.com

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Energy Storage

- **GKN Powder Metallurgy**, GKN Sinter Metals, PO Box 55, Ipsley House, Redditch B98 0TL, Worcestershire, United Kingdom, www.gkn.com/sintermetals



- **Hydrogenious Technologies GmbH**, Weidenweg 13, 91058 Erlangen, Germany, Phone +49-(0)9131-12640-220, Fax -29, www.hydrogenious.net

Event Organizers



- **22nd Group Exhibit Hydrogen + Fuel Cells + Batteries**, HANNOVER MESSE 2016, April 25 – 29, Tobias Renz FAIR, Phone +49-(0)30-60984556, tobias@h2fc-fair.com, www.h2fc-fair.com
- **GL events Exhibitions**, 59, quai Rambaud, CS 50056, 69285 Lyon Cedex 02, France, Phone +33-(0)478-17633-0, Fax -2, www.gl-events.com

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- **Busch Clean Air S.A.**
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Hydrogen Distribution



- **Hydrogenious Technologies GmbH**, Weidenweg 13, 91058 Erlangen, Germany, Phone +49-(0)9131-12640-220, Fax -29, www.hydrogenious.net



- **Wystrach GmbH**, Industriestraße 60, 47652 Weeze, Germany, Phone +49-(0)2837-9135-0, Fax -30, www.wystrach-gmbh.de

Membrane and Separator



- **FuMA-Tech Gesellschaft für funktionelle Membranen und Anlagentechnologie mbH**, Carl-Benz-Str. 4, 74321 Bietigheim-Bissingen, Germany, Phone +49-(0)7142-3737-900, Fax -999, www.fumatech.com

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- **PLANSEE**
Plansee SE, Bipolar Plates, Interconnects and Metal Supported Cells, 6600 Reutte, Austria, Phone +43-(0)5672-600-2422, www.plansee.com

Organization

- 
- **Deutscher Wasserstoff- und Brennstoffzellen-Verband**
German Hydrogen and Fuel Cell Association, Deutscher Wasserstoff- und Brennstoffzellen-Verband e.V. (DWV) Moltkestr. 42, 12203 Berlin, Germany, Phone +49-(0)30-398209946-0, Fax -9, www.dwv-info.de
 - **hySOLUTIONS GmbH**, Steinstrasse 25, Germany – 20095 Hamburg, Phone +49-(0)40-3288353-2, Fax -8, hysolutions-hamburg.de

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- **Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie**
National Organisation Hydrogen and Fuel Cell Technology (NOW GmbH), Deutscher Wasserstoff- und Fasanenstr. 5, 10623 Berlin, Germany, Phone +49-(0)30-3116116-15, Fax -99, www.now-gmbh.de

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- **WS Reformer GmbH**, Dornierstraße 14, 71272 Renningen, Germany, Phone +49-(0)7159-163242, Fax -2738, www.wsreformer.com

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- **FLUID CONTROL SYSTEMS**
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- **HIAT gGmbH**, Schwerin, Germany, CCMs / MEAs / GDEs for PEFC, DMFC & PEM-Electrolysis, www.hiat.de



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- **Deutsches Zentrum für Luft- und Raumfahrt (DLR) / German Aerospace Center**, Institute of Engineering Thermodynamics Energy System Integration, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany, Phone +49-(0)711-6862-672, Fax -747, www.dlr.de/tt, www.dlr.de/tt

FLEXIVA

- **FLEXIVA automation & Robotik GmbH**, Power Electronics – Hybrid Energy System Solutions, Weißbacher Str. 3, 09439 Amtsberg, Germany, Phone +49-(0)37209-671-0, Fax -30, www.flexiva.eu

Testing



- **TestNet Engineering GmbH**, Schleissheimer Str. 95, 85748 Garching / Munich, Germany, Phone +49-(0)89-237109-39, info@h2-test.net, www.h2-test.net

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- **OMB Saleri SpA**, Via Rose di Sotto 38/c 25126 Brescia, Italy, hydrogen@omb-saleri.it, www.omb-saleri.it

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The advertisement features a background with a stylized atomic model. On the left, the WHEC 2016 logo is displayed, consisting of a circular orange and yellow graphic with a white starburst pattern, followed by the text 'whhec 2016'. Below this, the text reads 'World Hydrogen Energy Conference 2016', 'Zaragoza - Spain', '13-16th June 2016', and 'info@whhec2016.com'. On the right, there are three logos: a purple square with 'H2', a green 'AeH2' logo, and a blue circle with 'H_a'. Below these, the text says 'Call for abstracts', 'Open April 2015', and 'Deadline 31st October 2015'. A red horizontal bar at the bottom contains the text 'So mark your calendars now, we look forward to seeing you in Zaragoza'. At the very bottom, the website 'www.whhec2016.com' is written in large red letters.

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