



H2-international – e-Journal

August 2016

You receive this August version a bit later than usual because of the summer holiday.

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Just a Reminder – Look at 2002

Editorial



The Clarity, © Honda

Dear Readers,

During my research for the article on the second generation of Honda's fuel cell vehicle, the Clarity Fuel Cell (see <u>Honda Hands Over Keys for First Clarity Fuel Cell</u>), I suddenly remembered days long past. More specifically, I recalled news pieces that I had written or read many years ago. I did a bit of a search and found the following lines, which I would like to share with you:

"One must recognize the distinct accomplishment of the second-biggest Japanese carmaker, Honda, which – like archrival Toyota – succeeded before all automotive manufacturers in the Western world to supply customers with fuel cell cars. This symbolic act had been preceded by a months-long race to the finish, which resulted in both Honda and Toyota handing the keys for six cars to collaboration partners on the same day – Dec. 2, 2002. Four units of Toyota's FCHV were used by government departments in the greater metropolitan area of Tokyo; two others were given on the same date to Californian universities Irvine und Davis in the US. Both American institutions have since paid EUR 10,000 per month for the cars as per a 30-month leasing agreement.

"To Honda, this event was so important that the carmaker's CEO, Hiroyuki Yoshino, first handed the keys for an FCX to Japan's Prime Minister Junichiro Koizumi in the morning and then flew to California to give the keys for another one to the thenmayor of Los Angeles, James K. Hahn.



"A step further on the path toward regular use of these innovative cars was taken by Honda in July 2005, when the Japanese carmaker handed over the car keys for the first privately owned fuel cell vehicle in California, since the state's infrastructure has been the most suitable for such means of transportation to date (around 26 filling stations). The symbolic leasing rate (incl. maintenance and insurance) amounted to around USD 500 per month."

These paragraphs were taken from my German book *Wasserstoff-Autos – Was uns in Zukunft bewegt*, published in March 2006 under the Hydrogeit Verlag (ISBN 978-3-937863-07-8).

I continued skimming through the pages to find the following press release from Honda:

"TOKYO, Japan, June 10, 2008–Honda Motor Co., Ltd. will provide its new fuel cell vehicle, FCX Clarity, as well as Civic Hybrid and other advanced technologies for the G8 Hokkaido Toyako Summit to be held July 7-9, 2008."

After a quick search, I discovered great similarities to another statement – also by Honda – only with a more recent timestamp:

"TOKYO, Japan, May 26, 2016 – Honda Motor Co., Ltd. is providing CLARITY FUEL CELL, Honda's fuel cell vehicle, and AUTOMATED DRIVE, an autonomous development vehicle, for the Group of Seven (G7) Summit 2016 Japan in Ise-Shima, which is being held on May 26 and 27, 2016."

Understandably, you may ask yourself why I'm quoting Honda as part of this editorial. My answer would be:

I'm beginning to grow weary of having to report time and again on the fuel cell industry's delays and failures to act. So I thought it prudent to just pause for a second and look back at what has transpired so far. I will leave it solely up to you to draw your own conclusions from the following articles.

As a small nudge, I suggest that you think about which companies were leaders in the fuel cell market back then and which are now. Or ask yourself why the names of those companies cannot simply be replaced by others from the automotive industry. And just read pages "Honda Hands Over Keys for First Clarity Fuel Cell" or "Incentives for 400,000 Battery and Fuel Cell Cars" to see which companies act with forethought as well as advance fuel cell technology without always considering the "dividends of shareholders" first.

Maybe after doing that, the next time you get the chance, you would like to speak to an employee from Stuttgart, Munich, Wolfsburg, Rüsselsheim or Ingolstadt about what happened over the last 14 years and what the results have been.

And before I forget it, please also compare the number of public H_2 filling stations in the US – then and now.

Best wishes,

Sven Geitmann Editor of H2-international





Japan's Eternal Runner-Up

Honda Hands Over Keys for First Clarity Fuel Cell Electric Transportation



Fig. 1: Further improvement in energy density

Life's hard on Honda: The Japanese carmaker has always been overshadowed by its biggest rival Toyota. Whereas Toyota is expanding its lead thanks to VW's diesel emissions scandal, Honda's efforts to shine in the spotlight, at least by promoting forward-looking technologies, have been met with only a lukewarm press reception. The latest example of that was the corporation's unveiling of its second generation of Clarity fuel cell cars in the fall of 2015. The presentation attracted much less attention than when Toyota showcased the first generation of its Mirai.

In 2002, Honda had already been competing with Toyota about which company would be the first to deliver their fuel cell cars to external testing partners (see editorial on p. 3). It seems as if bad luck may just follow Japan's number two anywhere. In March 2011, it was an earthquake and a tsunami which impacted the company's production of the FCX Clarity. Toyota and Nissan had also been affected, but Honda wasn't able to produce as many fuel cell cars as planned. Then, there was the recall of Takata airbags, which mainly impacted Clarity Fuel Cell cars, so that a same-date market launch with the Toyota Mirai – as in 2002 (see editorial) – was no longer achievable.

Takahiro Hachigo, president of Honda Motor, nevertheless announced that his longterm strategy was to increase the share of electric cars in total production to twothirds by 2030. This development should also benefit General Motors, which cooperates with Honda in the fields of fuel cells and autonomous driving.

Range above 700 kilometers

The first time Honda presented the Clarity Fuel Cell was a year after the Mirai, at the Tokyo Motor Show in October 2015. In Europe, the second generation of the Clarity was first sighted at the Geneva International Motor Show in early March 2016, shortly before the company started selling it on the Japanese market. The first customer receiving a Clarity Fuel Cell was the Japanese Ministry of Economy, Trade and Industry (METI), where Hachigo handed over the car keys personally in mid-March.

