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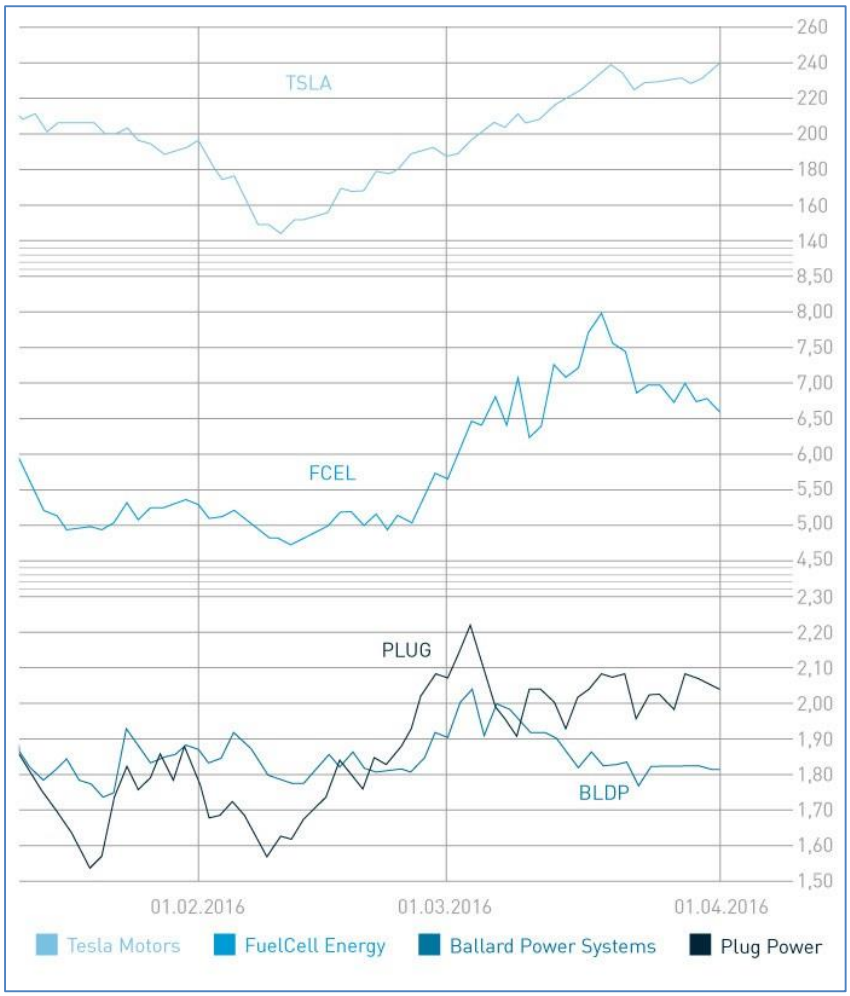
Content

Fuel Cell Outlook Never Been Better



Charts April 2016, © www.wallstreet-online.de

The large increase in the number of orders placed with each one of the fuel cell businesses analyzed in this and following articles promises a very bright future for the industry. Prototypes give way to mass production. The recent stabilization of the oil price is an effective mental tool. The road to profitability is there. The shares have potential – but not everyone has realized it yet!

High hopes for Beacon Falls project

The first-quarter figures of the 2016 fiscal year (as of 01/31/2016) were disappointing, considering the USD 12.5 million net loss attributable to common shareholders (after a USD 4.9 million loss during the same period last year). However, the share price seemed to suffer only a small temporary setback in the wake of its steep increase to USD 7.00 – and compared to the previous hike by USD 5.00 – before continuing its rapid rise. More than USD 400 million in orders have already been placed with the company, and if the large-scale Beacon Falls project can be realized (1st quarter of

2016), it won't be hard to do the math and forecast another USD 500 million in orders, which would give the stock an additional boost.

Decision in first quarter of 2016
The company's financial position is just as strong: In addition to cash reserves of over USD 80 million, Californian FuelCell Energy has another USD 70 million available as facilities for project funding. The stock market is counting on the promising outlook of this front runner in clean energy that uses fuel cells and waste heat to create efficiencies above 90% (power and heat). If the bid on this huge project is successful, Beacon Falls should be the reason for significantly higher stock quotes. Before the reverse split (1 for 12), the stock was quoted at above USD 10.00 per share – a fitting goal for the next round of share price jumps. Analysts from well-known investment banking firms have already set the target price to more than USD 20.

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

Plug Power: Growth Not Losing Speed

The fourth quarter brought another growth boost by 70% to USD 38.4 million compared to the same quarter last year. Plug Power's total revenue added up to more than USD 103 million, although it could have been 3.6 million more if the sale-leaseback transactions hadn't forced the company to distribute the amount for tax reasons across contracts. Revenue was originally thought to reach USD 100 million. The adjusted EPS with a loss of EUR 0.05 per share was within expectations. Sixty million of the around USD 111.8 million in cash reserves are "restricted," i.e., related to sale-leaseback activities. Meanwhile, the US-based company has acquired a loan facility worth USD 30 million, which is the basis for refinancing and is said to replace the "tied-up cash reserves" within a year. There is also talk of a renewal of the governmental investment subsidies (30%), but nothing definite yet.

Plug Power's 2016 target is a revenue increase of USD 150 million. It has already announced over USD 200 million in contract bookings. The goal is to increase the order total to above USD 275 million, which is easily achievable in light of the big customers that Plug Power has struck deals with recently. The company will use USD 20 million of its own cash in 2016, which is not endangering its liquidity. Nike

and Home Depot are now two of these big customers (“The roll-out at Home Depot was probably the best we ever had.”).

There are already over 3,000 tank refills with a consumption of around 2.5 t_{H2} per day. Another very positive development is the increase in the gross profit margin to above 30%, so that the break-even scenario is expected to be 12 to 18 months away – an important milestone.

Fuel cells in materials handling, © Plug Power

Political lobbying

Plug Power increasingly relies on political lobbying, as the US tax framework (grants, write-offs, etc.) at federal and state level does affect regenerative energies like solar electricity, but there is no expressed mention of fuel cell use. It is mainly an issue of extending the run time of existing subsidy legislation. The company has recently given various senators a tour of the company and held presentations on-site – a clear sign of lobbying for extensions. This leads me to believe that tax incentives will only be a matter of time. Their impact, however, is somewhat crucial to the share price, since they may persuade some customers to order earlier if grants are approved. After what I could gather, the decision – as I believe, a positive one – will be made in the first half of the year.

I expect new impetus from Europe, since Plug Power’s US customer base consists mainly of Europe-based businesses, especially from the automotive industry (BMW, Daimler and VW), and I believe a transfer of the business model (fuel cell systems for forklift trucks at German production sites, set-up of an H_2 infrastructure) to European locations can prove successful. In other words: Why does VW rely on fuel cell forklift trucks in the States, but not in Germany and Europe?

Interesting side note
Just like Nike, Home Depot is now definitely one of Plug Power's new big customers. The company has been able to win over the who's who of retail corporations, which necessitates changes in the entire logistics chain. However, each building- and security-related change of a large distribution center to house H_2-filling stations must be approved by various US agencies or the local construction authority. The applications filed can even be found on the internet. And this search will turn up a permit application for Home Depot's distribution center in Savannah. Clever stockholders are now on the lookout for similar applications, since they can be used as an indicator of which projects Plug Power will work on in the future.

