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Content

Ballard Steps on the Gas

Excellent Strategy for Asia and the Global Market

After the second-quarter figures from Ballard Power Systems came in at the end of June, there were several good news that underline which huge potential the Canadian fuel cell manufacturer can tap in China and Japan. The share price jumped more than 60 percent.

The most recent business Ballard won over as a partner was Chinese Broad-Ocean. The corporation boasts an annual production of more than 50 million motors worldwide and supplies several top-notch carmakers (Caterpillar, Tata, etc.), leading bus companies such as King Long and Van Hool among them. It has already bought a 9.9% stake in Ballard for USD 28.3 million and may increase its stake in the company to 20% – without receiving any position on the manufacturer's executive or supervisory board. Still, the Chinese organization could become a very important customer – even if only indirectly through a special agreement.

Fig. 1: Fuel cell bus with a FCveloCity® module by Ballard

Source: Ballard

Broad-Ocean placed an order for bus stacks with Ballard after the latter had finalized its meticulously negotiated agreement with Guangdong Nation Synergy Hydrogen Power Technology (Synergy). As part of a joint-venture (90 : 10), Synergy has been collaborating with Ballard to develop production capacities for fuel cell bus stacks in China. The overall investment in the project is said to be USD 450 million, which the Chinese corporation intends to pay for. During a recent phone conference, it was said

that the start of production was scheduled for 2017. The initial target is 6,000 stacks in the first, 10,000 in the second and 20,000 each year thereafter.

Broad-Ocean

Zhongshan Broad-Ocean Motor operates around the globe, but primarily in five Chinese cities which house the production facilities of leading bus manufacturers. Since Broad-Ocean has already placed an order for 10,000 fuel cell cars with Synergy, I suspect it will supply fuel cell stacks to several Chinese bus manufacturers or integrate these stacks with their buses. It seems reasonable to assume that this is the reason for the large order volume. Ballard could use the collaboration with Broad-Ocean as a perfect opportunity to manage sales of fuel cell stacks produced in collaboration with Synergy – what a strategic move. By the way, Synergy was the one from which Ballard received its first large order of 300 fuel cell stacks.

While Ballard will supply the important MEA components (membrane electrode assembly; 60% of the value content of a stack) and retains the exclusive rights to globally distribute the fuel cell stacks, Synergy will turn its focus on China. A great coup with which Ballard can make the most of the economies of scale offered by the Chinese mass production of fuel cells. An interesting side note is that Ballard will be able to exert much control and influence over the collaboration. Revenue from it is expected to add up to USD 168 million or more over five years – that is, revenue generated by Ballard alone for providing stacks, technical support and employee training.

Stacks for radio masts

Ballard also sold hydrogen-powered fuel cell stacks for radio masts to Synergy, which has provided the company with just the right product to serve the Chinese market. A potential contact for Synergy is the China Tower corporation: It manages the infrastructure activities of telecommunications companies China Telecom, China Mobile and Unicom, with assets valued at USD 36 billion. All in all, Ballard can continue to profit from license revenue without having to invest any of its own money. And a Chinese corporation like Synergy – or Broad-Ocean – will certainly be able to negotiate better terms when dealing with domestic businesses than a foreign enterprise ever could.

Toyota Tsusho as new partner

The next piece of good news came from Japan: Toyota Tsusho, a subsidiary of Toyota with USD 76 billion in annual revenue, aims to sell Ballard's products in Japan. A press release even said that in joining forces with Ballard, it intended to make an important contribution to Japan becoming a "hydrogen society." The framework agreement, the terms of which can only be speculated about, will be in effect at least until 2020.

The remarkable thing about all of this is that Toyota, the pioneer in fuel cells, is collaborating with Ballard, which shows just how much Ballard is held in high esteem. The press release explicitly stated that Ballard was the leader in fuel cell manufacturing. The deal could mean so many things. I wager that Ballard products, such as the ones manufactured jointly with Synergy and Broad-Ocean in China (fuel stacks for buses and other vehicles, as well as for forklift trucks, for which Toyota holds the top spot globally), could be sold through Toyota on several Japanese markets. And Ballard has received the exclusive rights to market several of the

stacks produced by Synergy, which means the rights to distribute the products outside of China. There is a lot of room for interpretation – but whatever the conclusion, the outcome will be favorable to Ballard.

Hydrogenics as a candidate for takeover?

Additionally, Ballard's cost-cutting program seems to be showing its full impact. The sale of backup power systems (H_2 fuel cells in China and methanol fuel cells in South Korea) for radio masts of two business partners will be enough to prompt an upward trend in the share price over the coming quarters. Not only was the Canadian-based company able to divest costly and low-margin business activities, but it can now earn money through licensing and supply without having to make any investment. Second-quarter revenue rose considerably (+58%) and the gross profit margin made a big jump (+29%).

Broad-Ocean's purchase of 17.25 million shares means Ballard has more than USD 70 million in his well-filled war chest. It's conceivable that these and new shares sold in the future could allow the company to make strategically intriguing acquisitions. Candidates for takeover need to generate at least USD 15 million revenue and a gross profit margin of above 30% (we will see). Acquisitions could still be made this year; two out of four takeover targets are said to be left. If I were on the board of Ballard, I would consider acquiring Hydrogenics to add fields such as H_2 infrastructure/filling stations and electrolysis systems to the business portfolio. Fuel cell buses in China need H_2 filling stations like in any other country and as a Ballard subsidiary, Hydrogenics could benefit from the parent company's collaboration with

Synergy and Broad-Ocean, but also Toyota (in theory). Hydrogenics (in collaboration with Alstom) has also been involved in the design of hydrogen-run trains – another addition to Ballard's product offering. And both organizations are headquartered in Canada.

Outlook

In a September press release, Ballard touted the strong relationship it had been developing with CRRC. The Chinese railroad car manufacturer had already been supplied with fuel cell prototypes for their hydrogen-run trains and streetcars, and had fuel cell systems integrated into their vehicles. Orders will only be a matter of time. The partnerships with Broad-Ocean and Synergy in China, the one with Toyota in Japan and several projects with VW and others are likely to prompt a re-evaluation of Ballard shares and drive up the stock price. Another piece of good news was announced by Ballard subsidiary Protonex: US authorities have recently granted the business essential import and export permits for drones used by civilians. They will make up the next vast global market for fuel cells – just think about the plans by logistics companies like Amazon.

The more people become aware of the new megatrend fuel cells and H_2, the more will Ballard be viewed as the industry's number one and the stock price will go up accordingly. I except it to get to double digits over the next three years. It will also be interesting to see what happens when Ballard can report the first quarterly profit in its history – it's on the best way to do just that. And whoever wants to bet on fuel cells on the stock market: There won't be a way around Ballard as the leader of the pack.

Risk warning: see also next article

Author: Sven Jösting

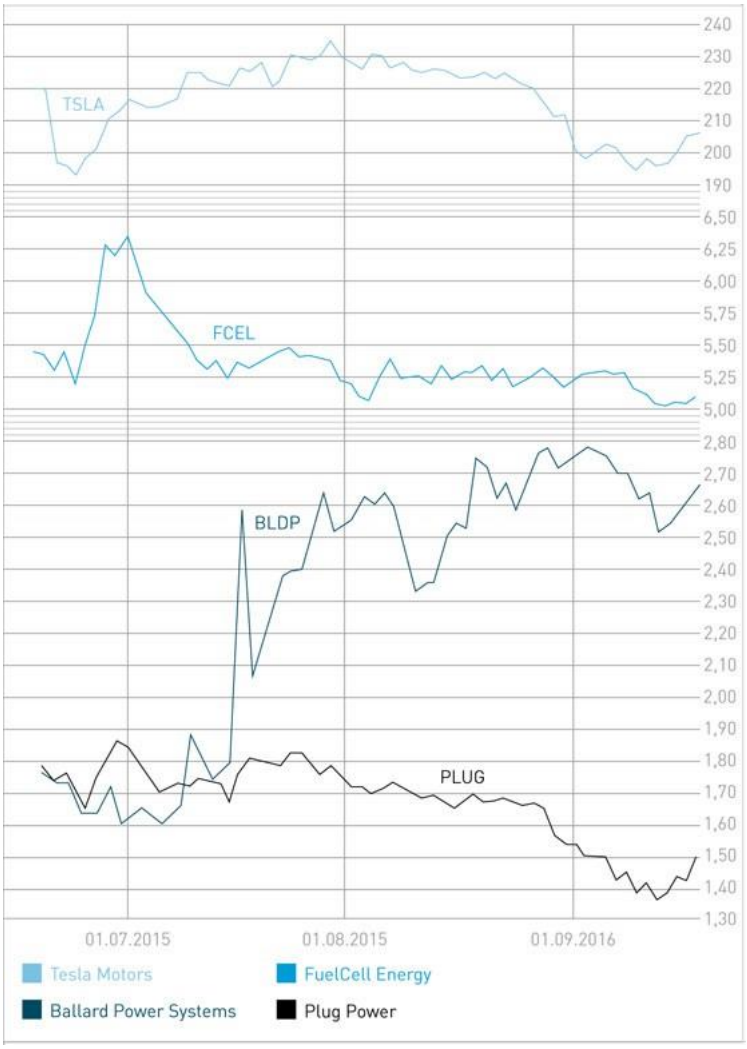
Plug Power: Change in Accounting Principles

The new non-GAAP accounting is still creating confusion. Based on non-GAAP, Plug managed to increase revenue in the second quarter to above USD 36 million. But although the USD 13 million loss that the company reported for the same period was indeed a reduction compared to growth, it continues to have a negative impact on the stock price. Many of the company's agreements are lease contracts and partial revenues must be recognized in each period. By its own account, Plug is working to provide greater clarity here.