The highlight of the vehicle is surely its enormous range of up to 750 kilometers on a full tank (Japanese standard JC08). The available range had been increased by 30 percent compared to the previous model, while drivers would still need no more than three minutes to refuel the 700 bar tank. Honda's chief engineer Keiji Otsu has recently told the German Spiegel magazine: "We reduced the volume by a third, no longer need more space than for a conventional V6 engine and have the smallest fuel cell of the entire automotive industry." The design of the Clarity Fuel Cell is the first where the entire fuel cell system is located under the hood, which leaves more space for the interior and – in contrast to all other fuel cell cars to date – provides room for up to five people.

Even if the car may sound like a commercially viable version, the factory in Takanezawa, Tochigi, will only produce 200 units of the 130 kW sedan per year. They will be initially sold per leasing agreement to prominent public figures (price: EUR 62,000). The car will reach the US and European market at the end of 2016. Germany, however, is not seen as a core market, which is why there have been only two units of the FCX Clarity in the country over the last years. Instead, the fuel cell cars will first be delivered to Denmark and the UK.

To complement its product portfolio, the Japanese carmaker will offer the Power Exporter 9000 as an APU to enable drivers to use the fuel cell power (9 kW; see p. 45) independent from the car. This "energy source on wheels," which has also made its way onto the market, is said to be able to supply an average household with enough electricity for a week.

Thomas Brachmann from Honda Germany explained to Spiegel: "The FCX Clarity hit the road in 2008. What we have unveiled here in Tokyo is therefore already a generation ahead of Toyota's model."

There Is No Stopping Plug Power

If the number of order bookings is anything to go by, then Plug Power is not only doing very well, but the company will be able to easily achieve or even exceed its ambitious goals: New orders worth USD 72 million in the first quarter increased backlog to an impressive USD 278 million.

The new booking target figure this year is USD 275 million. The revenue target is USD 150 million – after USD 100 million last year. However, there was some confusion, as Plug changed the accounting principles to non-GAAP. Based on GAAP, first quarter revenues increased to USD 30.1 million (same quarter last year: USD 9.4 million), but non-GAAP puts it at USD 15.2 million because of the latter's



method to evaluate leasing contracts. By its own account, Plug is primarily focused on getting out of its sale-leaseback transactions (e.g., Walmart contracts), since these restrict too much capital that cannot be otherwise invested in company operations – something that should change during the course of this year.

In 2016, the company is planning to establish 25 new locations. Plug collaborates with FedEx on projects to upgrade vehicles (e.g., at airfields) to fuel cell hybrids. The range is thereby said to increase from 60 to 160 miles, so that Plug is gaining an interesting additional source of revenue. My conclusion: The fast pace at which the company has grown is and continues to be impressive. Plug was able to continually up its gross profit margins. The aim is 30%; currently, margins are at 12.5%, although they are growing fast for fuel cell stacks.

Hydrogen as "consumption material" is also gradually becoming a more important and permanent source of revenue. Here, I could well imagine that Plug will produce the hydrogen on its own and buy less and less to increase margins. The company's share price development does not accurately reflect the growth of business, although Plug will face questions about its change of accounting principles and the impact from it.

On a side note: The US subsidy programs, which will run out at the end of 2016 and have not yet been extended, are extremely important. They provide tax incentives, for example, for the use of fuel cell systems in forklift trucks. An expected positive result – Plug is intensively lobbying representatives/politicians – could prompt a notable (extraordinary) share price bump.



Fig. 1: Plug Power has been partnering with H_2 producer HyGear since June 2016, © Plug Power

Risk warning: see below Author: Sven Jösting

Ballard Sets Its Sights on China

One should never be too enthusiastic, but if the Chinese government really takes up the battle against the country's dramatic pollution levels, fuel cells and hydrogen will become top priorities – domestically and globally. People will take note of the comments that Wan Gang, China's minister of science and technology, made during this year's industry conference H2Mobility in Berlin in early April. Gang – an engineer, who had a ten-year stint at Audi – considers the fuel cell's versatility and "green hydrogen" to be two key solutions for improving China's environmental situation.

During his presentation, he used many examples to point out that battery technology was expected to advance (providing greater energy density and increasingly lower prices), but that the fuel cell clearly remained his first choice. The enormous amount of renewable energy that China was aiming for (target is 200 GW of wind energy by 2020) was an ideal basis for "green hydrogen." Since the country thinks (has to think!) big, much will be written about the specific applications of fuel cells in China, as the Chinese need to instigate change and have no time to waste (at the eleventh hour).

A vision: What would it be for a goal should China aim to install charging points, but especially H_2 filling stations, in regular intervals along the new Silk Road to give a massive boost to H_2 transportation? Who knows – anything's possible!

An Audi h-tron was parked in front of the defense ministry building in Berlin. Ballard supplied the fuel cell patents for it, while Gang was employed at Audi – the perfect combination.



Fig. 1: Minister Wan Gang in Berlin

EUR 660 billion for China's infrastructure

At around the same time, China announced the launch of a three-year program worth EUR 660 billion and targeting the transport infrastructure, in particular mass transit by trains and buses. Another important factor: Of all companies to visit, the CP secretary of Guangdong province chose Ballard Power, signing a declaration of intent during his tour there – and this during the first Canada visit by such a high-ranking Chinese official over the last 50 years. Ballard has already collaborated with various Chinese partners and had cooperation agreements on the mass production of fuel cell bus stacks in place, especially in this economically strong region of the country. But typically, the stock price should have soared permanently thereafter. Instead, shares dropped again. Maybe the stock market has not yet become aware of all the potential China offers, or the skeptics who see China as a risky market are in the majority, as the country is often associated with IP violations (e.g., patent infringement).

Quarter figures and outlook breed optimism

Ballard Power was able to conclude the first quarter on March 31, 2016, with a rise in revenue by 76% compared to the same period last year. The company was also able to increase the gross profit margin by an impressive nine percentage points to 20%. Internal restructuring (the number of management positions was cut) helped reduce the base by more than USD 20 million to break even. The amount of USD 58 million in new order bookings has already surpassed last year's revenue. The most notable rise in revenue was recorded at 59% to USD 4.1 million for stacks delivered to Plug Power (materials handling) – a sign of good collaboration.