Still, one may ask why Plug Power refrained from announcing or touting the good news, since it is quite likely that the company signed framework agreements with large corporations like Home Depot, i.e., alteration of x distribution centers per year. Like Walmart, Home Depot has more than 100 of them. In light of quite a lot of share short selling, such news could have a positive impact on the stock price – if Plug Power had any interest in revealing such information!

USD 30 million funding
In the meantime, the USD 30 million loan (which runs one year at 12.5% interest) that Plug Power took out not too long ago has fueled speculations: What should the money be used for (and why the comparably expensive conditions)? The only thing that seems clear is that Walmart urged for sale-leaseback contracts when placing its orders. This means that Plug Power needs to put money "aside" and consider this money "restricted," which affects the company's overall liquidity. The USD 30 million loan is seen as one step to free up "currently tied-up cash reserves/equity capital" and remove the restrictions. Plug Power intends to accomplish that goal until the end of 2016.

Risk warning see page 3

Author: Sven Jösting

Audi Gets the Fuel Cell

As predicted several times before, #dieselgate is the driver of upcoming changes at German carmaker Volkswagen. In March 2016, it was said that the Wolfsburg-based corporation would concentrate all fuel cell activities at its Audi subsidiary. This will necessitate a move of most of the fuel cell research, which has so far been conducted in the German city of Salzgitter. Stefan Knirsch, board member and head of development at Audi, told the magazine Automobilwoche: "This January, the task of corporate research on fuel cell engines was given to Audi." And VW's board of directors had supported the concentration of activities. The company's employees in Salzgitter, however, weren't about to give up on their job prospects that quickly. Andreas Blechner, chair of the works council in Salzgitter, said to the magazine Automobil Produktion: "We intend to bring the corporation's R&D facilities for new engine advancements – in both fuel cell technology and battery cell production – to Salzgitter."

LOHC – A Reusable Bottle for Hydrogen

When not charged, Marlotherm is of clear yellow color

Five years ago, some called carbazole the “wonder fuel” and “fuel source of the future,” although basic research hadn’t even been concluded yet. After intensive development, Hydrogenious Technologies has just presented a potential successor to the carbazole legacy: dibenzyl toluene. On Jan. 29, 2016, the company based in Erlangen, Germany, brought its first hydrogen storage unit based on this liquid organic hydrogen carrier (LOHC) into operation at the company’s headquarters. Around 150 people were present when Ilse Aigner, Bavaria‘s economy minister, inaugurated the system.

Development started with the doctoral thesis of Daniel Teichmann, now CEO of Hydrogenious. When he was looking for a dissertation advisor in 2010, it was professor Wolfgang Arlt who took on the job and – as the story continues – he has never regretted his decision. Together with professor Peter Wasserscheid, whose

research was focused on ionic liquids, he discovered N-ethyl-carbazole ($C_{14}H_{13}N$, short: carbazole) as an energy carrier. When both professors presented their intermediate results at the beginning of this decade (see Arlt interview in HZwei issue from October 2011), it caught the attention of a lot of people, although research had still been limited to the laboratory.

Cornelius von der Heydt, head of sales at Hydrogenious Technologies, told H2-international: “The professors continued their research and tested a myriad number of different chemical compounds.” Finally, they found dibenzyl toluene. Von der Heydt said: “LOHC makes many market participants either think of carbazole or of toluene, which both show significant drawbacks compared to the material we’re using.”

For the 20-people team, it’s all about the heat transfer oil, which has been on the market for 40 years. The oil is similar to liquid diesel, but according to the chemical scientists, it‘s non-toxic, non-carcinogenic and won’t even go up in flames if a Bunsen burner is used – not even when it has been charged. However, the risk and safety warnings say it can be “fatal if swallowed and enters airways” (H 304) and “may cause long-lasting harmful effects to aquatic life” (H 413). But it costs only a few euro per liter.

There has long been a safety sheet for the non-charged substance. Certification for the charged one is ongoing, according to von der Heydt, and should be completed as soon as this summer.

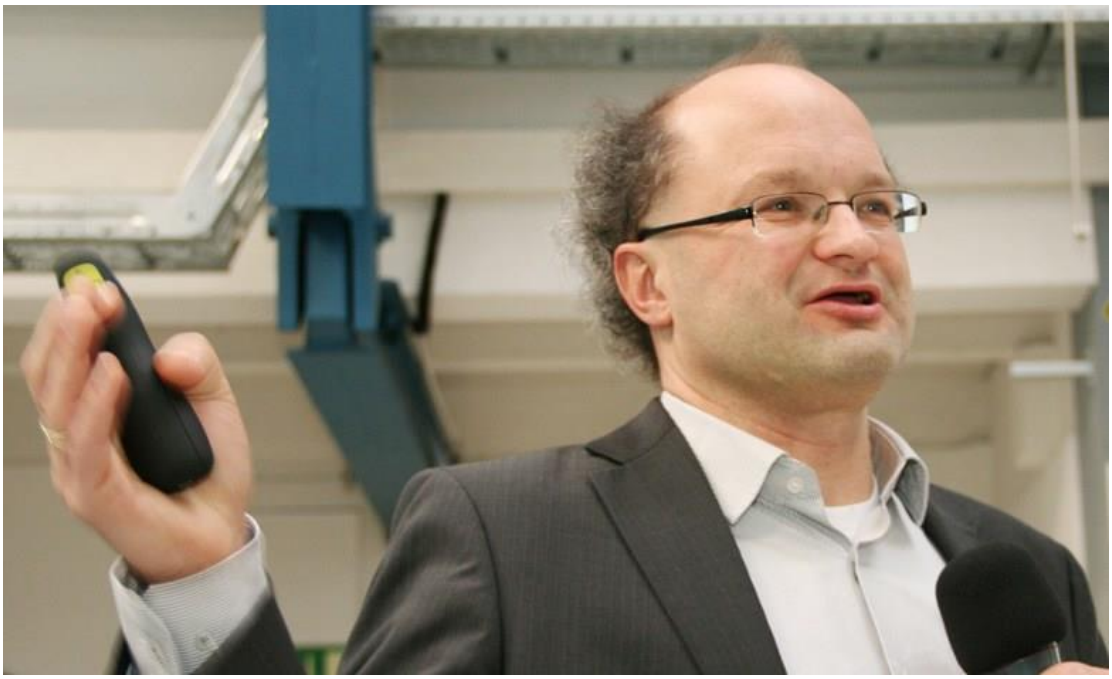
Tab.: Storing 3 kilograms of hydrogen.

	GH_2 (300 bar)	**LOHC** (ambient pressure)
Weight	250 kg	50 kg
Volume	150 L	50 L

Pilot at Fraunhofer IAO

The Hydrogenious approach is based on the use of the organic chemical compound as a hydrogen transfer liquid. Wasserscheid, head of the Helmholtz Institute Erlangen (HI ERN), explained during the inauguration ceremony: “Nowadays, our energy industry relies on liquid fuels. LOHC is a medium that acts like a reusable bottle for hydrogen and is safer and better than the fuels that are available today.” To test the liquid, the Bavarian-based company set up a solar system on the roof of a neighboring building (98 kW_{peak}), in order to create hydrogen through sustainably generated power. This hydrogen is then stored in the “wonder fuel.” The electrolysis process uses the first generation of Siemens Silyzer systems, with a unit having been installed at the headquarters’ factory hall. Whereas the waste heat of the container is offered to the nearby swimming pool, the created hydrogen flows at 50 bar into the hydrogenation plant to be added to the dibenzyl toluene.