A very important factor will be the legal certainty surrounding tax incentives for fuel cell systems, as the relevant rules will expire by the end of 2016. A clear-cut decision in favor of tax incentives/depreciation will give Plug's share price a big boost. Other large customers of Plug's, such as Carrefour in France, show that the company's business model works. It could also be interesting to see whether a corporation like Federal Express will place an order with Plug for retrofitting an entire fleet of airport supply and courier vehicles after having successfully completed the trial runs. An order of this magnitude could rake in a lot of money – I would think as much as USD

100 million over the long run. Plug's primary source of revenue from these kinds of contracts will be the sale of hydrogen, although retrofits will play a role as well.

Fig. 1: Share price development of Plug Power and other companies



Source: www.wallstreet-online.de, Stock price as of Sept. 15, 2016

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

Clean, Quiet and Extremely Comfortable

Test Drive with a Hyundai ix35 Fuel Cell

Electric Transportation

Fig. 1: H_2 refueling at the Berlin filling station

Hyundai has been on the market with its mass-produced ix35 fuel cell car since 2013. Last year, 250 units were shipped to Europe, with 120 sold or leased to German businesses alone. And this year, Linde established BeeZero, which ordered as many as 50 of them for its vehicle-sharing service in Munich. Even though the fuel cell version won't be coming to every Hyundai dealership within the next months, H2-international put it to the test for nine days to show you the technology and equipment – in addition to Mortimer Schulz's experiences of driving the ix35 long-distance (p. 9).

The test car arrives well wrapped inside a closed trailer after being shipped directly from Offenbach to the address of our publishing house. It has a full tank and is sparkly clean – not surprising, given the fact that it has only been driven for 4,500 kilometers (2,796 miles). Instead of a normal car key, the shipping company hands me a remote control for the Keyless Go system. That is all. One more signature and I am standing alone next to a big, white off-road truck.

The ix35 Fuel Cell is based on the Tucson, a five-door SUV with five seats. It's already the fourth generation of Hyundai's fuel cell vehicle (after the Santa Fe FCEV in 2000, the Tucson FCEV in 2004 and the ix35 FCEV in 2012). In March 2013, the

company started mass production in South Korea. Despite today's small market, it is both the first and the most popular vehicle of its kind in Germany.

Relaxed driving

I sit down on the comfortable leather seat and press the ignition button. The lights on the dashboard turn on and I hear a short, but friendly melody to greet me. I put the gear shift into Drive, slowly press down on the accelerator pedal and the ix35 starts moving quietly, just as you would expect from an electric car. You can hear neither a buzzing, nor an annoying humming sound – and enjoy silent driving. Stepping on the brakes will recover some of the energy I had to use up. Compared to that, combustion engines are sluggish, loud and dirty or simply put, inefficient.

Despite its curb weight of 1.9 tons, the 100 kW electric engine provides the station wagon class with a decent bit of acceleration, although it's not as quick as in electrically-driven sports cars. The registration papers show a rated power of 53 kW. As I can see from the energy flow chart on the dashboard, the fuel cell is being supported by the battery from time to time, for example, during start-up or acceleration.

The high-voltage battery offers a capacity of 24 kWh and the 144 L (= 5.6 kg) GH_2 storage provides more than 188 kWh, which results in a potential range of 594 kilometers (369 miles). During my freeway drive, I achieve a top speed of 165 kph (103 mph) – it won't go any faster.

H_2 refueling made simple

I need to fill up twice in the nine days that I have for testing the fuel cell car. The first time is directly after the DWV general assembly meeting: An association member whom I offered a ride to the Berlin main station sees first-hand how hydrogen tanks are filled up at the Total station on Heidestrasse: Drive up to fuel pump – get out – put fuel card into machine – attach fuel nozzle – wait – put back fuel nozzle – done.

It's easy enough, but it only works the second time we try. The receipt I get shows zero kilogram, although the tank is full. Just to be sure, we ask the worker at the checkout counter. Reply: "The hydrogen isn't our responsibility." It looks as if the H_2 refueling bit is still entirely in the hands of the Clean Energy Partnership.

A few days later, I fill up the tank again. Here, at the filling station on Holzmarktstrasse, everything goes as planned, although I didn't look up this station on cleanenergypartnership.de either, in order to make sure it was operational. The receipt shows the correct amount this time: EUR 20.52 for 2.16 kilograms of H_2, to be billed through the CEP fuel card. As long as the H_2 filling stations are open, everything works as it should.

There is not much more to report about the car, except for the fact that at the beginning, you don't know exactly whether the vehicle is still on or off. But as so often, practice makes perfect.

A heavy price to pay – despite incentive

The ix35 Fuel Cell confirms without a doubt that fuel cell technology has long been mature enough for use in transportation. Leave it to the price and the infrastructure to throw up roadblocks on the path to commercialization – and, of course, the self-inflicted wounds of some important market actors.

Hyundai's website lists the price for an ix35 Fuel Cell, incl. VAT, as EUR 65,450 (monthly rate of EUR 599). The price excluding VAT is EUR 55,000 – meaning it falls within the range of the EUR 4,000 economic incentive (see p. 26). This makes the ix35 Fuel Cell the currently only fuel cell car to be eligible for a direct financial incentive in Germany.

In South Korea, the situation is much more favorable to electric car buyers, who receive subsidies and tax incentives of EUR 21,400 per vehicle. The country's economy ministry intends to increase the number of H_2 cars to 9,000 by 2020 and to 630,000 by 2030. The Korean government also plans to have 80 H_2 filling stations up and running by 2020.

New generation

In the meantime, the Asian manufacturer has already been developing the next generation of fuel cell cars. Hyundai Motor announced that a new model would be available later this decade (presumably in 2018 before the Olympic Winter Games in Pyeongchang). It could be based on the Tucson again, but with a top speed of 180 kph and a design targeting primarily non-business customers – and at a lower price. Frank Meijer, head of the Fuel Cell Electric Vehicles department at Hyundai Motor Europe, told motoring.com.au that as roominess and usability were important, it would again be another off-road vehicle, a crossover or an SUV.

A Journey South in an ix35 Fuel Cell

Long-Distance Road Test: Bergen–Bolzano

Electric Transportation

Hyundai is one of the few carmakers in the transportation sector to have already made use of the fuel cell as a mass production feature in road transport. Its European subsidiary organized a several-day trip from Bergen in Norway to Bolzano in Italy to offer drivers from across the continent plenty of opportunities to test out the car even over longer distances. On June 12, nine Hyundai ix35 Fuel Cell set out on a five-day journey to travel around 2,300 kilometers (1,429 miles) from high up north in Europe to Italy. From time to time, they were accompanied by six other FCEVs, which joined the group for a short distance in Offenbach, Munich and Innsbruck. On behalf of H2-international, Mortimer Schulz took part in this unique pioneering event for which Hyundai did not only supply the cars, but also covered the costs of hotels and food and the travel expenses to get to the start of the journey and back home from the finish line.

Day 1 – Bergen, Norway

Our journey starts at 6 in the morning, after everyone arrived at their own pace the day before. Around 20 people (journalists, photographers, company representatives and Hyundai employees) get into the nine FCEVs and the two escort vehicles. I am one of them and I am getting ready as well. This fuel cell model is already familiar to me from earlier, shorter test drives, but such a long “hydrogen journey” is a new experience entirely – and a thrilling one at that.