Recently, the company has also concluded the planned sale of part of its methanol telecom backup power business: Taiwanese Chung Hsin Electric & Machinery put USD 6.1 million on the table, of which USD 3 million have already been paid and USD 3.1 million will be based on milestones within the next 18 months, as well as at least another USD 2 million for stack purchases. The key aspect of this transaction: The sale made it possible to reduce expenses by above USD 4 million a year. Ballard was able to end the quarter with USD 44.3 million cash on hand, plus the aforementioned USD 3 million.

Ballard highlights

The company has also received a USD 12 million bus stack order from Guangdong Synergy Hydrogen. And Ballard subsidiary Protonex delivered PEM stacks to Insitu, a wholly owned subsidiary of Boeing. Insitu will integrate these fuel cell stacks into unmanned aerial vehicles called ScanEagle. Additionally, Protonex announced on June 1, 2016, that the company had received its largest individual order to date (worth USD 5.8 million) by the U.S. Army, which intends to use fuel cell systems among special operations forces.

Risk warning: see above Author: Sven Jösting

Tesla Raises New Capital

Tesla CEO Elon Musk was as eloquent as ever when he raised the targets for the company's electric car models: Instead of producing 500,000 electric cars (total figure, all models – i.e., Model S, Model X and Model 3) in 2020, the company should already achieve that number in 2018 and increase it to one million in 2020.

One can question whether these targets will become reality, as they require even more large infusions of cash, making additional capital increases inevitable. And this although Tesla has just recently sought more money: a gross amount of USD 2.3 billion, to be exact. However, the raised capital needs to be reduced by USD 600 million, money that Musk – as he claimed – needed for tax payments. He also "only" exercised stock options – I suspect with price development remaining in the lower two digits (still, mere speculation at this point).



Fig. 1: Tesla CEO Elon Musk, © Tesla

However, he possesses many more, which add up to over USD 1 billion in total book value and he does not sell Tesla shares from his own stock. Nevertheless, the maneuver again leaves unanswered questions, since he clearly does pull money out of the Tesla venture. The shares he mortgaged for personal loans have not been included yet either.

The increase in capital, the previously available cash on hand (more than USD 1.4 billion) and the preorders for Model 3 (370,000 at USD 1,000 prepayment per unit add up to over USD 370 million) will provide the company with enough liquidity for right now. This means that at present, capacities can be aligned with the CEO's revenue forecast or one can create the basis for achieving them. In my opinion, however, the latest capital increase won't be the last, as the Gigafactory will still require some more cash infusions. It may also be possible that Tesla will increasingly



rely on Asian manufacturers and delay or slow down the expansion of the factory (which should go online soon) to retain more of that liquidity.

Samsung as another cell supplier

Several rumors have pointed to Tesla seeking a collaboration with Samsung to sure up cell supply. But Musk replied via Twitter that the company had an exclusive collaboration agreement with Panasonic and that it would stay this way. What else could he have said anyway without the risk of having it look like he snubbed Panasonic or possibly endangered the partnership? Regarding the energy storage projects Powerwall and Powerpack, however, other partners (Samsung?) may come into play, according to opinions by Internet forum users.

Stock market right to be cautious

The development of the share price shows that the stock market may not take the Tesla CEO's forecasts at face value, as it dropped from above USD 255 to below USD 210 and only went up to USD 220 after the latest capital increase. This could also be just cosmetic surgery, since banks and brokers have a stake in "maintaining" the right share prices. Even more than 400,000 preorders of Model 3 (includes double orders, which is why the figure is 370,000 further above) do not change anything, as these have so far been only options with the intent to purchase (including a money-back guarantee), but aren't actual sales contracts.

By the way: There are signs that the money from these options was used to repay loans secured against Tesla assets (production means). In any case, it's a positive development if it turns out to be true (no guarantee it will), as this saves the company interest payments.

On a side note: Today's Model 3 buyers will have to wait until the end of 2017 or rather until 2018 to get their vehicle if they place a firm order today. But the competition doesn't sit on its hands, as all well-known carmakers have announced various battery-driven models with attractive ranges to enter the market at cheaper prices by 2018. I will stick with my conclusion that over time, there will be more skepticism (losses, capital flight, need for new cash, departure of important employees) to make the stock market wary of Musk's euphoric outlook and prevent new share price hikes. The market cap of USD 34 billion, in my view, includes any positive development that could be expected in the future.

Risk warning

Investors must understand that buying and selling shares is done at their own risk. Consider spreading the risk as a sensible precaution. The fuel cell companies mentioned in this article are small and mid-cap ones, i.e., they do not represent stakes in big companies and the volatility is significantly higher. This article is not to be taken as a recommendation of what shares to buy or sell – it comes without any explicit or implicit guarantee or warranty. All information is based on publicly available sources and the assessments put forth in this article represent exclusively the author's own opinion. This article focuses on mid-term and long-term perspectives and not short-term profit. The author may own shares in any of the companies mentioned in this article.

Author: Sven Jösting



eZelleron Moves Abroad

News



CEO Sascha Kühn, © eZelleron

While some talk about the bankruptcy of start-up eZelleron from Dresden, Germany, others only say that the headquarters were relocated to the US. How much truth is to these rumors? First, what is certain is that the delivery of fuel cell device kraftwerk will be late, as bankruptcy proceedings for eZelleron GmbH began on April 18, 2016, at the local court in Dresden.