"Hydrogen is a strategic resource to meet demand during supply shortages." Together with Matthias Beller (see below), Wasserscheid was awarded the Gottfried Wilhelm Leibniz Prize in 2006.



Prof. Peter Wasserscheid

The so-called StorageBOX consists of two storage tanks, which were originally designed for milk processing and can hold up to 1,000 liters. One of the tanks contains the carrier, which absorbs the hydrogen in the reactor at 150 to 250 °C. One liter of LOHC can store 600 liters of GH_2 (energy density: 1.9 MWh/m^3). The catalyst is made of ruthenium. The almost-quiet intake process consumes up to 0.6 kilograms of hydrogen per hour. It is possible to repeat the reversible procedure around 1,000 times. And with the thermal oil showing a density similar to water (1,050 kg/Nm^3), it can be stored indefinitely.

The crystal-clear liquid treated with hydrogen is then transported inside trailers to its destination. Even the company from northern Bavaria thinks it's unlikely that hydrogen-driven cars will receive an LOHC tank in the future. But the liquid could make the supply of H_2 filling stations a much more efficient business if instead of GH_2 trailers – which mainly transport steel and only around 300 kilograms of hydrogen – suppliers would use LOHC-filled trucks. A 40-ton trailer could transport around 1,800 kilograms of hydrogen-treated LOHC and would even be allowed to go through all kinds of tunnels, whereas GH_2 transports are not permitted in some of them.

The current test run supplies the Fraunhofer Institute for Industrial Engineering (IAO) in Stuttgart, Germany, which had a dehydrogenation system installed for demonstration purposes. The ReleaseBOX set up there reverses the previous exothermic process: The oil is pre-heated before passing through a 100 kW reactor, in which the gaseous hydrogen is separated at 300 °C from the heavy carrier medium. The use of platinum and palladium catalysts makes this a very simple

separation process (boiling temperature: 390 °C). After purifying, the hydrogen generates electricity as part of a 30 kW fuel cell that charges electric cars.

Martin Johannes Schneider, head of Hydrogenious's project development, said during the ceremony that "a few days ago, we placed our signatures under a large H_2 logistics order placed by an American company." The project is planned to be realized until January 2017. However, to be able to run further tests on the design, Schneider called for the addition of the technology to at least one of the 50 filling stations built with the help of a German H_2 infrastructure program. So far, the administrator of that program, NOW, hasn't commented on the idea.

StorageBOX, © Hydrogenious

Wealthy investor

Hydrogenious – which was presented with the Innovation Award of Bavaria in 2014 – receives the necessary financial backing from Anglo American Platinum (Amplats). The South African corporation invested USD 4 million in United Hydrogen Group (UHG) this January. As one of the world's largest operators of platinum mines, Amplats has an inherent interest in the market roll-out of fuel cell cars, as their stacks require platinum as a catalyst – not unlike the three-way catalysts of conventional vehicles. In a media release to Creamer Media's Mining Weekly Online, the marketing head of Amplats, Andrew Hinkly, said: "We ultimately want to reduce the cost of delivered hydrogen and increase access to hydrogen refueling stations. Our investment in UHG goes a long way to achieving both of these goals and supporting development of the FCEV market."

The investment was made by Amplats's PGM Development Fund, which supports growing start-ups early on, in order to increase sales in platinum group metals (PGMs). Hydrogenious Technologies is one of the partners of this program and

collaborates with UHG. The price for platinum suffered a considerable drop last year, which is why the subsidiary of Anglo American is trying to up demand again. The desire for a quick recovery also explains the platinum corporation's investments in Ballard Power Systems and Altergy Systems.

The Hydrogenious design is one of four projects funded by the state of Bavaria in the framework of the Bavarian Hydrogen Center (BH2C). In her inaugural speech, state minister Aigner said she was "proud and very pleased." She added: "Investing in and developing storage technologies locally is the right path to take. LOHC is one of the crucial technologies to consider."

A 1,000-liter LOHC tank replaces 57 H2 pressure gas cylinders

Areva does its own research

But research on the technology is not limited to Erlangen. The French Areva group as well as Swiss H2-Industries have set up their own research projects for LOHC. H2-Industries, which was founded by entrepreneur Michael Stusch in 2011, is currently looking to raise capital for their design. In fall of 2014, the company from Wollerau entered into a cooperation with professor Matthias Beller from the Rostock-based

Leibnitz Institute for Catalysis (LIKAT), which has done some research on new catalysts for this type of application. Additionally, Stephan Möller – who manages balticFuelCells and whose second job is to provide energy consulting to end customers – is head of research at LIKAT laboratories. He also is the boss of the five H2-Industries employees sitting in an office in Teterow in northern Germany. Möller said: “Our new pilot plant in Teterow near Rostock is close to the University of Rostock, to LIKAT, to the Fraunhofer Institute for Manufacturing Technology (IPA) in Rostock, and to businesses required for a smooth realization of our ambitious plans.” He also explained to H2-international that H2-Industries put its faith in the same brand as Areva H2Gen – Marlotherm (brand name for dibenzyl toluene) – and that the company intends to go public to raise money. According to his statements, “there are a number of interested investors.”

The primary concern of Areva H2Gen, the German subsidiary of the French state-owned company specializing in nuclear technology, is still its electrolysis business. In mid-March 2016, it became a member of the DWV initiative Performing Energy. When talking to H2-international, Kerstin Gemmer-Berkbilek, the business’s LOHC representative, confirmed that the company was currently not trying to increase public awareness of the technology, but would be open to collaborations in the field of system integration.

Overall, the new competition is helping Hydrogenious’s case. As von der Heydt explained, LOHC has been taken much more seriously since a large industrial group like Areva announced that they were developing the technology. It has even prompted several representatives of big oil and gas companies to visit Erlangen. “Before that event,” he said, “everyone used to be a skeptic, since we do take away the business model of the traditional suppliers.” Now, he hopes that NOW will finally start listening too.

Cella develops solid storage

Cella Energy favors a somewhat different approach. The British business relies on pellets, which incorporate amino borane through a chemical process into nano-size polymer fibers. The fibers, which can absorb the hydride at temperatures of around 85 °C are being manufactured by electrospinning and pressed afterward. It is thought that their small size (few millimeters) makes them easy to pour, and they are said to be low on toxicity, non-aggressive and capable of storage at ambient temperatures in conventional tanks. Amino borane, however, is considered explosive. The technology was developed at the Rutherford Appleton Laboratory near Oxford, UK, where Cella Energy was created as a spin-off in 2011 for commercial purposes by the former founder and owner of Voller Energy, Stephen Voller (left Cella in 2013), as well as professor Stephen Bennington.

Energy Saxony: Rohleder Replaces Franke

On March 1, 2016, Lukas Rohleder took over management of Energy Saxony. The 34-year-old replaced Robert Franke, who became head of the Office of Economic Development in Dresden, the capital of the German state of Saxony, on Oct. 1, 2015. Rohleder was last employed as the executive assistant for political communication at

aireg, after he had worked as a research assistant at the Bundestag office of Germany's finance minister, Wolfgang Schäuble.

Lukas Rohleder

Christian von Olshausen, who chairs Saxony's network for innovative energy technologies and is CEO of sunfire, said: "With Mr. Rohleder, Energy Saxony welcomes a trusted expert on German and European energy policies."