The first part of the trip takes us mainly on the Fv 48 highway 101 kilometers (63 miles) in best weather and under the clear, blue sky typical of Scandinavia from Bergen to the Gjermundshamn harbor, along breath-taking hill formations and waterfalls. The speed limit in Norway is 80 kph (50 mph) on highways and 50 kph (31 mph) in towns and cities, which will surely up the mileage. But the available range shown on the gauge is shrinking faster with every kilometer I go. Either I’m driving more aggressively than I thought or the morning temperature of 10 °C (50 °F) has a negative impact on fuel consumption. Later in the day, a colleague from Hyundai recommends that I try out the E instead of the D mode (“lever to the left and then forward once”).

Fig. 1: ix35 Fuel Cell road test across Europe

Pictures: M. Schulz

We proceed on the Fv 551 highway, sometimes in groups, and make a few stops to snap pictures in the midst of the snowy landscape of Folgefonna National Park. Another 325 kilometers (202 miles) on the Rv 36 toward Porsgrunn and it will be time for the first scheduled H_2 refueling. The fuel gauge, however, inches ever closer to

low until it only shows one bar left and even starts to blink. It's still 36 kilometers (22 miles) till our next stop, so after some introspection, a look at all instruments and a check of whether I can turn off any more electric consumers in the car, I start driving again and use every hill I can find to replenish the battery.

At 2:49 in the afternoon, I am in Porsgrunn. Some of the others have already arrived. After refueling, the pump display shows 4.89 kg of hydrogen. The manager of the H_2 filling station, which has been operated by HYOP since 2007, explains that the hydrogen is produced only 100 meters (328 feet) away at an industrial facility and is transported to the station at low pressure through a gas pipe. It is only here that the hydrogen is compressed to 700 bar (around 10,000 psi). The price per kilogram of H_2 is NOK 90 (EUR 9.60), but as a travel expense the bill is paid by Hyundai.

Then we drive another 33 kilometers (21 miles) to the Larvik ferry terminal, and everyone manages to get on the four-o'clock ferry in time. At 7:45 in the evening, we reach Hirtshals in Denmark and drive the remaining 67 kilometers (42 miles) to Aalborg during sundown.

After 526 kilometers (327 miles) on the first day in about nine hours of driving (excluding breaks), I am pretty relaxed when I arrive at the hotel – all thanks to electric driving. As the driver's seat in the ix35 Fuel Cell is somewhat raised and very comfortable and the running gear is well-adjusted to the point where you hardly notice the pavement, you get to enjoy a featherlight "hydrogen experience" and a view of the landscape through the large window panes. The instrument panel design is minimalistic and besides the typical car noises, you will rarely hear the fuel cell technology in action. From time to time, you may here a short whistling sound when steam is blown off.

Day 2 – Aalborg, Denmark

On the second day, we start driving at 8:26 in the morning. Today's trip is going to be 453 kilometers (281 miles), via Aarhus, Kolding and Hamburg. First, we fill up the tank in Aarhus at a refueling station operated by H2 Logic (4.04 kg of H_2). During a presentation by Hyundai Denmark in Kolding, representatives of the Danish hydrogen movement explain to us that Denmark has already seen the installation of nine H_2 filling stations; two more are being built and will still go online this year.

The trip from Denmark across the border into Germany is a freeway exclusive, with a variety of herd animals greeting us along the way. Just like in Norway, the road is filled with many different electric cars and plug-in vehicles. I feel like we are part of a vision to shift the focus of transportation to more eco-friendly alternatives.

After 453 kilometers, I refill 4.61 kg of hydrogen at the Vattenfall station in Hamburg Harbor City.

Day 3 – Hamburg, Germany

The consistent speed level of 110–120 kph (68–75 mph) leaves much time to discuss H_2 transportation. My passenger today is a colleague from Hyundai, who directs my attention to the hydrogen sensor integrated into the car roof. And he explains to me the center console and the purpose of the energy flows shown live on screen. The display depicts how hydrogen is being fed into the fuel cell, which generates

electricity for the 100 kW electric motor. Stepping on the brakes will feed electrical energy into the battery for when I feel like pressing down the accelerator pedal.

We arrive in Düsseldorf at the Air Liquide station on Höherweg after putting another 399 kilometers (248 miles) behind us. Several employees of Air Liquide have already been waiting for us there to serve refreshments and talk a bit about the company and the H_2 infrastructure. While I listen to their presentation, my car is being filled up with 4.67 kilograms of hydrogen. The special feature of the filling station is the touchscreen above the fuel pump and the round instruments in traditional Formula 1 style to show us the rapid increase in hydrogen pressure.

Five kilometers or around 3 miles farther and we are at our next hotel. It's the end of the third day of our journey, and I dine in a restaurant that I can only recommend.

Day 4 – Düsseldorf, Germany

This day's 628 kilometers (390 miles) will make for the longest part of our trip, with a stop at Hyundai in Offenbach and at a filling station in Geiselwind. Start is 8:23 in the morning – arrival in Munich-Unterhaching is scheduled for 7:40 in the evening.

In Offenbach, Hyundai Germany shows us the Ioniq, the company's newest model. It comes in two versions, electric-only and hybrid. A third plug-in hybrid variant will be unveiled in 2017.

After only 154 kilometers (96 miles), most of the FCEVs arrive in Geiselwind at around the same time, meaning not everyone can fill up their car immediately. And the station needs to re-pressurize after several refills, which results in an unexpected wait – something we have not had at any of the other stations. In the end, I get my 4.13 kilograms of hydrogen and drive another 245 kilometers (152 miles) to Munich-Unterhaching.

A dark-blue FCEV with a bee on its back is parked in front of the hotel – and is surrounded by a throng of journalists. It's now Linde's turn to present its car-share business BeeZero, which offers a total of 50 FCEVs across the region of Munich. The company's innovative approach integrates the use of apps and social media, two things that embody the zeitgeist of the fuel cell and renewable transportation era. What I like most about it is the contemporary thinking of "don't believe in owning a car, but in using the opportunities it offers for transportation."

I'm glad that late-evening refueling on Detmoldstrasse is done by the support team.

Day 5 – Munich, Germany

The 305 kilometers (190 miles) from Munich via Innsbruck to Bolzano comprise the final and the shortest of the five day trips. When travelling south, the terrain is becoming increasingly hilly, and after 162 kilometers (101 miles), we are off to another event in Innsbruck: the inauguration of the Green Energy Center Europe. After the obligatory photo op, we proceed to the third Austrian H_2 station, which is located on Andechsstrasse in Innsbruck and is operated by Linde (but no refill for my car there). Afterward, we get on Brennerstrasse to drive the last 128 kilometers (80 miles) to our final destination.

It is the place where the Institute for Innovative Technology (IIT, see Interview with Walter Huber from H2 South Tyrol) has set up a self-sufficient filling station at the

highway exit Bolzano-South. Here, energy from a nearby hydropower plant provides the electrical energy for hydrogen electrolysis. The fuel is created and stored locally. Each day, five H_2 buses manufactured by Van Hool and owned by the city of Bolzano are filled up at the station at 350 bar (around 5,000 psi).

A final presentation, an excellent lunch and a group photo round off these five incredible days – 2,316 kilometers (1,439 miles) in 30 hours and 41 minutes (without breaks). And what about the fuel? The 22.34 kilograms of hydrogen I filled up on my own plus the refueling in Munich and the fuel consumed to drive the last part of the trip add up to approximately 30 kilograms of hydrogen in five days.

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CPN – Great Potential but Little Traction?

Close to Being Competitive

Research & Development

The UPS industry was supposed to be the fourth pillar of the German National Innovation Program Hydrogen and Fuel Cell Technology (NIP). Instead, the niche market considered to be an innovative force in the industry has yet to offer more than a glimpse into its possibilities. Industry network Clean Power Net (CPN) has tried to instill confidence by posting encouraging news articles, but some market actors are still waiting on the right environment that can deliver more steam for market development and boost product sales. Largely not in dispute, however, is the notion that the market offers great potential for growth.

Fig. 1: GenStore™ system at MTN in South Africa

Source: Heliocentris

Clean Power Net was founded in 2010 to bring together a variety of companies from the uninterruptible power supply market (UPS or what used to be called “early markets”). On March 15, the network’s 21 companies and R&D organizations met in Berlin for the organization’s fifth general assembly, entitled “Market for Fuel Cells Continues to Grow.” CPN said that not only were successful reference projects paving the way for the fuel cell to enter new markets, but that there was also increasing demand for fuel cell solutions in emergency power supply and that many customers had already been using fuel cells to displace diesel units in UPS applications. But sustainable, mass-market adoption of the technology is still not in sight.