Although the company from the German state of Saxony collected more than USD 1.5 million in January 2015 during a spectacular crowdfunding campaign (see HZwei issue from April 2015), the money seems to have not nearly been enough for the planned advancement and manufacturing of fuel cell chargers running on liquid gas. The situation is already getting complicated here because the campaign, for which eZelleron boss Sascha Kühn had established a separate company in the US, eZelleron Inc., was handled through US online funding platform kickstarter.com. The preorders from the 11,500 supporters on Kickstarter have been managed by the American business, which continued operations as usual. The only enterprise to file for bankruptcy was German eZelleron GmbH.

Almost at the same time as the start of the bankruptcy proceedings, precisely five days prior, eZelleron opened a new office in Palo Alto. Accordingly, eZelleron Germany announced that their headquarters would be moved to the US, as the



"attitude and the drive for such revolutionary technology can only be created and nurtured in Silicon Valley." Co-founder Martin Pentenrieder explained: "Unfortunately, it is still an impossible task to seek growth capital in Europe."

Despite the bankruptcy, Kühn intends to keep his company's staff in Dresden and produce the fuel cell devices in his hometown, just as had been originally planned. But to do that, eZelleron GmbH will most likely be liquidated and its assets transferred into a kraftwerk Inc. holding company with headquarters in Silicon Valley.

On June 1, 2016, the company announced through its Kickstarter web page that there would be a six-month delay in shipping the devices because of the currently unclear company situation, which was met with harsh criticism by some supporters.

German Accelerator

Like Hydrogenious, kraftwerk is participating in the German Accelerator program initiated by the federal economic ministry, a program intended to help start-ups gain access to international markets. In mid-October, eZelleron GmbH had already been selected for the program by a panel of experts. German Accelerator also provided the office in Palo Alto.

New FCH JU Head

News



P. Vannson und B. Biebuyck (right), © FCH JU

In May 2016, the Fuel Cells and Hydrogen Joint Undertaking (FCH2 JU) got a new executive director. In the middle of that month, Bart Biebuyck took over the task from



Bert de Colvenaer, who left in December 2015 – after which Philippe Vannson, the head of the Advanced Energy Systems unit of the European Commission, filled in the role temporarily. Biebuyck used to be Technical Senior Manager at the Fuel Cell Department of Toyota Motor Europe, where he participated in the German Clean Energy Partnership (CEP) in Berlin. Additionally, the Dutch national worked two years on the Small Vehicle Development Project by PSA and Toyota.

Pierre-Etienne Franc, Chair of the FCH2 JU Governing Board for Hydrogen Europe, explained: "The hydrogen and fuel cell industry has reached a critical point, and we need strong leadership for the opportunities and challenges ahead. Bart Biebuyck brings with him extensive expertise [...] and a deep understanding of the technology." Biebuyck himself said: "I feel honored to have been selected to lead FCH2 JU, and I am looking forward to working with all members to popularize this clean technology within the European community, in order to contribute to an eco-friendly economy."

EU Adopts PACE

Residential Market

The EU has decided to continue subsidizing fuel cell heating systems. The Fuel Cells and Hydrogen Joint Undertaking (FCH JU) announced that on June 1, 2016, the European Union launched the PACE project (Pathway to a Competitive European FC mCHP market) with incentives worth EUR 34 million. Its aim is to have more than 2,650 micro-CHP systems installed at non-field test customers by February 2021 to support market ramp-up. At the same time, a monitoring project should provide the feedback needed to enhance any further developments. The program with an overall cost of EUR 90 million is thought to give manufacturers the opportunity to set up their lines for mass production and automate manufacturing, in order to save equipment costs. It makes PACE the successor to ene.field, which has also been coordinated by COGEN Europe, but will run out after five years in August 2016.

As a consequence, four of the leading European manufacturers (Bosch, SOLIDpower, Vaillant and Viessmann) have pledged to increase their production capacities by 2018 to more than 1,000 units per year. Each of them will set up more than 500 units as part of the PACE program.



Germany Prepares for Technology Rollout Program

New Management Duo Introduced Residential Market

There's movement in the heating segment: Besides new entries trying to find their place on the market, efforts are well underway to ramp up the installation numbers of fuel cell heating systems in 2017. At present, however, the Technology Rollout Program (TEP) is still waiting for Brussels' approval. To be prepared for the day the program comes into force, the Fuel Cell Initiative (IBZ) has reshuffled personnel and responsibilities.

The lingering uncertainty about what the final version of the TEP expected this year will look like means that market players have been primarily focused on reshuffling personnel and responsibilities. First, there needed to be a reshuffling of tasks in the fuel cell heating segment, after the Callux innovation program ran out at the end of 2015 (see HZwei issue from April 2016). As the end of the program had left Alexander Dauensteiner as the long-time spokesperson for this Field Test of Residential Fuel Fuels and Head of Product Management Innovation at Vaillant Group without a proper assignment, he was voted into the management of the Fuel Cell Initiative (IBZ) at the beginning of this year, now heading the organization jointly with Markus Staudt, manager of the Viessmann Werke office in Berlin, Germany. Both men follow in the footsteps of former IBZ spokespersons Andreas Ballhausen, who used to work for CFC and is now part of the management at SOLIDpower, and Markus Seidel from EWE.



Fig. 1: Markus Staudt, new IBZ spokesperson

The IBZ has meanwhile adopted the new subline:

Center of Excellence for Residential Fuel Cell Supply

TEP still scheduled for 2016

Dauensteiner explained: "After 15 years of research and development, the industry has now reached the important threshold." It means that the Technology Rollout Program (TEP) is still expected to be implemented this year. It is supposed to run for seven years, so that around 75,000 systems should be in operation in 2022, possibly leading to a sustainable market at that point.

Staudt said that there were 700,000 heating systems currently sold each year; heat pumps alone made up 60,000 units annually. The aim is to put the fuel cell into the situation that the heat pump is in today, although the latter has been a mature technology for several years now.

Frank Heidrich, department official at Germany's federal economic ministry, however, acknowledged during a podium discussion at the Hanover trade show that "we are experiencing certain delays here regarding EU funding regulations" and that the TEP as an individual program would have to be approved by Brussels. Since April 26, 2016, the relevant papers had been available at the EU's Brussels headquarters, so that the representatives there had two months for the entire process. "If everything goes well, we should be done with this at the end of the year," Heidrich said.