Coop Sticks Around – Axpo Quits

Despite announcements to the contrary, the H_2 project in Glattfelden in the Swiss canton of Zurich (see HZwei issue from July 2015) will deliver on its promises. At the beginning of March 2016, rumors had it that Axpo and Coop would stop their joint project. The project's coordinator, Hansjörg Vock from H_2 Energy, told H2-international that "the rumors weren't true," as "only Axpo had exited the project," but had done so by mutual agreement. Vock explained: "Coop is as motivated as ever to continue work on the project. The exit of Axpo will have absolutely no negative impact on it – neither regarding dates, nor scope." He added that Coop had already ordered the H_2 filling station as well as a truck prototype and eleven fuel cell cars. The filling station is scheduled to go online in 2017.

nanoFlowcell Ad Campaigns Continue

Motor Show Geneva 2016

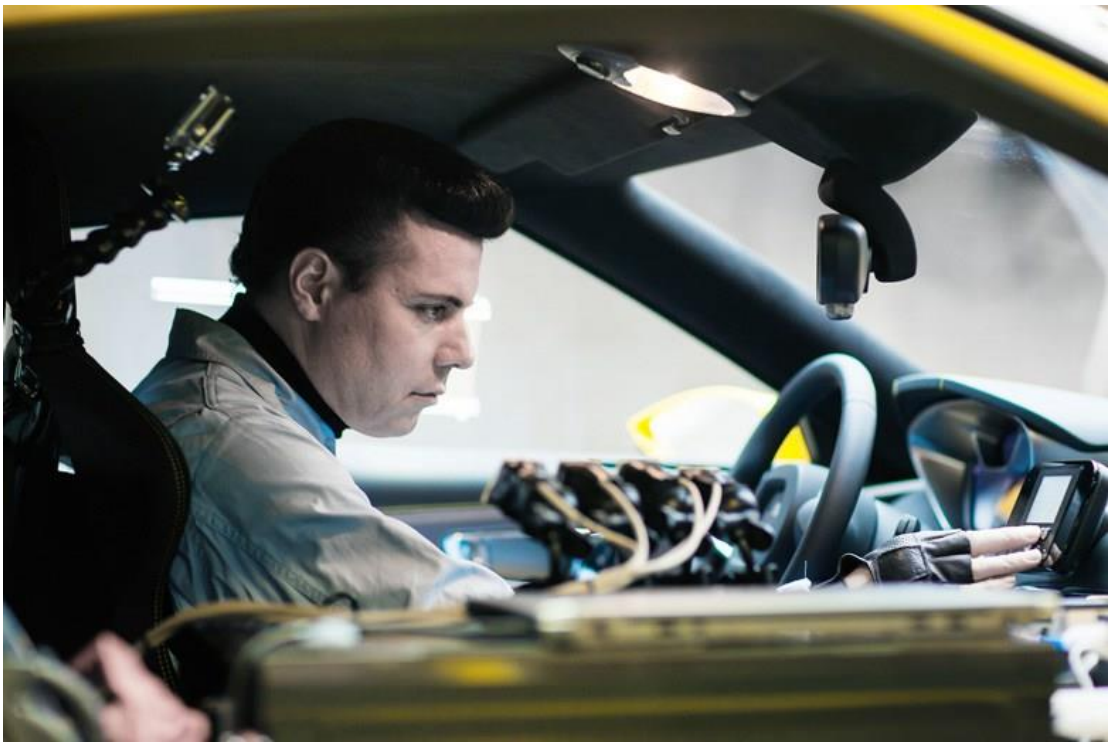
Like in the last years, nanoFlowcell garnered a lot of attention at this year's International Motor Show in Geneva, Switzerland. Like in the last years, there are big announcements, but little to back them up. The 2016 headlines: The QUANTiNO had successfully completed a 14-hour test drive indoors, the car's range would soon increase to 1,000 kilometers, and a "Quant City" should be created in Switzerland. Given that there is little evidence to support these claims, it seems to confirm people's suspicions that the announcements are primarily part of a marketing campaign and that none of the projects will be realized in the near future.

In February 2016, the QUANTiNO became street legal. Almost two years before that – in July 2014 – the Quant E had been given a permit for test drives on public roads (see HZwei issue from July 2014). The fundamental difference between the recent model and its predecessors is that the new car is a so-called low-voltage vehicle with 48 volts, while its predecessors were high-voltage cars. Of course, the start-up again used the opportunity to speak of a "world premiere."

NanoFlowcell, which has its legal domicile in Vaduz, Liechtenstein's capital, said that the QUANTiNO was celebrating its premiere as "the world's first low-voltage electric vehicle with road license." Last year, it had still been presented as a concept study of a small-size sports car. This February, the company was issued a permit from the SGS-TÜV Saar to test the vehicle on public roads. When talking to H2-international, Torsten Laub from SGS Germany confirmed that the Type Approval department of SGS-TÜV Saar had conducted "an assessment for allowing an exception to normal permit rules for a single test vehicle. This assessment mainly focused on basic equipment and general safety-relevant features." The NDA between nanoFlowcell and the test institute bars Laub from adding anything further.

The electric sports car is said to offer an output of 80 kW distributed onto four electric motors, accelerating the car to 100 kph in less than five seconds. By nanoFlowcell's own account, this engine enables "entirely new mileage figures" of the 2+2 seater with all-wheel drive (length: 3.91 meters, weight: 1,420 kilograms, top speed: 200 kph). It announced that "the QUANTiNO was designed specifically for daily use, housing a smaller engine that consumes less power but offers a greater range" than the Quant E. This means that the new model was "the first electric car suited even for long and frequent car trips."

A press release went on to say: "The low-voltage system in the QUANTiNO works with the nanoFlowcell® drive to form an exceptionally efficient symbiosis that promises a significantly greater potential range compared with the HV systems commonly used in electric vehicles. Furthermore, it eliminates the danger of electric shocks that can be caused by a high-voltage system in the event of an accident or when undertaking repair work to HV components."



Test driver Nunzio La Vecchia

New Quant FE presentation

This year's Geneva successor to the Quant E and the Quant F is the **Quant FE**, by the company's own account, "a thoroughbred sports car with a coupé-ish 2+2 design whose nanoFlowcell® powertrain aligns perfectly with its sporty DNA. The 801 kW (1090 HPmetric) in its veins accelerates this electric street racer from 0 to 100 km/h (approx. 62.5 mph) in a fleeting 2.8 seconds." What's more, "the energy needed for this kind of oomph is produced by the onboard power plant in a sustainable and toxicologically completely harmless process." The "E" in the name is short for "Evolution" and should point to the "advanced state of development of the vehicle to near-series maturity." Both the Quant FE and the QUANTiNO basically allow for a small batch production with modular components. Whether this will come to pass is said to be decided this year, depending on the outcome of a feasibility study.

Uninterrupted 14-hour drive

A first, longer test run was done in mid-February 2016 on a track near Zurich Airport. Spokesperson Ralf C. Kaiser from Hill+Knowlton Strategies told H2-international, that this test drive "primarily focused on the longevity of the nanoFlowcell." The alleged simulations included driving through the city or at 70 kph through the countryside, although the ad video only showed an around 200 meter-long indoor track in a factory hall. Kaiser said that lawyer Willi Luchs from Zurich's Luchs & Partner was present on-site during refills and tank sealing, and supervised the entire test run. When talking to H2-international, Luchs confirmed that "the QUANTiNO was driven non-stop and without any refill or recharge." He added: "I was there the whole time when the car made its record drive over 14 hours."