Fuel cells for government radio

And this although the outlook is promising. One application where fuel cells are becoming increasingly popular as emergency power supply is digital police radio. First field tests at government agencies and organizations tasked with providing security (in short: BOS – see 116 radio masts are equipped with FC systems) were completed successfully in March. Henrik Colell, CTO of Heliocentris Energy Solutions and spokesperson of Clean Power Net since its foundation, was pleased to announce that “the BOS Brandenburg showcase has thrust our entire network into the limelight.”

Members of CPN also took part in a bidding process initiated by the federal state of Bavaria. The German state intends to replace its diesel generators for emergency power supply of government radio, which would raise the number of fuel cell systems in operation in this field alone to around 220.

It was a promising sign for Colell: “We have managed to raise public awareness of the technology and inform people about its many uses. In the minds of decision-makers from politics and business, fuel cells have become a reliable alternative for secure power supply.” His statement was a reference to a potentially increasing demand for solutions supplying energy to traffic control systems at railroads, banks or hospitals. One of the prospects is Deutsche Bahn, which is convinced of the benefits of the technology. Not too long ago, in July 2015, its subsidiary DB Bahnbau Gruppe – which has recently joined the network – entered into a cooperation agreement with Proton Motor Fuel Cell on the sale and maintenance of fuel cell UPS systems. Proton, in turn, is expanding into other European countries and regions, from Switzerland to the Orkney Islands (see Eco-Power for Orkney Islands).

Export fund with EUR 350 million budget

Colell, however, also told H2-international that despite their best efforts, the CPN members “have not been able to implement a domestic market deployment program for UPS systems.” NIP 2.0 is said to subsidize demonstration projects and R&D too, in order to improve system performance and cut more costs. But to further support business activities abroad to the best of one’s capabilities, there are discussions about some kind of fund-based measure to strengthen the global market position of German fuel cell exports (see Interview with Klaus Bonhoff from NOW).

Such a measure would involve an export fund to finance projects worldwide for six years. With a total budget of EUR 350 million, the fund is expected to support the installation of up to 90,000 fuel cell systems. The money could be provided as low-interest loans to realize larger projects that will prompt economies of scale and lead companies to tap cost-cutting potential. But so far, the entire thing is just an idea that has been floated around in talks with the federal economy ministry.

Share price tumbles

Even without CPN’s start-up troubles, some network members – businesses with a long history among them, such as Heliocentris and SFC – struggle with keeping their investors committed. Both companies have been part of the fuel cell business since the beginning of fuel cell development at the end of the last century. But they risk trying their financial backer’s patience, as the route to commercialization is a long and winding road. SFC Energy’s shares have been at the same low level for seven years, which should be noted is 80 percent below the original issue price from 2006. Even the last increase in capital in mid-August 2016 hasn’t done much to change the situation (gross proceeds: around EUR 1.5 million).

SFC may regularly report the conclusion of new multi-million euro contracts, but the stock price just wouldn’t go above EUR 7 over the past years. That would explain the rather cautious attitude among many of the company’s investors. Another issue is that since 2015, the company has had to fight off a competitor offering similar products on a market that is still quite small: Keymile based in Lower Saxony has recently joined forces with Danish fuel cell manufacturer IRD to integrate the DMFC generator model 800 into its own UPS systems. The Hanover trade show in 2016 was the first event at which the company presented its units to the public. They are methanol-based just like SFC’s. And like the business from Brunnthal, the Hanover competition targets air traffic, pipeline and border control systems, which need to stay online even during power outages or work as true off-grid solutions.

Heliocentris Energy Solutions, which has been headquartered in Berlin-Adlershof since 1995, is not much better off. The company also went public in 2006, but its share price did not experience a dramatic drop until the end of last year. Here too, shares are quoted 80% (lately even 90%) below their issue price, down from a +25% high in summer two years ago and half a year after the takeover of FutureE Fuel Cell Solutions (for more information, see Heliocentris – Profile of a Listed Fuel Cell Company and Heliocentris Files for Bankruptcy).

NOW study: Fuel cell alternative with appeal

A promising study has recently been conducted by David Hart and Franz Lehner from E4tech on behalf of NOW. After examining the European market for emergency power supply of up to 100 kW of capacity, the authors concluded: “The use of fuel cells instead of conventional emergency power systems in a variety of pilot projects has helped showcase the benefits of the new technology and present it as a mature alternative with operational advantages. […] US tax incentives for fuel cell systems have already turned these units into an intriguing alternative to diesel generators. […] Complete fuel cell systems of up to around 10 kW of capacity are expected to have the best chance of competing with conventional units on today’s market.”

The analysis went on to say that high acquisition costs were currently the biggest barrier to further deployment. These costs, however, were offset by lower operating expenses, which would almost certainly make the fuel cell competitive by 2020 or 2025.

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Fuel from Artificial Leaves

How to Produce Hydrogen Through Photosynthesis

Research & Development

Hydrogen is thought to be a highly efficient and an almost perfect solution for energy storage. And its importance is growing in light of the volatility of renewable energies. But the conventional and rather complicated hydrogen generation through solar energy and subsequent electrolysis reduces the efficiency of the process. An interesting alternative could be artificial photosynthesis, for which researchers all over the world are developing the methods. Success and efficiency both hinge on suitable materials for the cells. The technological battle for the best efficiency (which has doubled over the last years) is in full force.

Fig. 1: The small cell sets a record in efficiency by converting 14% of the incoming sunlight into hydrogen.

Source: HZB, M. May

Plants have long been able to convert sunlight into chemical energy through photosynthesis. Solar energy captured by technological means may indeed be available worldwide in abundance, but not all the time and everywhere. The development of solutions storing solar power in batteries or hydrogen has a long way to go, and this although any harnessed energy could be captured much better in the form of hydrogen than electrically. Professor Roel van de Krol, who heads the Solar Fuels Institute at the Helmholtz Zentrum Berlin (HZB), explained: “One kilogram of a fuel like hydrogen stores about 100 times as much energy as a comparable battery.” A particularly interesting storage solution is one based on nature itself: artificial photosynthesis, a technology that is being researched across the globe.

Artificial leaf produces hydrogen

It has already been possible today to convert sunlight into chemical energy through artificial semiconductor systems. The “artificial leaf” required for the process consists of a solar cell, two electrodes and a membrane, combined with added functional layers. If immersed in water and put in sunlight, the harnessed electrical energy at the photoanode splits the water into oxygen atoms, protons and electrons, i.e., hydrogen. Whereas the oxygen remains in one chamber, the electrons and protons are led through the membrane into another, where a photoanode is used to combine them into hydrogen.

At present, there are still some issues to work out: Despite the additional layers of material, enough light must come through the solar cell to create the voltage for splitting water. Moreover, the semiconductor materials that typically make up the solar cell have not been able to withstand the acid-laced water for very long. The artificial leaf needs a strong protective film that is both translucent and conductive. A new method uses a nanofilm of titanium-oxide, which encloses the silicon electrodes to protect them from corrosion. This novel approach has enabled the researchers at the Helmholtz Zentrum to increase the solar-to-hydrogen efficiency to just under twelve percent.

Above 15% efficiency

An international team made up of researchers from the Helmholtz Zentrum Berlin, the TU Ilmenau, the Fraunhofer Institute for Solar Energy Systems and the Joint Center for Artificial Photosynthesis (JCAP) of the California Institute of Technology has now succeeded in increasing the efficiency for direct solar water splitting a second time. The new benchmark value is 14 percent. The researchers used multi-junction solar cells made of III-V semiconductors, which they said would make it possible to raise efficiency above 15 percent and attain stable cell structures for more than 1,000 hours. Long-time reliability is making progress as well. Initially, the samples only lasted for a few seconds before production output collapsed. After about a year of enhancements, the team was able to secure cell stability for more than 40 hours by encasing the sensitive semiconductors in an extremely thin, organic and translucent layer of linked carbon atoms.

“Forecasts indicate that the generation of hydrogen from sunlight using high-efficiency semiconductors could be economically competitive to fossil energy sources at efficiency levels of 15% or more. This corresponds to a hydrogen price of about four US dollars per kilogram,” Professor Thomas Hannappel from the TU Ilmenau said. Professor Hans-Joachim Lewerenz from JCAP, who worked closely with the researchers from the HZB, added: “We’re nearly there. If we also manage to increase charge carrier mobility at the junctions a bit further, we could even use this semiconductor system to store more than 17 percent of the incident sunlight chemically as hydrogen.”