The planned subsidy amounts to around EUR 10,000 for 1 kW_{el}, with systems of up to 5 kW_{el} being eligible for funding (capped at EUR 28,000; linear distribution in between). On top of that, there were the feed-in incentives from the CHP Act. Heidrich, however, noted that proper maintenance would be a prerequisite to ensure quality upkeep: "The installer has to offer a ten-year maintenance contract. Otherwise, there won't be any funding."

EUR 500 million over seven years

Dauensteiner went on to say that during the NOW general assembly in Berlin, a representative from Toshiba had told them that Japan had invested all in all EUR 650 million in the ENE-FARM program. The planned German one's seven-year budget of around EUR 500 million had a similar size. This led Dauensteiner to conclude: "If we pull this off, I do believe we could close an important chapter and show that we, too, here in Germany and Europe are able to offer innovations on the market – just as the Japanese have done."

However, he also noted that installation figures weren't exchanged between competitors, as this wasn't allowed by law, but that data on the number of heating units installed was collected by neutral organizations (e.g., attorneys) instead. Dauensteiner said about the development of the heating segment: "In five to seven years, fuel cell heating systems could become competitive." This means that in 2020, they "could be as viable as heat pumps are today."

SOLIDpower cooperates with CCTC

Until the beginning of this year, SOLIDpower's staff still had enough on their hands with concluding the takeover of Heinsberg-based CFC. Frank Obernitz, formerly president of CFC, told H2-international that it had been possible to "secure all jobs and customers." He, however, took on a position in February 2016 as CEO of Guidion Germany, a Düsseldorf company specializing in "energy industry services."

SOLIDpower, headquartered in Mezzolombardo, Italy, meanwhile gained a foothold on the Chinese market by signing a contract with Chaozhou Three-Circle Group (CCTC) in mid-January 2016. CCTC is considered one of the ten most important manufacturing companies for electrical and ceramic components in the People's Republic and snatched up some of the IP from Australian Ceramic Fuel Cells Limited (CFCL), which went bankrupt in 2015. Guido Gummert, CEO of SOLIDpower Germany, explained: "This agreement is giving SOLIDpower the big opportunity to establish BlueGEN on the market as it deems fit." The first cells from CCTC's production have already been delivered to Heinsberg.



Fig. 2: The first version of eneramic had already been presented at the HMI 2010.

New market actor in SOFC segment

A new market actor in the micro-CHP segment is Ceragen based in Unterhachingen. The company from the German state of Bavaria was founded in the fall of 2014 by Oliver Freitag and Marc Bednarz and has been operating on the high-temperature fuel cell market since July 2015. Freitag, who was an important contributor to the founding of SFC Energy, meaning he originally worked on direct methanol fuel cells, is now trying his hand on solid oxide ones. The relevant expertise comes from the Fraunhofer Institute for Ceramic Technologies and Systems (IKTS), which has invested more than EUR 11 million in the technology since 2007. The system is based on eneramic, a liquid gas-driven SOFC unit, which had already been presented at several occasions by the institute from Saxony as an APU prototype over the last years (see HZwei issue from April 2015).

The past months have been detrimental to establishing a spin-off. Meanwhile, a Ceragen factory was set up at the Dresden location. But Bednarz, who helped grow elcore before working as a freelance consultant for the IKTS until June 2015, left Ceragen at the end of April 2016 to join the green tech industry in Asia.

Freitag told H2-international that the first version of eneramic offered an output of 100 W and was combined with a heat storage unit. The latest plan was to test the first devices in the field at locations of strategic customers and increase output to 250 W_{el} or 500 W_{therm}. The targeted material cost for the stack was below EUR 300 per kilowatt. Manufacturing partners were standing by, but it would still take more than 18 months before the company could offer a market-ready product.

Big H₂ Industry Investments

Hanover Trade Show 2016

Trade Shows

Tobias Renz was able to celebrate a bit of a record this year: With overall 160 exhibitors from 25 countries, there have never been so many booths on the joint space of Hydrogen + Fuel Cells + Batteries organized by him. One of the reasons for this success may have been the many participants from the US, which alone had sent 21 industry representatives to the German trade show. America was this year's partner country of the world's biggest industrial exhibition. It should come as no surprise then that the partner choice prompted numerous complications on the trade show premises during the morning of the first day, as security was stepped up when President Barack Obama and Chancellor Angela Merkel began the traditional opening tour around the trade show.

This year, the mood in Energy Hall 27 was neutral or optimistic, proving to be much better than it had been throughout the last years, in which exhibitors and attendees wavered between resignation and impatience. For example, the fuel cell suppliers sounded quite positive, having manufactured and shipped a pretty high number of units in some market segments. Companies such as borit Leichtbau-Technik reported that their production capacity of 100,000 bipolar plates was currently exhausted. But it remains to be seen for what exactly all of these plates are going to be used. Even with the additional info of around 400 pieces being required per stack, the question remains which business will need all of these stacks. The only thing certain up to now is that the automotive industry is the company's main customer and requires numerous plates for the many tests that are being carried out.

Overall, the Hanover trade show boasted 5,200 exhibitors from 75 countries. Together, they used five percent more space than in 2014.