However, the test had to be halted after those 14 hours, not because the energy had been drained from the vehicle but from the driver, Nunzio La Vecchia, who had shown serious fatigue. After his arrival, the car had used up only "around half of" the two energy storage units, which hold 159 liters each. On March 2, 2016, the company released further details – or more to the point, revised their previous statement by saying that the car had consumed only 22% of the stored "fuel." The energy consumption was said to be "12 to 14 kWh per 100 kilometers." But details about the miles driven or the average speed were not part of Ralf Kaiser's explanation: "That's still a secret." Nevertheless, nanoFlowcell announced: "Under normal driving conditions, the QUANTiNO can cover a theoretical range of more than 1,000 kilometers on a single tank. Precise range figures will be determined during test driving to be conducted on European roads in 2016." Further tests are said to follow in the first quarter of 2016 before there is a decision on a small batch production.

Calculations

Even if there are few details at the moment, the 14-hour test revealed some information about the car.

Tank volume:	2 x 159 L	
Fuel consumption:	22% = around 70 L	
Energy demand:	13 kWh per 100 km	
Energy density:	600 Wh per liter or kilogram	
This results in:		
Energy consumption (test run):	70 L x 600 Wh / L	= 42 kWh
Range:	42 kWh / (13 kWh / 100 km)	= around 320 km
Average speed:	320 km / 14 h	= around 23 kph

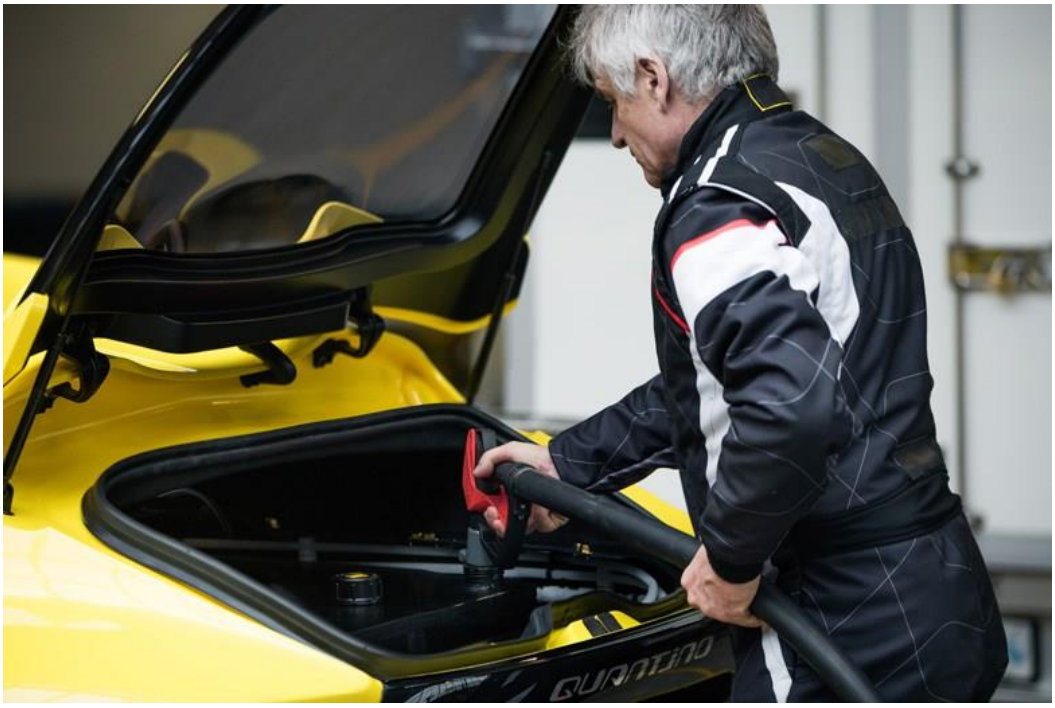
A full tank would actually increase the range at this average speed to above 1,400 kilometers.

Facts missing

The Quant E is to have a tank of two times 200 liters, meaning the car can store a total of 120 kWh, but only consumes around 20 kWh per 100 kilometers. It was also said that it would be relatively easy to increase tank volume to as much as 800 liters. "Likewise, filling up the QUANTiNO with ionic liquid involves a process similar to that for a petrol-powered vehicle – with a hose and a refueling nozzle. […] The ionic liquid, which is harmless to the environment and to health, is also cost-effective to produce."

In a January 2014 interview found on the company's website, La Vecchia said: "The power density of the nanoFlowcell® at 600 W [editor's note: he probably meant to say "Wh"] per kilogram or per liter is greater than any comparable system; five times greater, to be specific. That means you can drive five times further with our system than you can with a conventional battery system, including the most state-of-the-art lithium-ion batteries." The news piece also said: "In addition, flow cells can go through 10,000 charging cycles with no noticeable memory effect and suffer almost no self-discharging."

There is no way to back up these claims at present, since there is no way to replicate the results. Peter Fischer, Group Leader Redox Flow Batteries at the Fraunhofer Institute for Chemical Technology (ICT) told H2-international: "The energy density of most redox flow batteries is too low for mobile applications. The most promising systems for use in vehicles are metal-solution/air- or metal-ion/air battery packs, as these systems could possibly create the highest energy densities of all units available. But few of these types of batteries have made it into research publications, and most of the ones published in the literature would not be suitable to power a car."



Fueling QUANTiNO

Fischer also told Christiane Brünglinghaus, who reported about nanoFlowcell for Springer Professional, in March 2015: "Nowadays, conventional flow batteries based on vanadium sulfate theoretically achieve energy densities of up to 19 to 38 Wh/L with respect to pure electrolyte solutions." Bromine-based systems would theoretically achieve energy densities of 570 Wh/kg (e.g., zinc-bromine), Fischer went on to explain, but the actual energy density was far lower – maybe 70 Wh/kg. Fischer said about the solution's alleged low toxicity: "However, most battery-electrolyte solutions are classified as environmentally harmful, since they typically consist of metal salts dissolved in acids or bases."

Professor Robin Vanhaelst from the Institute of Vehicle Technology (IFBW) of the Ostfalia University of Applied Sciences in Wolfsburg, Germany, had already voiced his profound skepticism in 2014 when talking to Technology Review ("absolutely utopian"). The current news have not changed his opinion. In an interview with H2-international, he explained that "Redox Flow batteries suffer from very, very low energy density." The energy density was proportional to the membrane surface area, and the latter was strictly limited in vehicles. This meant that "in today's world, redox flow cells are not an attractive option, as not one of these cells reaches the levels of lithium-ion ones." In his view, this also included stationary use: "There's a pitch-black picture to be painted here."

Vanhaelst's comments are an indirect call on La Vecchia to finally present sensible scientific documentation that at least analyzed one individual cell, as everything so far had been "pretty incredulous." But he did confirm that the energy density figures stated by nanoFlowcell would constitute a "quantum leap forward compared to lithium-ion technology." He also raised the possibility of fast-charging electrolyte liquids if the above-mentioned properties were factually true, so that the liquid wouldn't have to be replaced but could be charged within a few minutes.

The Fraunhofer Institute for Environmental, Safety and Energy Technology, in contrast, will no longer publish any statement about the topic because of its on-going legal dispute with nanoFlowcell. Meanwhile, La Vecchia himself is busy touting his ownership of several patents – which is, in fact, true. Besides patents on solar technology from 1998 and 1999, he has also held one on a car-shaped "computer mouse, particularly a laser mouse" (EP 2 211 254 A1) since 2009.

Hard to believe

Quite a bizarre find was the video of a user who goes by the name of "macartus." The video shows La Vecchia driving through Zurich in a bright yellow QUANTiNO. When he stops at a traffic light, a group of about ten kids run across the street to take one photo after another of the sports car. Without exception, they all use compact or reflex cameras – no cell phones. Hard to believe that so many teenage boys in Switzerland carry around such big equipment, isn't it?