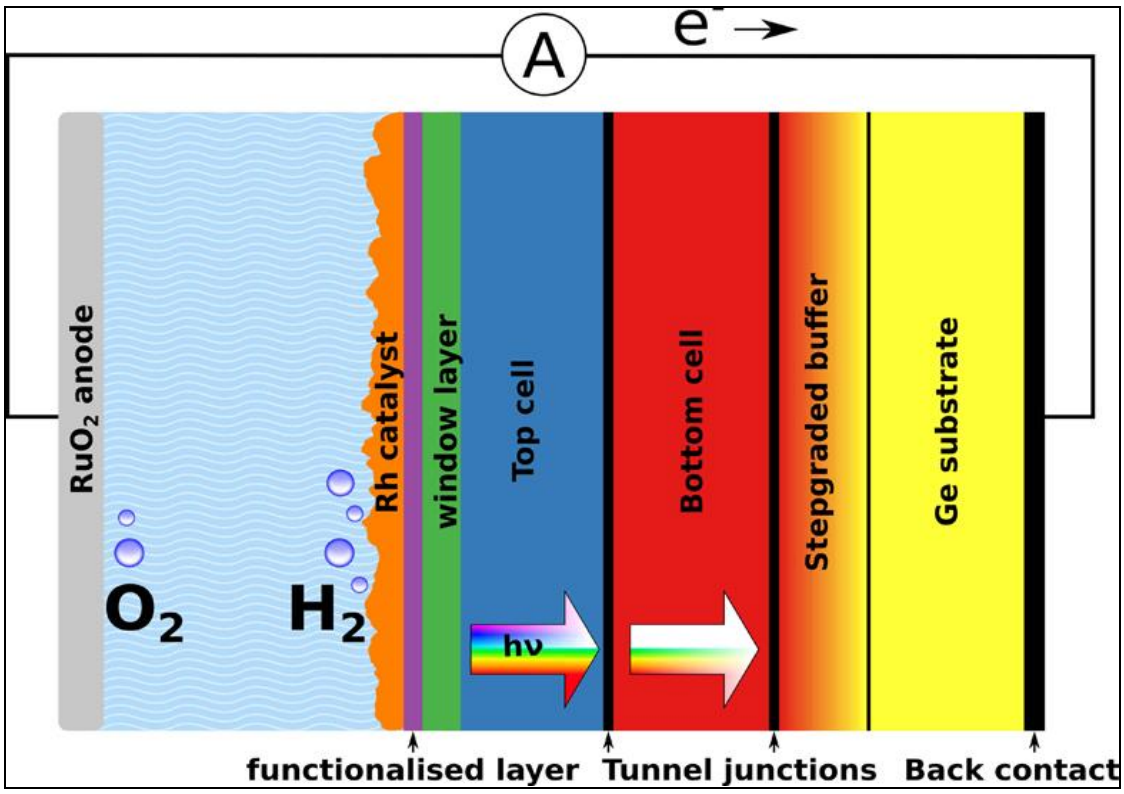
Search for inexpensive catalysts

In research, higher efficiency goes hand in hand with a search for inexpensive and efficient catalysts which are required at the anode for water splitting and the decrease of reaction times. So far, the process has used effective but expensive metals like platinum. Conversely, the artificial leaf contains a JCAP-developed catalyst that is cheap and consists of a two-nanometer-thick nickel layer to increase efficiency. Another 62.5 nm thin film of TiO_2 prevents corrosion and improves the stability of the gallium-arsenic photoelectrode. A principal element of the JCAP development is the plastic membrane that keeps the oxygen and the hydrogen gases separate to prevent the creation of oxyhydrogen.

The Helmholtz researchers have been experimenting with catalyst materials from iron-nitrogen combinations in graphite, which had originally been developed for fuel cells. Sebastian Fiechter, deputy director of the Solar Fuels Institute, said: “We can also use the data we collected on these metal-NC catalysts to develop catalytic materials for solar-based hydrogen production, one of our HZB projects. However,

thorough research into FeNC catalysts was difficult, since most approaches lead to highly heterogenous materials containing inorganic matter such as iron carbides or nitrides in addition to the desired FeN_4 cores." But in the end, they were able to separate the two through a special process.

Fig. 2: The multi-junction cell is covered with a catalyst at which hydrogen forms.



Source: HZB, M. May

Meanwhile, the artificial photosynthesis of small cells of few square centimeters in size had worked rather well in a laboratory environment, van de Krol explained. But to put them to use in real-life H_2 production, they would need to become larger and remain stable for a long time. A work in progress are systems of 50 square centimeters (7.75 square inches) with a stability of more than one thousand hours. "The material is key," van de Krol said. Today, there are either stable and inexpensive materials or stable and largely efficient ones, or cheap materials of great efficiency – but there is no material that meets all the requirements. "If you were to create hydrogen with the best solar cells, solar concentrators and expensive precious-metal catalysts available, you could achieve 20% efficiency, but it would be an extraordinarily tedious process," van de Krol explained. It may take another ten to 15 years until the first systems reach market maturity.

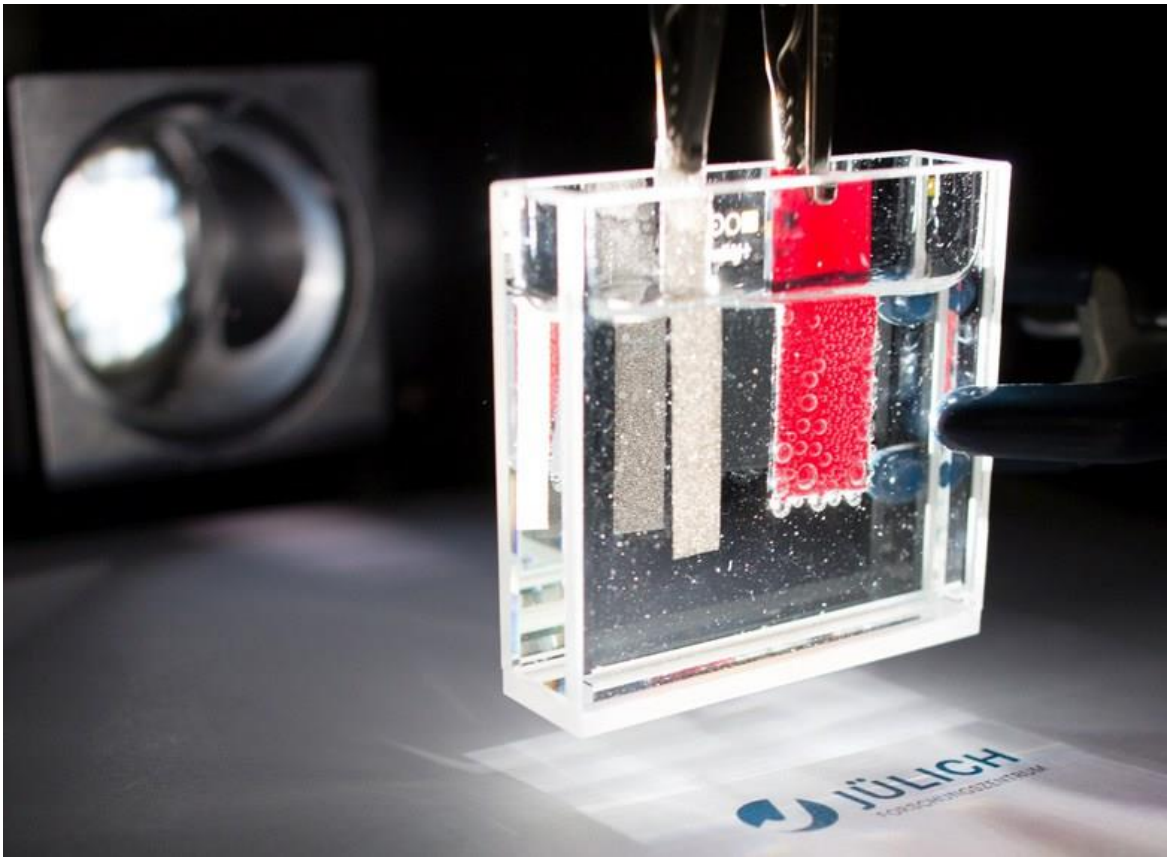
More layers = more capacity

There are yet other organizations which explore the potential of solar-based hydrogen production: Researchers from the Institute of Energy and Climate Research at the Jülich Research Center have developed a silicon-made multi-layer solar cell that can be produced quite cost-effectively and creates hydrogen based on artificial photosynthesis directly from sunlight. The efficiency achieved so far is 9.5 percent. "The difficulty, however, is to create a sufficiently high photovoltage. In practice,

around 1.6 volts are necessary to kick-start the reaction for water splitting. Common crystal silicon solar cells, which have a photovoltage considerably lower than one volt cannot accomplish that," explained Jan-Philipp Becker.