Fig. 1: Maroš Šefčovič, Commission Vice-President for the Energy Union (left), spent a lot of his trade show time talking about fuel cells (pictured here in a conversation with Franz Loogen from e-mobil BW)

DOE promoting fuel cell technology since 1970

To recognize the efforts made by this year's partner country, Tobias Renz also invited a US guest to join the podium discussion during the Public Forum. One of the things Sunita Satyapal, Director of the Fuel Cell Technologies Office at the American Department of Energy (DOE), mentioned during the first day's press conference was that the US had already started its research into the technology in the 1970s at the Los Alamos National Laboratory, a New Mexico institute of the American government. In 2009, the DOE had launched an initiative dedicated to materials handling and backup systems, which was the reason why – contrary to Europe – especially low-floor vehicles had become relatively popular across North America. In contrast, micro-CHP plants with fuel cells had not been a key topic overseas, although Japan had already seen thousands of installations (see <u>Germany Prepares for Technology Rollout Program</u>). California had certainly been the state where the biggest efforts had been made to promote the fuel cell sector, Satyapal continued, but added that Hawaii likewise had invested a lot of time in advancing the technology.

NEL invests in H2 Logic

Norway was another heavily represented nation, with overall eight organizations at Renz's joint space. Again among the Norwegian exhibitors was NEL Hydrogen, which had acquired the Danish supplier of hydrogen filling stations, H2 Logic, for EUR 34.3 million last year. H2 Logic continues to operate as a subsidiary under its



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previous management and with its former staff as part of NEL ASA, a spin-off of Norsk Hydro. In turn, NEL ASA subsequently grew from a manufacturer of electrolysis systems into a globally leading supplier of hydrogen filling stations. It is the reason why NEL announced at the beginning of April 2016 that it intended to set up a new manufacturing facility for H₂ stations at H2 Logic headquarters in Herning, Denmark. The factory, in which NEL is investing around EUR 9 million, is to be equipped with enough capacities to allow for the hydrogen supply of 200,000 new fuel cell cars per year: After the ramp-up, the company intends to produce 300 H2Station[®] systems each year at the new location.



Fig. 2: Although Obama did not find his way into hall 27, the French economic minister, Emmanuel Macron, showed up at the joint space.

RGH2 cooperates with TU Graz

An interesting new market player, which used the trade show to make its case to the public for the first time, was Rouge H2 Engineering (RGH2). The company based in Graz, Austria, specializes in energy storage. It intends to install steam reformers directly at refueling stations to create hydrogen for biogas onsite, thereby eliminating the complicated H₂ transport. RGH2 relies on the expertise of professor Viktor Hacker, head of the Fuel Cell Group at the Technical University of Graz, and the knowledge of AVL. The special feature of the company's reformer is the combination of all important components (H₂ generation, storage and release) inside one unit, making it possible to use gas from the most different sources when creating hydrogen. The hydrogen will then be stored in a metal-rich "contact mass" and released after being heated up again. The result is H₂ gas at comparably high pressure of between 40 and 100 bar.

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Hacker, who had the production method patented in January 2016, said that the contact mass did not consist of a metal hydride, but either iron, wolfram, molybdenum or germanium, which is at least partly reduced by the hydrogen or even the carbon monoxide or gaseous hydrocarbons under the given temperatures. This meant that different types of hydrocarbons could be used as a basis. The method also made it comparably easy to increase pressure by adding gas at ambient pressure and siphoning off pure hydrogen at excess one.

H₂ gas is produced inside the reformer by using hot steam at temperatures of preferably between 400 and 1,000 °C. This will oxidize the metal and release hydrogen. The high purity of the released gas was one of the many advantages of the new approach, Hacker said. President Florian von Hofer added that any given number of these reformers could be combined in parallel. For example, 50 units could supply enough hydrogen to refill 50 to 80 fuel cell cars per day (approx. 250 kg). He continued that the company was planning to install its first system in Austria next year.

Von Hofer also told H2-international that it was a conscious choice to select the Hanover trade show, and particularly Tobias Renz's joint space, to be the platform and the first event to showcase the business's new technology. After comparing this trade show with numerous others, he was convinced that the Hanover one was where he would find his target audience. To him, the Hanover trade show was the "event most suited to our needs." And he actually seemed very satisfied – both with his booth and with the amount of interest from attendees ("warm welcome, everything's just as it should be").

De Nora also chose the Hanover trade show to present his company's latest generation of gas diffusion electrodes (GDE). Based on a license agreement, the Italian business is picking up where BASF left off. Several years ago, BASF Fuel Cells had moved to the US before abandoning the field altogether. Their previous work on Celtec MEAs has now been licensed to and continued by De Nora and Advent (electrodes), Trigona (membrane), as well as Serenergy and Advent (MEAs). In Rodenbach, Germany, De Nora Deutschland has around 100 staff, who work on chloralkali electrolysis, oxygen-producing electrodes and water treatment.

AVL and Greenlight join forces

AVL List and Greenlight Innovation used their time during the trade show to announce that they were planning to develop a joint testing platform for fuel cell engines (cars & utility vehicles). The Austrian and the Canadian company signed a collaboration agreement which calls for a timely solution for car OEMs and manufacturers of fuel cell trucks. The new testing platform should offer load banks, electric engine test stands and climate chambers, and be equipped with software to automate and simulate as well as enable measurements, tests and inspections.

Ross Bailey, CEO of Greenlight Innovation, explained: "Greenlight has 25 years of experience in the fuel cell and hydrogen industry, AVL more than 65 years in automotive powertrain development – by joining forces, we are offering best-in-class products and services for fuel cell system testing." He added: "When a company like AVL declares its commitment to this technology, it signals the world that fuel cell vehicles can become reality."

High-pressure storage market changes

News have also been coming in from the high-pressure storage industry: After economic difficulties prompted a takeover of the German manufacturer of composite containers, Dynetek, by the UK's Luxfer, Californian competitor Quantum filed for Chapter 11 on March 23, 2016, and has since been looking for an investor. xperion Energy & Environment seems to have had better luck, judging by the fact that it was the first time the company from Kassel, Germany, exhibited in Hanover. The 150-staff business belongs to the Avanco Group and specializes in natural gas and hydrogen, specifically in composite Type 4 high-pressure tanks.