Many company addresses, many open questions

Besides many open questions about technical details, there are also doubts as to who is behind the start-up. For example, Didi Prolovski reported last March on www.mycar.net that there was no factory hall at the initial company address in Schaan, but only the law firm Müller & Partner, of which Roland Müller is a partner. Then, it was said that the company's headquarters had moved to Landstrasse 97, a building that houses only the Laurentius Pharmacy Schaan as well as empty office spaces. When asked by H2-international, the real estate management of the property replied in short that both nanoFlowcell and La Vecchia were "unknown" to them.

After Müller left nanoFlowcell, La Vecchia has been representing the company together with Hektor Albert Bertschi since January 2016. Bertschi owns a one-man energy consultancy in Kilchberg and has had a stake in nanoResearch since October 2015, ever since La Vecchia sold his shares of the company. The publicly traded entity based in Lugano in Swiss Tessin is dedicated to "research, development, and the search for opportunities to discover and use new materials, processes and technologies, with a special interest in people with low environmental impact." But

whoever expects a research institute at Via San Lorenzo 15 will be disappointed when he sees the entirely ordinary multi-family building located at that address.

On Nov. 11, 2014, the company was still based in Zug and had the name NLV Solar. That was the time when Giorgio Ramis Leone Grandini joined the company and became chair of the supervisory board. The reputation of the notary is somewhat tarnished, however, by online statements such as the following: “Giorgio Ramis Leone Grandini has not been the (co-)founder of any business since 1995, has filed for bankruptcy with 4 companies, and has had 15 enterprises removed from the registry or liquidated.”

La Vecchia like a show star

Reading through the company history of nanoFlowcell will also reveal the opening of the Juno DigiLab Virtual Reality Centre in Zurich-Riesbach in 2001 and its name change to nanoFlowcell DigiLab in 2013. The company address of Juno Technology Products at Seefeldstrasse 301 turns out to be, if at all, an office of Juno DigiLab in the backyard of the building – adjacent to an advertising agency – but not a laboratory. This is seemingly at odds with nanoFlowcell’s description of La Vecchia being the man “behind the design and development of the innovative engine technology in the nanoFlowcell DigiLab in Zurich.”

Just recently on Feb. 22, 2016, Juno Technology Products – which had been renamed to Quant World in 2012 and is managed jointly by La Vecchia and Grandini

– moved to Zug. To contact the company, one must take the indirect route through "c/o MSG Services GmbH, Bahnhofstrasse 10, 6302 Zug."

In December 2014, it was also announced that there were "over 100 R&D professionals" driving the market readiness of the Quant E "just around the corner from the development center of one of Germany's premium sports car manufacturers" in Weissach in the German state of Baden-Württemberg. At the same time, news broke that the publicly traded company established a German subsidiary called nanoProduction, based in Waldshut-Tiengen, also in Baden-Württemberg. The primary goal of the organization located at Im Wallgraben 48 was to gain approval as a new carmaker with an international World Manufacturer Identifier, in order to pave the way for mass production. Together with its two directors, Bertschi and La Vecchia, the nanoProduction subsidiary was also given the task of establishing the manufacturing division of the nanoFlowcell group, including negotiations with suppliers and development partners. But even here, the address stated was only a Postbank branch office, with no nanoProduction in sight. The question that comes to mind is whether the company consists of anonymously used office spaces or just PO boxes.

Who is behind nanoFlowcell?

So far, H2-international has not been able to determine who is actually running the publicly traded company. The lack of information concerns both statements about the size of the company and its financial strength. For example, it has yet to be established how La Vecchia was able to pay for his prototype design, his marketing campaigns and his exhibitions at trade shows, and who owns a stake in the company or who funds it. The only thing Ralf Kaiser told H2-international was that "more than EUR 100 million" had been invested in the business.

Fiction or reality?

The question what this lack of information means is not least important in light of the claim that the municipal administration of Tenero-Contra had already signaled its interest in the allegedly planned Quant City. There, in the Tessin region, is where a press release said the nanoFlowcell DigiLab would move to. According to nanoFlowcell, "a state-of-the-art research and development center" was planned to be built on an area of 25,000 m2, including a Quant Academy, which was said to merge the R&D areas of the company group and enable scientific work on flow cell technologies as well as ionic liquids. Construction was scheduled to start at the beginning of 2016 to create 150 to 200 new engineering, research and lawyer jobs in 2018 – but only if the contract for the purchase of the plot was signed. The company went on to say: "We're in preparation for our Quant City planning. The negotiations about the construction site, however, are ongoing." The operator was given as nanoResearch, a wholly owned subsidiary of nanoFlowcell.

A nanoFlowcell press release quoted the municipal council of Tenero as saying: "In addition, in June we looked into the plans to set up a production and research facility in Tenero for Quant vehicles. In keeping with the approved planning, the municipal council in Tenero supports unreservedly this development on the site of the former paper factory." H2-international, however, has so far not been able to independently verify this statement, as no Tenero council member has replied to our request for information.

Conclusion
Admittedly, there is a chance that the redox flow technology could achieve a greater range than massive and heavy lithium-ion batteries because large-size liquid storage also enables longer trips, even if the energy density is lower. For instance, Volker Pulskamp-Böcking, the former spokesperson of nanoFlowcell explained in an interview with Die Welt in summer 2014: “There is enough hollow space for a bigger tank size.” But high range is not everything: It’s also about energy density, and there are crucial details missing in that regard.

So it remains doubtful whether there has actually been a technological breakthrough or if these are only bits and pieces to create just as much marketing buzz needed in spite of the fact that there’s nothing really new to report.

As long as nanoFlowcell seems unwilling to have its ideas subjected to an independent and thorough analysis, there is (too) much room for speculation.

Figure sources: nanoFlowcell

New Eurosolar Management – Scheer-Pontenagel Quits

Scheer-Pontenagel, © Eurosolar

Over decades, Irmgard Scheer-Pontenagel and her husband – Hermann Scheer, who died in 2010 – had been influential figures who helped shape the renewable energy industry. After a 25-year tenure at the helm of Eurosolar, Scheer-Pontenagel has stepped down and made room for Tobias Jaletzky, who started working at the association based in Bonn, Germany, in 2013. The person supporting him as vice president, especially in matters of international business, is Lina Hedwig. Scheer-Pontenagel will continue to be the publisher of the Solarzeitalter magazine.

Hybrid Cars Put the Brakes on Electric Transportation

Jürgen Halasz

The number of electric vehicles in use on Austrian roads could grow from 4,700 to around 8,000 this year, according to a statement made by the country's environmental protection agency. In 2017, the figure could jump to 23,000; in 2020, there could be around 174,000 electric cars driving in the Alpine state. Jürgen Halasz, chair of the association for electric transportation at the federal level (BEÖ, see also HZwei issue from April 2015), an organization founded at the beginning of last year, believes that even a figure of 250,000 will be possible. All of these forecasts, however, include plug-in hybrids as well.

Mr. Halasz, Volkswagen has announced that it was going to put 20 new electric versions on the market over the next five years, most of them hybrids. Will hybrid

engines advance the goal of electric transportation just as much as purely battery-driven cars, or do you believe they will actually prolong the dominance of combustion engines?

Halasz: Combined electric and combustion engines slow down the transition to electric-only transportation instead of accelerating it. The range of electric cars is more or less enough for many private-sector customers. There is no need for an added diesel engine. Of course, the prerequisite for emission-free electric transportation is that you charge the car with nothing other than power generated from renewable sources.