"A multi-layer structure of cells stacked on top of each other is much more efficient at capturing the spectrum of sunlight ranging across a variety of wavelengths," explained his fellow researcher Félix Urbain. "The voltage also increases up to 2.8 volts and provides enough flexibility to use not-so-precious metals like nickel as catalysts instead of expensive platinum ones," he said. H_2 generation benefits from the higher voltage of the thin-film solar cell. Tests show that the silicon thin-film solar module can be used for the efficient generation of hydrogen (see figure 3). "Overall efficiencies of above ten percent seem quite possible," said Professor Uwe Rau, head of the Jülich Institute of Energy and Climate Research.

Fig. 3: Hydrogen formation at the photocathode with a silicon-based thin-film solar cell (red); oxygen develops at the metal electrode (silver)



Source: Forschungszentrum Jülich

Algae and cyanobacteria

Researchers from the Center for Biotechnology at Bielefeld University are working on a way to utilize proteins from algae and semiconductor nanomaterials to capture the energy of the sun. This energy will then be used by the new artificially created catalysts to produce hydrogen. And researchers at the Hebrew University in Jerusalem have already coupled the light-absorbing parts of cyanobacteria with an electrode for biocatalytic power generation. By using a polymer and a nanoparticle made of platinum, they managed to link the light-harvesting complexes and reaction

centers of cyanobacteria photosystems to an electrode through oxygen molecules. If sunlight enters a cell, the glucose molecules can convert it into gluconic acid with the help of special enzymes. The released electrons move to the electrode and can be fed into an electric circuit. At present, however, these bacteria only achieve a modest 1% efficiency.

Author: Edgar Lange, freelance journalist specializing in fuel cells and hydrogen

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How to Retire the Diesel Engine

Interview with BSM's Thomic Ruschmeyer

Politics

German association Solar Mobility (BSM) should at least be known to those who attend automotive or energy trade shows from time to time. Since its founding in 1989, the BSM has had a large exhibit at many of these events and offers a variety of vehicle types – from solar-powered cars to electric buses – for attendees to touch and discuss. To some, the association may at first seem to cater primarily to visionary pioneers of the solar industry, but its members have made every effort to raise public awareness without which end customers may have never known about the benefits of electric transportation. The association has also become a household name in political circles after it got involved in the design of the charging infrastructure regulations and the implementation of the EU's AFI directive. The following is an interview with BSM chair Thomic Ruschmeyer, who sat down with us at the association's Berlin office close to the Brandenburg Gate to talk about the industry's successes and failures.

Ruschmeyer: I have recently come across the number of 1,700 applications submitted [by Aug. 2, 2016; editor's note]. That is something, but there is no outright run on electric cars, at least not yet. It's a good sign that something has – finally – happened, but the spread between EUR 3,000 for a hybrid and EUR 4,000 for an electric car is a bit modest.

H2-international: Do you think that hybrid cars enjoy one favorable condition too many?

Ruschmeyer: The incentive is geared toward the capabilities of the German automotive industry: combustion engines – electric drive for the hybrid version. Many of these plug-in hybrid cars, however, only offer room for an electric turbocharger. They aren't designed for driving long distances electrically, but the grant amount you receive is relatively high.

H2-international: What is on the market today?

Ruschmeyer: Regarding electric-only vehicles, there is the VW e-up!, the e-Golf and the BMW i3. Ford offers something, Daimler does, but it's still not as if you could just go to a car dealership and buy a car the usual way. If available at all, electric vehicles can be found more at the back of the showroom and then they are mostly for lease.

Officially, you're still talking about 30 electric vehicles on the market and 50,000 ones registered, but the numbers vary by a lot depending on who's reporting them.

Fig. 1: Thomic Ruschmeyer

H2-international: In April, the federal government introduced the economic incentive and the draft law has been published in the Federal Gazette. Has it already led to a boost in electric car sales?

H2-international: Has someone already come around, meaning have any carmakers indicated that they would indeed push ahead with electric transportation?

Ruschmeyer: We have recently been to a workshop during which a representative from the German Association of the Automotive Industry left us with the impression that the industry was coming around. It seemed as if the carmakers could warm to the idea of one or two cents being added to the fuel price – as a CO_2 tax used for the sole purpose of establishing the relevant infrastructure – primarily for electricity, but also for hydrogen. He didn't elaborate further. At least, there is some change in attitude, and you would have to say "dieselgate" certainly played a big part in it all. The diesel isn't clinically dead yet, it just seems as if it is being pushed out of the market. Still, its use will continue in other devices and transport means, such as construction machinery, ships and trucks.

H2-international: Let us talk a bit about the law on electric transportation. Are you satisfied with it?

Ruschmeyer: We've made it abundantly clear over and over that we do not think plug-in cars should be allowed to carry an e-label. The e-label is something we

wanted and that we consider a success on our part. But if the plug-in hybrid version of a Porsche Panamera – I am speaking in hyperbole, of course – receives the label and you see them roaring past you on the bus lane, while you can't do the same with a CityEl or an electric scooter that has a moped license plate, then the original goal has been slightly missed. It is also counterproductive to creating a favorable public opinion for the technology.

H2-international: How many bus lanes have been opened to electric cars?

Ruschmeyer: Almost none.

H2-international: And what about the other parts of the electric transportation law?

Ruschmeyer: It has no impact except for the regulation that electric vehicles are now allowed to park at charging stations and combustion-engine cars can be towed away from there. However, you are only allowed to charge for four hours and there is no way for the authorities to confirm this, since each car-charging meter is different. For example, if you have an e-up!, you first need to unplug and turn off the ignition before being able to see how full the battery is. The i-MiEV, iON and C-Zero have their energy gauge so far down that you need to at least open the door to give a rough estimate of the battery status. Carmakers have promised improvements, but even though the time limit does make sense to prevent drivers from parking their cars at charging stations for as long as they like, it is also a barrier to the network integration of electric cars and renewable energies. Additionally, the regulations on charging points may introduce a rule to let your reserve a charging spot and pay for it – whether or not you actually charge your car during that time.

H2-international: Do you know of any other good government-initiated policies?

Ruschmeyer: The ten-year tax exemption for electric cars – for which the government often takes credit, although it isn't in the law – is a joke, to be honest. The charging point regulations aren't much different. If you look at the time it takes to get a charging station approved in a public space in Germany, you will have to expect lead times of six to eight months – and additional costs for staff. The process is much faster and less expensive in a country like the Netherlands.

H2-international: How committed would you say is federal transport minister Dobrindt? He was not at the closing conference of the Showcase program in Leipzig. Did he attend the industry conference by the federal government in Berlin in June?

Ruschmeyer: No minister was there – and no OEM executive either.

H2-international: In retrospect, how would you characterize the German approach of funding through showcase projects?

Ruschmeyer: It was good thinking to put as many applications to the test as possible. Some projects were duplicates or quite similar, which may have been OK to compare differences in results. However, some project designs reminded us too much of what we had already done a long time ago. I do not want to criticize more than necessary, since we did participate in the program with our own two projects. The showcases were quite good and were needed to advance the cause. But what has certainly been a problem is the lack of ideas for a follow-up. We now have figured out the basics, but we would need another project to continue our work.

IMG_5255.jpg

H2-international: What will the market look like in the future? Volkswagen reportedly intends to set up its own battery factory. Is that realistic?

Ruschmeyer: Volkswagen's hand has been forced somewhat and it needs to generate some revenue to pay off the penalties that were imposed. I do not think the battery factory will come in the shape and size that is being reported right now. You don't just close the engine factory in Kassel and start producing batteries there. What I could imagine is that they develop cell configurations and start working on power electronics. But that a large corporation like VW abruptly changes course, that isn't even possible structurally. It is no different at companies such as BMW, where technicians developing electric cars are rather the exception than the rule.

H2-international: But if an increasing number of electric cars does hit the road soon, what would battery charging look like? Billing in particular is still a complicated issue.

Ruschmeyer: If you want to charge an electric car the normal way when you are on the road, the best thing to do would be to integrate a power meter into the car – that would be relatively easy. The meter could have its own ID number and this number would be registered with the customer's electric utility. A variety of SIM cards could be used to establish a connection to your house and record consumption.

H2-international: Would this not also make much more sense for inductive charging compared with the cable version? And when will we no longer have to carry cables around?