Fig. 3: Cross-section of a composite high-pressure tank

Interest in MobiliTec continues to dwindle

Electric transportation was less visible this time around than it had been in the past. In contrast to previous years, the Ride & Drive only offered fuel cell cars for a spin, but no battery-driven ones. Additionally, there were much fewer electric cars in hall 27 in 2016. Whereas 2014 saw 154 exhibitors displaying their product offerings on around 4,000 m², there were only 120 this year on half the space. Instead, the 2016 edition was more focused on the digitalization of transport means. NPE chair Professor Henning Kagermann said at the start of the MobiliTec forum: "The future of transportation is in networks, electricity and automation. [...] The autonomously driving vehicles we will get can only be electric ones. [...] Sometime between 2020 and 2030, electric transportation will finally succeed conventional engine designs."



Incentives for Battery and Fuel Cell Cars

EUR 1.2 Billion for 400,000 Electric Cars Electric Transportation

The Car Summit that took place in the chancellor's office resulted in the creation of the long-requested economic incentive for electric cars. In Berlin on April 26, 2016, Chancellor Angela Merkel came to an agreement with the heads of the automotive companies about an "incentive lite," to which the industry had to contribute at least half of the funding. That didn't stop other politicians and environmental organizations from criticizing the agreement. It's still unclear how popular the new incentive will become.

The original plan was to explain at the beginning of the year in what way electric transportation is going to be promoted in the future. However, the German federal government requested another postponement in February 2016, since the departments involved couldn't come to an agreement. Professor Henning Kagermann subsequently called on the government to announce a decision by March 2016 at the latest, as the target figure would otherwise have to be revised. But in Leipzig, the NPE chair said that he didn't see a problem with a consensus being reached one month after the deadline he asked for.

In fact, at the end of April, the parties involved did come to an agreement, which was approved on May 18, 2016, by the chief executive body of Germany. Federal economic minister Sigmar Gabriel said: "This is an important signal to the industry. The measures passed today in the cabinet, especially the economic incentive, will lead to more eco-friendly electric cars on our roads. The growing demand will trigger important and essential investments across the entire value chain of electric transportation."

Government and industry share funding responsibility

The decree now stipulates that buyers of electric-only cars receive EUR 4,000 for their purchase. The amount is the same for fuel cell vehicles. The sales contract, however, must indicate that the carmaker has reduced the car price by half of the overall incentive amount, i.e., EUR 2,000, before the owner can apply for the second half of the incentive online at the Federal Office for Economic Affairs and Export Control (BAFA). People purchasing a plug-in hybrid must abide by the same rules, although they receive a slightly lower amount (EUR 3,000).

BAFA application

As with the 2009 scrappage program, BAFA will again be responsible for payment. BAFA president Arnold Wallraff promised to Autohaus: "Back then, it took us four to five weeks between receiving all relevant papers and paying the owner. We intend to make payout of the electric car incentive even faster."

In any case, buyers must keep their new electric cars for at least nine months. Additionally, the vehicle must not cost more than EUR 60,000 (net price of basic model on price list). The incentive will be paid until the EUR 600 million budget is exhausted (which adds up to EUR 1.2 billion when including the other half of the incentive funded by the industry), but not beyond June 30, 2019. Applicants eligible



for the incentive are private citizens, businesses, trusts and associations, to whom or which the new car is registered. The money for the infrastructure expansion (all in all, EUR 1 billion) will be taken from the Energy and Climate Fund.

More charging points

The entire list of government measures also includes a ten-year exemption from vehicle tax for electric cars bought prior to 2020. They also allow for a tax-free non-cash benefit if the car is charged at work. The expansion of the charging points is said to be funded with EUR 300 million. This includes 10,000 normal AC charging stations (EUR 200 million) and at least 5,000 fast-chargers (EUR 100 million). Another EUR 100 million are to be invested in increasing the share of electric cars in the federal government's vehicle fleet to 20 percent from Jan. 1, 2017, on.

NPE chair Kagermann, who himself did advocate against an economic incentive in 2010, made clear that without further subsidies, the number of new electric cars would have "only" been between 400,000 and 450,000. However, federal transportation minister Alexander Dobrindt expects the new regulations to provide enough funding for the purchase of around 400,000 electric vehicles. Whether the incentive will actually lead to many more electric versions being sold is still an open question.



Fig. 1: Minister A. Dobrindt at press meeting, © BMVI

Regulatory taboo

In contrast, the Green Party criticized the agreement, pointing in particular to how the incentive is being paid for by all taxpayers. The vice-chair of the party's parliamentary faction, Oliver Krischer, said: "The right thing to do would be to have the drivers of overpowered gas guzzlers fund the incentive." Even among the Christian Democrats, many are against the agreement. There is much talk about the subsidy being feared to have no real impact, as it may just be claimed by people who would have bought such a car anyway, and about the agreement touching on a regulatory taboo leading

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to the distortion of competition. Additional criticism has been leveled at the fact that other industries seemed to need incentives much more urgently than the automotive one does. Especially now, during a time when the diesel scandal is still reverberating, it remains a difficult task to convince a majority of the public why government funding should be used to reward the same German carmakers that for years haven't touched hydrogen and battery technology and have stubbornly been clinging to diesel instead.

Reiner Holznagel, president of the German Taxpayers Association, remarked: "It's absurd that the revenue of some carmakers is higher than the budget of the ministries from which they get their subsidies. There is no objective necessity for these kinds of incentives."

Eco-bonus

The EU Commission gave the green light: On June 16, 2016, Gabriel announced that the subsidy guidelines could be presented to the Economics Committee of the German Bundestag.

Hydrogen Car Garage

Electric Transportation

Anyone who already owns a fuel cell vehicle and needs to have it repaired now has someone to turn to: Car dealership Karl Russ has opened its own hydrogen garage. The Mercedes dealership in Nürtingen invested more than EUR 70,000 in equipment and monitoring technology to be able to make all necessary repairs on fuel cell vehicles while complying with German safety standards. The garage had already been inaugurated at the end of 2015. Managing partner Stefan Russ told the Nürtinger Zeitung: "Thanks to our customers, we can already service F-Cell vehicles according the manufacturer's instructions. Our new repair shop has us well prepared for future car generations."