Who's the target group for electric car purchases?

Halasz: Sixty percent of all newly registered cars are company vehicles. It's important to incentivize the purchase of company cars to entice businesses to choose the electric version. I believe that it'll be the top managers who will be the first to ponder whether the economic benefits warrant a switch from an Audi Q6 to a Tesla model. However, drivers have to be aware of the car's limitation: a range of, on average, 300 kilometers. Their company can also deduct the input VAT. Right now, electric cars are the only vehicles with this benefit. Last but not least, the battery-driven version will sure up the renewable image of a company. Such a scenario could subsequently lead to economies of scale. Only if you sell more medium sedans powered by electricity alone will electric cars become cheaper in this segment as well as competitive to combustion engines. But the price for a liter of gas is just too low at the moment.

What can a supplier like Wien Energie – your primary employer – do to help get more electric cars on the road at a faster pace?

Halasz: We're in the process of testing the different electric cars that are part of our vehicle fleet and collecting data on their use. Our goal is to learn how to replace our vehicles one by one with electric versions. At present, our 400-car fleet includes 18 electric vehicles, which makes five percent of the total. But we surely haven't reached the end of it.

What figure do you think will be possible?

Halasz: Half of the fleet of our Energie Graz colleagues has already been changed to electric. Wien Energie is a bit of a different story, since the range of an electric car means we couldn't serve the outskirts of our supply area. So our vehicle fleet makeup is more conservative. But a 50 percent share should be possible over the next years.

Will transportation become an intriguing new business model for utilities in the future?

Halasz: Sure, demand for transportation as a service is on the rise. Utilities will soon offer customers a vehicle for rent, and it doesn't always have to be a normal car or a utility vehicle. It could as well be a two-wheeler (electric motor scooter or electric bike). Two-wheelers are becoming increasingly popular. Most of the time, riding on two wheels will get you faster around the city.

What are the challenges at the moment?

Halasz: The access cards owned by drivers for charging an electric car must work throughout different regions. This is paramount for increasing the acceptance of electric transportation. BEÖ is a network of eleven regional and municipal utilities. The association's goal is to allow car charging by using only one access card or app across all regions. At the beginning, each utility had its own system for charging. In the future, all of these systems need to be synchronized to manage customer data. The software interfaces will have to be capable of connecting to all new systems.

Does Vienna, as the biggest city in Austria, have a pioneering role in electric transportation?

Halasz: Yes and no. On the one hand, the subway has been running on electricity for more than 100 years. On the other, we must decide how much of an individual's transportation needs should be subsidized at all. The keyword is: Parking space economics. Vienna's city council has just decided to let carsharing customers and drivers of electric taxicabs "refill" at charging points accessible by the public. This doesn't include private customers, though, who can charge their cars in the garage and benefit from the comparably cheaper installation of a wall-mounted home charger. However, it will be crucial to make electric transportation more visible to the public eye – and that won't be possible if cars are hiding in garages.

What conclusions did you draw from the Vienna pilot project?

Halasz: We will extend the project run. "NeuMo" is short for the New Urban Transportation consortium, which consists of several businesses and two research institutes. The consortium provides a link between public transportation and different rental as well as carsharing companies. There's also the Smile project. It's open to all providers of transportation solutions and is thought to enable a hopefully smooth change from public to individual means of transportation. Another project in Vienna is called E-Taxi. A taxicab can be subsidized with up to EUR 8,000. The target: 250 electric cabs driving around the city by 2018.

Do you see electric cars being used as mobile power storage in the future?

Halasz: That mainly depends on the range that the car can provide. If it only offers 130 kilometers, it is highly unlikely that customers will be tempted to feed electricity into the public grid. If the range is greater, it could be an interesting option – together with new tariffs as part of a smart grid.

Jürgen Halasz interviewed by Niels Hendrik Petersen

Tesla Makes It Happen – Just Like That

First things first: This isn't one of these test drive articles narrowly reporting all the various technical details or complaining about a not-so-perfect weight distribution. It is about the experiences made with Tesla's Model S on one single day of driving, during which it quickly became clear that the author had found his new dream car.

There's a lot of demand for taking Tesla's vehicles out for a spin. It took some time until *H2-international* was given an electric car for testing purposes and the experience only lasted one day. The 24 hours, however, were enough to see that the Model S takes the driving experience to an entirely new level.

Pick-up in Berlin-Schönefeld

The car provided to us was a Model S P90D, which was driven across Germany from Düsseldorf to Berlin-Schönefeld and handed over there for our test drive by the charming Carla Felicia Gritz from Tesla Germany's communications department. The Berlin service point of the US-based manufacturer is located in the middle of many undeveloped areas and in close vicinity to the Berlin-Brandenburg International airport, which is still under construction. It houses a repair shop, a store and one of the overall 53 superchargers found across Germany.

Shortly after I arrived, the communications coordinator for the German-speaking region gave me a concise explanation of the technology and of all the car's gadgets. She then presented me with the "key" – a somewhat misleading description, as it looked more like a thumb-size toy car without wheels. The remote control establishes contact with the car automatically as soon as the driver is only a few meters away

from the vehicle. The turn signals flash, the door handles emerge, and the car is ready, although the mini-computer is still in your pants pocket.

The interior of the vehicle boasts a large screen, which has replaced the radio in the middle console. It was obvious soon enough that almost all car applications are controlled by this touch screen: Whether it's the seat heating for all five passengers or the sunroof, the entertainment system or even the headlights, for which I later tried to find a knob without any success. Everything runs through the computer, which also offers free wireless Internet access. The centralized control offers drivers fast access to various music databases (with comfortable selection by voice command) and even to movies while taking a break somewhere. It soon dawned on me that this might be the real "iPhone on wheels" (In 2012, Daimler's head of R&D, Thomas Weber, described the then new A-Class that way).

Compact dimensions with low ground clearance

Autonomous driving starts here

I paid really close attention when Gritz began talking about "autonomous driving," although I was somewhat skeptical. To my knowledge, this was a technology under development, but possible insurance issues alone would push any implementation schedule back to the end of the decade. The Tesla expert, however, told me that she had let the car take over for almost all the way from Düsseldorf to Berlin. Halfway through the trip, the navigation system had suggested that she stop at a fast-charge station, where she could take some time to enjoy her coffee, and then she had

approached Berlin quickly but without any rush. That might take some getting used to at first, she admitted, but you would get the hang of it very quickly. The car even changes lanes on its own.

Wow! Now, I am truly impressed.

Anyway, enough of the technical gimmicks: I wanted to get in and start driving. My eyes began to searchfor the start button, but I quickly remembered that the car had already been started. Carefully, I put down my foot on the accelerator pedal and the car worth EUR 145,000 (incl. all upgrades and VAT) began to move forward without making any noise. It soon became clear to me that Tesla had not designed a "compromise on wheels," but a full-fledged sports car. The first attempts at acceleration made me aware what it meant to have a maximum power of 400 kW at your disposal.

I couldn't resist trying out the autopilot the first chance I got: on Berlin's thruway. First, I was very cautious, but soon relaxed because the design was indeed working as intended: The cockpit shows all vehicles in front of and next to the Tesla car, as well as the road markings. However, a lot of traffic or winding roads will prompt the board computer to request that the driver take over at the wheel.
Truly astonishing: Whereas others only talk about it, Tesla makes it happen – and it has my greatest admiration for that.