Ruschmeyer: I don't think we can completely get rid of the charging cable, since induction charging requires quite a lot of effort. Personally, I would also be somewhat skeptical, as the technology will need to be put into the ground. Humidity and frost that close to electrical lines? That's troublesome. I can just point you to the potholes, which get ever bigger in winter. I can well imagine induction technology to be used for certain means of transportation: buses, cabs and delivery vans, meaning electric vehicles which stop somewhere for a while and where the time to get out a cable isn't worth it. Some private customers may indeed invest four figures into their own garages, but I do not think that this will become the norm.

H2-international: What about hydrogen: Some have begun to say that if electric cars like Tesla's can guarantee a range of 500 kilometers (311 miles), there would not be a need for fuel cell vehicles anymore. Now, fuel cells are increasingly talked about as range extenders. What do you think?

Ruschmeyer: I am all for the latter, since range extenders are a pretty smart solution. Use the battery not just as a small buffer for braking energy, but for battery-electric driving in general and otherwise, get electricity from a fuel cell, which may even be optional. I can see this concept at work wherever more energy is required, even in aircraft, where I would rather trust the fuel cell for providing propulsion than batteries. What I do not believe to be a sensible solution is a fuel cell in city SUVs.

H2-international: And in your opinion, how will the government resolve the question of taxation? If more and more vehicles drive electrically, but power and hydrogen are exempt from the mineral oil tax, where does the government intend to get the missing billions from?

Ruschmeyer: Then get ready for a toll system. One option for electric cars could be an integrated meter, as it is being discussed in Switzerland right now. In the morning between seven and nine, a trip to the city will cost EUR 1.50, while charges will be only EUR 0.70 from nine to eleven. Pricing could be used to control traffic, but it would also promote exclusivity.

H2-international: Do you think that such plans will only be seriously considered after a possible change in government, e.g., by a conservative-Green Party coalition?

Ruschmeyer: Chances would probably be higher then, although they would be even higher if the Green Party were the major partner in this coalition (laughs).

Three New H_2 Filling Stations

Electric Transportation

Source: Daimler

Since this summer, Germany has been able to offer eco-conscious drivers two more opportunities to fill up their hydrogen tanks. The first new station went online in Wuppertal on June 19 and is viewed as the prototype for the planned nationwide H_2 infrastructure, according to the Clean Energy Partnership. The project supported by EUR 670,000 consisted of the addition of a hydrogen fuel pump to the Shell gas station on Schmiedestrasse near the interchange Wuppertal-Nord. Stijn van Els, chair of the German Shell companies, said “that this alternative engine fuel will play an increasingly stronger role in markets such as Germany, the Benelux countries, the UK and the US from the 2020s on.”

The second filling station went online on July 15 on the premises of the Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW) on Helmholtzstrasse in Ulm. The station marks an important step in bridging the gap in the east-west link between Munich and Stuttgart/Karlsruhe to the south of the city. The two installations pushed the official number of hydrogen filling stations in operation in Germany by early September 2016 to a total of 17, while another 17 were still under construction and an additional 19 were in planning. Unofficially, however, three locations were closed for maintenance or defects and two did not transmit information about their operational status. But on Sept. 23, another station opened in Metzingen, south of Stuttgart.

Areva H2Gen Starts Production

News

Manufacture of electrolysis systems in Les Ulis, France

Source: Areva H2Gen

On June 24, 2016, French technology supplier Areva H2Gen inaugurated its first production facilities for PEM electrolysis systems in the presence of the country's environment minister, Ségolène Royal. The new buildings are in Les Ulis near Paris, France, at the company's main plant, which has seen a doubling in staff in the two years since it went online. The plant will reportedly produce 30 electrolysis systems per year. Some of the components will be used for the new hydrogen filling station that is being set up in Rodez, a project supported by the H2ME program (Hydrogen Mobility Europe). The station will be supplied by hydrogen generated from hydropower plants and is said to serve as a refueling site for a fleet of several Renault Kangoo ZE H2 operated by Braley, a waste disposal company based in town. The new H_2 filling station in the Sébazac-Concourès commune is planned to go online in late 2016; local hydrogen production will reportedly start in June 2017.

Policy Shift in Renewable Energy Sources Act 2017

BMWi Launches "Next Phase of Energy Transition"

Energy Storage

German economic minister Sigmar Gabriel spoke of the "largest reform of the electricity market since the liberalization in the 1990s."

Source: Bundesrat, Frank Bräuer

On July 8, the Renewable Energy Sources Act 2017 (EEG 2017) was passed by both houses of the German parliament. Its most important addition is that from 2017 on, "rather than being fixed by the government, future rates of renewables funding will be determined by the market by means of dedicated auction schemes," the economy ministry announced. Whereas the parliamentary opposition and several environmental associations have criticized the EEG 2017, the BMWi described it as the "next phase of the energy transition." Renewable energy technologies had already reached market maturity and were ready to face the competition. The 2025 target was to increase the renewable share in electricity consumption from today's 33 percent to 45 percent. Owners of smaller plants (< 750 kW) do not need to take part in the bidding process.

Conversely, several critics of the law have said that the change in rules would stall the deployment of wind power plants just as much as it did on the PV market. Peter Knitsch, state secretary at the environment ministry of North Rhine-Westphalia, said: "The federal government is wrong to stop funding completely. Let me also say that these rules run counter to the aims agreed upon during the COP21 talks in Paris."

On the day that the law was passed, Robert Habeck, energy minister of Schleswig-Holstein, stood before the Bundesrat assembly saying that the measures put in place were "not sufficient," especially since the opportunity for integrating the renewable power market with the transportation and chemical industry had been missed. Gabriel, however, replied that the sector integration was the next item on the agenda.

No final consumer fee

The amendment does not explicitly mention power-to-gas, but it does say something about systems converting power into heat, so that there is a backdoor through which P2G systems could benefit from the amended legislation. To be more precise, one of the suggested remedies for the current shortage in the German grid is the plan to improve the standing of CHP through financial support of up to two gigawatts of added load in a still-to-be-specified area. By helping with the retrofit of existing CHP plants (> 500 kW) through the addition of electric heat sources, such a move is expected two kill two birds with one stone: First, immersion heaters need power and second, CHP plants on-site no longer produce any electrical energy. It will lessen transmission grid loads without creating a gap in heat supply.

Another rule stipulates that other systems, no matter their technological basis, could profit from the change in rules if the 2 GW threshold is not achieved by power-to-heat systems alone. Then power-to-gas systems could be used, although their utilization would still need to be specified by additional regulations. By fall 2016, we shall know whether the envisaged two gigawatts can be provided by these types of systems.

An important aspect is the reimbursement of grid transmission fees, EEG surcharges and other charges and taxes, which have so far been paid by the consumer. Electricity produced by power-based heat suppliers – or possibly by P2G systems – will no longer be at a financial disadvantage. Bernd Pitschak, managing director of Hydrogenics, explained: "In our view, an electrolysis system is not a final consumer, but a facility producing something that is sold and that reaches an end customer eventually. This final consumer could be a hydrogen filling station or a chemical plant."

MEKS Awaits Approval

News

Construction of MEKS, Sperenberg's multi-energy power plant, now entirely hinges on state government approval. In mid-July, the mayors of the four German towns involved signed a contract for the establishment of a community working group. But whereas local authorities would certainly welcome MEKS, the ones at state level have put a hold on the project, saying the selected area was not suitable for the construction of wind power facilities. The plan was to set up a 5 MW electrolysis system on the premises of the old airport of the Kummersdorf Proving Ground. This

system was to receive the required eco-power from a 100 MW PV array and a wind farm consisting of 45 turbines (with 3 MW each) – although both will still have to be built. The H_2 gas could be stored in an already existing pipe system used for peak shaving (diameter: 1.4 meters or 4.6 feet; overall length: 3.5 kilometers or 2.2 miles; volume: 480,000 m^3 or 16.95 million ft^3) by the Thyrow gas plant, so that the 50,000 inhabitants of the participating communities could be supplied almost entirely by renewable electricity. But without state approval, MEKS will go nowhere – despite the support pledged by BTU Cottbus and large companies, such as Enertrag, Vattenfall and McPhy.