Abt Secures Second-Place Finish

8th Round of Formula E Series in Berlin Electric Transportation



Fig. 1: Burning rubber on hot asphalt

It smelled like burned rubber: no engines roaring, but wheels screeching. And after the group of vehicles disappeared behind the next turn, everything went quiet again until the regenerative electric engines and screeching slicks forebode the fast-approaching race cars once again. FIA's eighth round of the Formula E Championship held on May 21, 2016 in Berlin was anything but boring. Around 15,000 people could experience that for themselves on a sunny and warm spring day and later cheer Daniel Abt's second-place finish on home turf. This season's win at the sold-out BMW i Berlin ePrix was the third one in a row for Sébastien Buemi and his Renault team e.dams.

It was indeed thrilling to watch: The repurposed Karl-Marx-Allee in the midst of Germany's capital offered everything what a good car race needs, from burning rubber, risky overtaking maneuvers, accidents sending car parts flying, and, of course, a champagne shower – but no deafening engine roar, which seemingly wasn't missed by the audience.

Just like Formula 1

Drivers naturally pushed forward the first chance (or chicane) they got, which was when teammates Nelson Piquet Jr. and Oliver Turvey razed a front wing off each other's car and Buemi moved into the lead after starting second. Jean-Éric Vergne, who began the race in pole position, was able to counter with a surprise maneuver,



but few laps later, the Swiss national in his Renault Z.E.15 again took the lead and defended his position up until the finish line. Vergne ultimately placed fifth.

During the entire race, there was a thrilling competition for the second, third and fourth place between Daniel Abt, Nicolas Prost and Lucas di Grassi, the Brazilian national who had started as eighth and partly succeeded by moving ahead of Prost to become third after several failed attacks (see figure 3, p. 3). Shortly thereafter, drivers were instructed to run safety car laps because of a vehicle that broke down on the track. Despite Abt being given a team order ("Let Lucas by"), di Grassi wasn't able to overtake him in the end, which meant that the Brazilian is now leading the overall ranking by only one point. Abt said after the race that he had given his teammate a sign to race past him two laps before the end, but admitted that he had not wanted to risk his place on the podium, as Nicolas Prost, also from Renault e.dams, was breathing down his neck. Despite the quarrels, Abt was all smiles during the podium celebration in front of a home audience.



Fig. 2: Lucas di Grassi and Daniel Abt (right) during the podium ceremony

"We know that we always want more, but today was a fantastic result for the team."

Alain Prost, winner of several Formula 1 championships and senior team manager of Renault e.dams

Nick Heidfeld from Mahindra Racing did push forward to fifth during qualifying, but had to start in the last row like his teammate Bruno Senna because of too low tire pressure. Still, Heidfeld secured a good seventh place after 48 laps and took home six points for the championship ranking. The German, who lives in Switzerland, said: "Unfortunately we had to start the race from very far back due to the penalty but I am happy with how well we recovered."





Fig. 3: The residents living nearby had the best view on the race.

Who will win the world championship this second Formula E season will now be decided in the final two days of racing on July 2 and 3, 2016, in the Battersea Park in London, UK. After eight races, Abt places seventh in the driver ranking (50) and Nick Heidfeld ninth (47). In the team ranking, Renault e.dams is currently in the lead with 202 points before ABT Schaeffler (191 points).

There won't be a race in Moscow, as originally scheduled for the beginning of June 2016. Instead, the organizers are turning to fans for ideas which racetrack in New Delhi could be suitable for next season.

Rules

Each Formula E team has two drivers in the race, who both have two vehicles available. Instead of refueling the cars during the race, as it is done in Formula One, the Formula E drivers just get into their second car with a fully charged battery (28 kWh). Their vehicle's output is 170 kW during the race and 200 KW during qualifying, which is ensured by its control unit. This unit also regulates the FanBoost, which gives the three "most popular" drivers temporary access to 200 kW during the second half of the event. Additionally, the car swap halfway through provides them with better opportunities for individual strategies and offers the audience a more fulfilling racetrack experience.

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Fig. 4: Halfway through the race, it sometimes got quite crowded at pit road.

Up to five-speed transmission

During the first season, all drivers started in identical cars, but the current one at least allowed for individual powertrain designs, prompting already seven manufacturers to develop their own solutions for engine, inverter and transmission. It is the reason why almost all teams have meanwhile switched to multispeed (two- to five-speed) vehicles. For example, the team of ABT Schaeffler Audi Sport has designed a three-speed electric engine. Only DS Virgin Racing and NextEV TCR rely on two one-speed electric units – one per rear wheel.

Although developers of electric cars typically refrain from installing gearboxes, quickly shifting speed is said to provide even greater performance during the ePrix. It is why Formula E cars accelerate from 0 to 100 kph in 2.9 seconds and reach 225 kph on straight parts of the 1,927 kilometer long racetrack. Starting next year, developers will have even more freedom in designing their vehicles, which will lead to even greater competition – and possibly, also more teams and more drivers.

The required electricity is fed into the lithium-ion batteries by using a charging plug. Only the two BMW i3 vehicles, which stand by as medical cars, as well as the two BMW i8, which are safety cars, use inductive charging, so that they're ready to go at any time.

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Fig. 5: Inductive charging

"The technology we now see on the racetrack will later make it onto public roads." Alejandro Agag, founder and promoter of Formula E

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- October 15th to 17th, 2016, **World of Energy Solutions**, on the Stuttgart Fair Ground, Germany, <u>www.world-of-energy-solutions.de</u>
- October 18th to 20th, 2016, eMove 360° Europe, Mobility 4.0: electric connected – autonomous, in Munich, Germany, <u>www.emove360-expo.com</u>
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