ADAC Test
"The 'autopilot' is a combination of the well-known car assist features 'adaptive cruise control' and 'lane keeping assist.' It's quickly earning the trust of drivers after they hit the road."

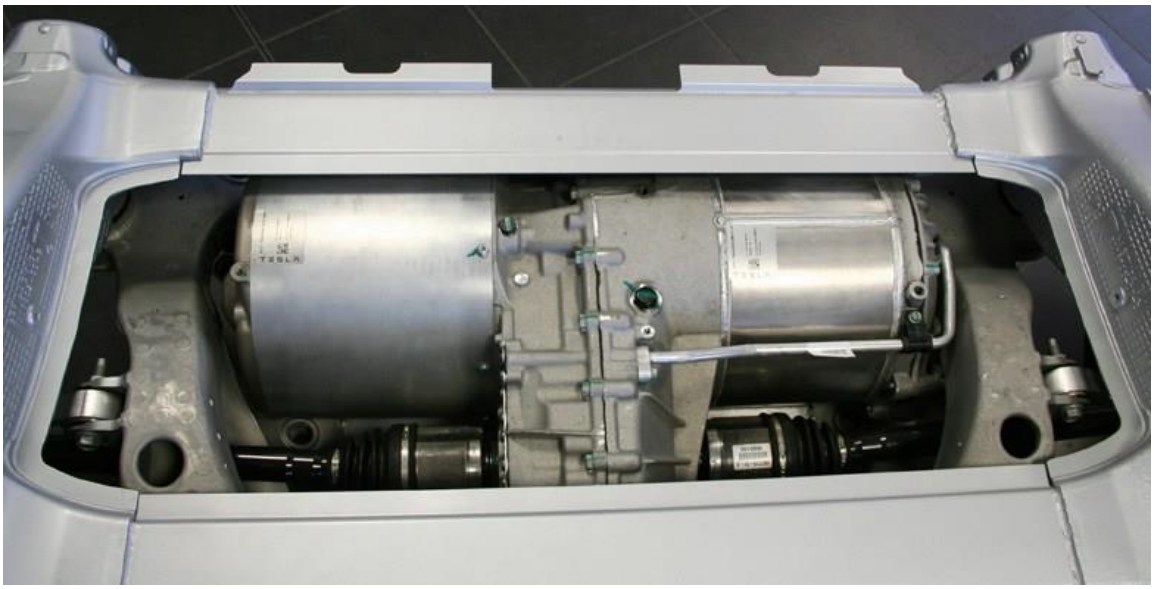
When it blows your mind
Back home, I instantly took my kids and went with them on a test drive. The first few kilometers were enough to see that they were even more enamored with this model as they had been with the BMW i8 (see How Much Electric is in Hybrid?) – which, in fact, is "only" a hybrid version. Even at higher speeds, the P90D does just fine. Still, I didn't feel like exceeding 200 kph, which to my surprise, the car arrives at pretty quickly.

However, there was later another opportunity to get that adrenaline pumping: Gritz had shown me the car's "blow your mind" mode that I only knew from YouTube. The setting was originally called "Insane" mode, but was renamed to "Ludicrous" and enables an even faster acceleration.
So we stop on a deserted countryside road, select Ludicrous on the touch screen and start the countdown: Within 3.0 seconds, the electric all-wheel drive propels us to 100 kilometers per hour without the clutch smoking or the wheels spinning – despite a start on wet ground. Not bad!

Few range limits
What's especially reassuring during all these tryouts: There is virtually no so-called range anxiety with this 2.7-ton electric car. Range extender included, this model has a range of 505 kilometers (NEDC estimate). When I took back the Tesla the next day at moderate ambient temperatures, it still showed 160 kilometers of range left,

despite the car displaying an average energy consumption of 266 Wh/km. How's that possible?

When I asked Gritz about it, she just pointed to the design of the vehicle: The sandwich structure at the underside of the car is completely filled out with battery cells (90 kWh, 700 kg, see figure above). A fast-charge point at direct current would allow the driver to charge half the battery within 20 minutes. In contrast, a full recharge at home would take around 30 hours.



Electric engine with converter

Else, the car only has a rear motor as well as a DC/DC converter (see figure). The Model S P90D (D = all-wheel drive dual motor) houses a second motor on the front axle. According to Elon Musk, who presented this engine in Los Angeles in October 2014, the structure allows for an optimal torque transfer to both axles within milliseconds. With the car having a power rated at 169 kW on the title, it also explains why there were no wheels spinning during our acceleration test in spite of the wet road and why the vehicle put on such an impressive performance.

The simple chassis structure illustrates the crucial difference to conventional engines: This electric car has only 19 movable parts. Fuel or diesel cars have around 400.

Model 3 for EUR 35,000

Such a "road show" begs the question why most other automotive manufacturers favor a design that limits the range and size of the car. Because of Tesla's continued success (more than 50,000 Model S produced last year, Best Cars 2016 award by the magazine Auto Motor & Sport), the mood seems to be shifting, albeit slowly. But whereas an increasing number of carmakers announce so-called "Tesla fighters," which are thought to compete with the American models sometime in the future, the US-based manufacturer is mainly attempting to downsize: At the end of March 2016, Musk presented the less pricy Model 3, a Tesla car that ordinary citizens could afford and which should be on the market for EUR 35,000 at the end of next year.

Daimler ends collaboration with Tesla

After Daimler – much like Toyota – had already sold its Tesla shares in October 2014, the German carmaker from the Swabian region cut ties with the US manufacturer this March. Harald Kröger, who oversees the electric car R&D activities at Mercedes-Benz told the magazine Automobilwoche. “We have had an excellent project with Tesla and a very good collaboration with our overseas colleagues. However, we currently have no plans for follow-up projects because we now have our own excellent supply base.” Tesla was Mercedes’ supplier of battery packs and powertrains for the electric version of the company’s B-Class.

See also stock analysis

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- July 4th to 5th, 2016, in Birmingham, United Kingdom, **International Hydrail Conference**, University of Birmingham Centre for Railway Research and Education, www.hydrail.org
- June 15th to 17th, 2016, in Detroit, MI, USA, **16th Advanced Automotive Battery Conference**, Fuel Cell Technology and Applications, www.advancedautobat.com
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Event Organizers

- **23nd Group Exhibit Hydrogen + Fuel Cells + Batteries**, HANNOVER MESSE 2017, April 24 – 28, Tobias Renz FAIR, Phone +49-(0)30-60984556, tobias@h2fc-fair.com, www.h2fc-fair.com

- European Fuel Cell Forum, Obgardihalde 2, 6043 Luzern-Adligenswil, Switzerland, Phone +41-4-45865644, Fax 35080622, forum@efcf.com, www.efcf.com

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Literature

Ten Years of HZwei News

Ten years ago, Hydrogeit Verlag printed its first issue of the

HZwei magazine

German counterpart of H2-international

Entitled “H2Tec” in 2000, the Magazine for Hydrogen and Fuel Cells had been published for six years prior under SunMedia before the people responsible for it intended to go their separate ways – because the industry hadn’t advanced as quickly as they had expected.

Every six months and in comparably simple layout, H2Tec had reported about the activities in the H2 and fuel cell industry on no more than 20 pages. A lot has happened since then: Circulation increased to 4,500 and the time between issues was cut in half. The number of pages grew as well – first to 32 and meanwhile to 56.

After ten years, HZwei’s editors can now rightly claim to have created the only well-established long-running trade publication on hydrogen and fuel cells across the German-speaking region.

www.hzwei.info

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