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read more: www.h2-international.com

Events

- December 12th to 14th 2016, **H2FC Researcher Conference**, H2FC SUPERGEN, in Belfast, Northern Ireland, http://www.h2fcsupergen.com/conference/
- January 31st to February 2nd, 2017, **Fundamentals & Development of Fuel Cells**, Organised by DLR, in Stuttgart, Germany https://moreevent.meetingmasters.de
- February 7th to 9th, 2017, **E-world energy & water**, in Essen, Germany, www.e-world-essen.com
- February 16th, 2017, **Fuel Cells for Stationary**, in San Francisco, CA, USA, www.knowledgefoundation.com
- March 1st to 3rd, 2017, **European Fuel Cell Car Workshop**, EFCW2017 is an output of SMARTCat – a FCH-JU project, in Orleans, France, https://efcw2017.sciencesconf.org/
- March 14th, 2017, **Hydrogen & Fuel Cells into the Mainstream**, The 13th International Hydrogen and Fuel Cell Conference #CCSHFC2017, NEC, Birmingham, United Kingdom, www.climate-change-solutions.co.uk
- March 14th to 16th, 2017, **Energy Storage Europe - IRES**, in Düsseldorf, Germany, www.energy-storage-online.de, www.eurosolar.de

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Companies

Electrolyzers

- **AREVA H2Gen GmbH**, Maarweg 137, 50825 Cologne, Germany, Phone +49-(0)221-888244-88, Fax -67, www.arevah2gen.com
- **Diamond Lite S.A.**, Rheineckerstr. 12, PO Box 9, 9425 Thal, Switzerland, Phone +41-(0)71-880020-0, Fax -1, diamondlite@diamondlite.com, www.diamondlite.com
- **Giner, Inc.**, 89 Rumford Avenue, Newton, Massachusetts 02466, USA, Phone +1-(0)781-529-0500, information@ginerinc.com, www.ginerinc.com
- **Hydrogenics GmbH**, Am Wiesenbusch 2, 45966 Gladbeck, Germany, Phone +49-(0)2043-944 141, Fax -6, hydrogensales@hydrogenics.com, www.hydrogenics.com
- **Proton OnSite**, 10 Technology Dr, 06492 Wallingford CT, USA, Phone +1-(0)203-678-2000, info@protononsite.com, www.protononsite.com

Energy Storage

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

- **Hydrogenious Technologies GmbH**, Weidenweg 13, 91058 Erlangen, Germany, Phone +49-(0)9131-12640-220, Fax -29, www.hydrogenious.net
- **MicrobEnergy GmbH**, Specialist in Methanisation, Bayernwerk 8, 92421 Schwandorf, Germany, Phone +49-(0)9431-751-400, Fax -5400, info@microbenergy.com, www.viessmann.co.uk

Event Organizers

- **23rd Group Exhibit Hydrogen + Fuel Cells + Batteries**, HANNOVER MESSE 2017, April 24 – 28, Tobias Renz FAIR, Tobias Renz, 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
- **Peter Sauber Agentur Messen und Kongresse GmbH**, World of Energy Solutions, Wankelstr. 1, 70563 Stuttgart, Germany, Phone +49-(0)711-656960-55, Fax -9055, www.world-of-energy-solutions.de

Fuel Cells

- **FuelCell Energy Solutions GmbH**, Winterbergstr. 28, 01277 Dresden, Germany, Phone +49-(0)351-2553739-0, Fax -1, www.fces.de, Stationary fuel cells for commercial and industry: CHP solutions, hydrogen production and power storage

- **Heliocentris Energy Solutions AG**, Rudower Chaussee 29, 12489 Berlin, Germany, Phone +49-(0)30-340601-500, Fax -599, info@heliocentris.com, www.heliocentris.com

- **SerEnergy A/S**, Reformed Methanol fuel cell systems for stationary and e-mobility, Lyngvej 8, 9000 Aalborg, Denmark, Phone +45-8880-7040, www.serenergy.com

- **Tropical S.A.**, 17 Krokeon Str, 10442, Athens, Greece, Phone: +30-(0)210-5785455, Fax: -7, info@tropical.gr, www.tropical.gr

Fueling-Recirculation and Air-Supply

- **Gebr. Becker GmbH**, Hölker Feld 29-31, 42279 Wuppertal, Germany, Phone +49-(0)202-697-255, Fax -38255, info@becker-international.com, www.becker-international.com

- **Busch Clean Air S.A.**, Chemin des Grandes-Vies 54, 2900 Porrentruy, Switzerland, Phone +41-(0)32-46589-60, Fax -79, info@buschcleanair.com, www.buschcleanair.com

Gas Diffusion Layers (GDL)

- **MeliCon GmbH**, Metallic Lightweight Construction, Porschestr. 6, 41836 Hückelhoven, Germany, Phone +49-(0)2433-44674-0, Fax -22, www.melicon.de
- **SGL Carbon GmbH**, Werner-von-Siemens-Str. 18, 86405 Meitingen, Germany, Phone +48 (0)8271-83-3360, Fax -103360, fuelcellcomponents@sglgroup.com, www.sglgroup.com

Hydrogen Distribution

- **Hydrogenious Technologies GmbH**, Weidenweg 13, 91058 Erlangen, Germany, Phone +49-(0)9131-12640-220, Fax -29, www.hydrogenious.net
- **Wystrach GmbH**, Industriestrasse 60, Germany – 47652 Weeze, Phone +49-(0)2837-9135-0, Fax -30, www.wystrach-gmbh.de

Membrane and Separator

- **FUMATECH BWT GmbH**, Carl-Benz-Str. 4, 74321 Bietigheim-Bissingen, Germany, Phone +49-(0)7142-3737-900, Fax -999, www.fumatech.com
- **Plansee SE**, Bipolar Plates, Interconnects and Metal Supported Cells, 6600 Reutte, Austria, Phone +43-(0)5672-600-2422, www.plansee.com

Organization

- **German Hydrogen and Fuel Cell Association**, Deutscher Wasserstoff- und Brennstoffzellen-Verband e.V. (DWV), Moltkestr. 42, 12203 Berlin, Germany, Phone +49-(0)30-398209946-0, Fax -9, www.dwv-info.de
- **hySOLUTIONS GmbH**, Steinstrasse 25, 20095 Hamburg, Germany, Phone +49-(0)40-3288353-2, Fax -8, hysolutions-hamburg.de
- **National Organisation Hydrogen and Fuel Cell Technology (NOW GmbH)**, Fasanenstr. 5, 10623 Berlin, Germany, Phone +49-(0)30-3116116-15, Fax -99, www.now-gmbh.de

Reformers

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

Research & Development

- **Fraunhofer ICT-IMM**, Reformer and Heat Exchanger, Carl-Zeiss-Str. 18-20, 55129 Mainz, Germany, Phone +49-(0)6131-9900, info@imm.fraunhofer.de, www.imm.fraunhofer.de
- Fraunhofer ISE, **Fraunhofer ISE**, Heidenhofstrasse 2, 79110 Freiburg, Germany, Phone +49-(0)761-4588-5208, Fax -9202, www.h2-ise.de

Suppliers

- **Anleg GmbH**, Advanced Technology, Am Schornacker 59, 46485 Wesel, Germany, Phone +49-(0)281-206526-0, Fax -29, www.anleg-gmbh.de
- borit, **Borit NV**, Bipolar plates and interconnects, Lammerdries 18e, 2440 Geel, Belgium, Phone +32-(0)14-25090-0, Fax -9, contact@borit.be, www.borit.be
- ElectroChem, Inc., **ElectroChem Inc.**, 400 W Cummings Park, Woburn, MA 01801, USA, Phone +1-781-9385300, www.fuelcell.com
- HIAT HYDROGEN AND INFORMATICS INSTITUTE OF APPLIED TECHNOLOGIES, **HIAT gGmbH**, Schwerin, Germany, CCMs / MEAs / GDEs for PEFC, DMFC & PEM-Electrolysis, www.hiat.de

- **Kerafol Keramische Folien GmbH**, Koppe-Platz 1, 92676 Eschenbach, Germany, Phone +49-(0)9645-884-30, Fax -90, www.kerafol.com/sofc

- **WEKA AG**, Schuerlistr. 8, 8344 Baeretswil, Switzerland, Phone +41-(0)43-833434-3, Fax -9, info@weka-ag.ch, www.weka-ag.ch

System Integration

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

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

Testing

- **SMART Testsolutions GmbH**, Rötestrasse 17, 70197 Stuttgart, Germeny, Phone +49-(0)711-25521-10, Fax -12, sales@smart-ts.de, www.smart-testsolutions.de
- **TesTneT Engineering GmbH**, Schleissheimer Str. 95, 85748 Garching / Munich, Germany, Phone +49-(0)89-237109-39, info@h2-test.net, www.h2-test.net

Valves

- **Bürkert Werke GmbH**, Mass Flow Controllers, Christian-Bürkert-Str. 13-17, 74653 Ingelfingen, Germany, Phone +49-(0)7940-10-0, Fax -91204, www.burkert.com
- **OMB Saleri SpA**, Via Rose di Sotto 38/c – 25126 Brescia, Italy, hydrogen@omb-saleri.it, www.omb-saleri.it

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