

H₂international

THE E-JOURNAL ON HYDROGEN
AND FUEL CELLS



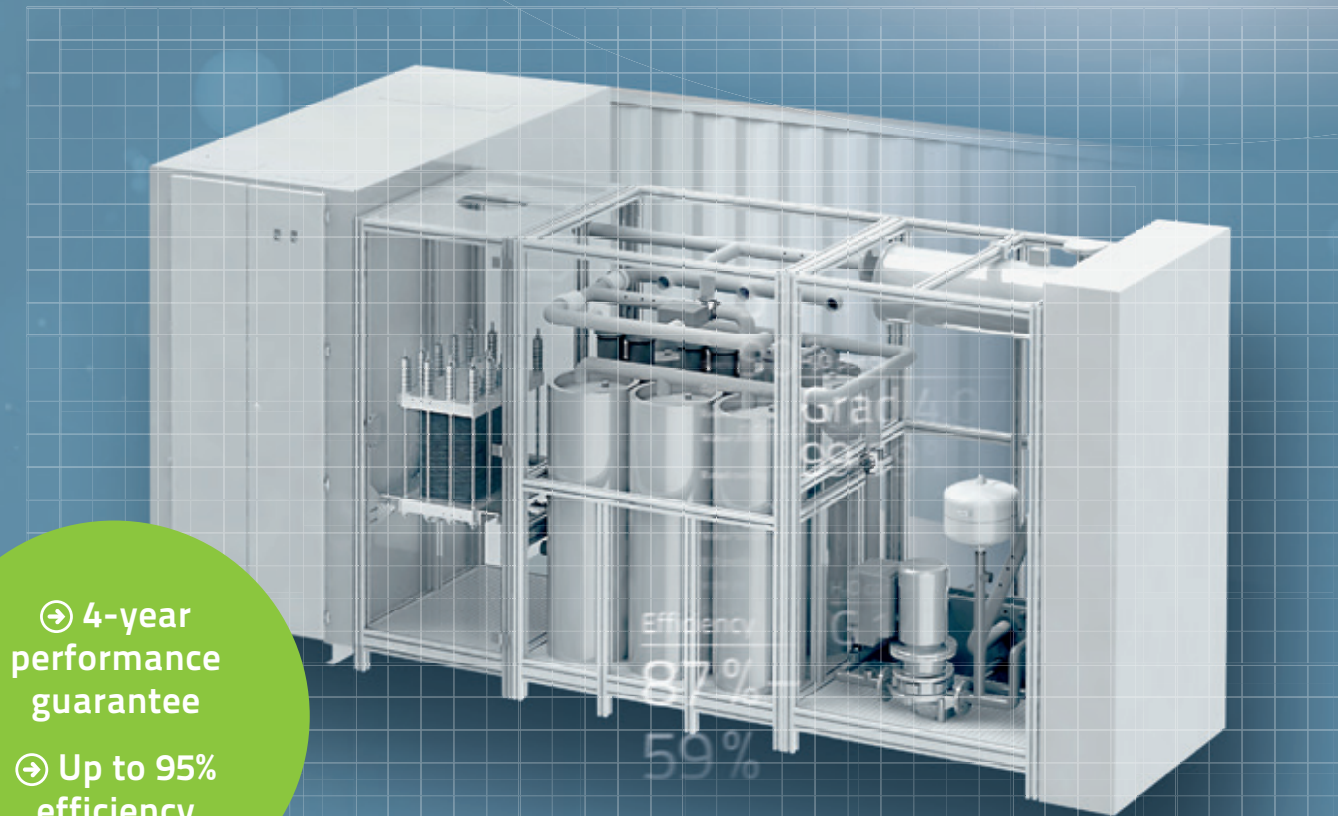
→ IN A SOLAR-HYDROGEN CATAMARAN
AROUND THE WORLD

→ INTERVIEW WITH DENA-CEO
KRISTINA HAVERKAMP



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CONTENT

3 Legal Notice

4 Editorial

Concentration on hydrogen and fuel cells

5 News

ZSW Gets New Building
H2ORIZON Breaks Ground
New DLR-Institute for Energy Networks
Intersolar Gets Smarter

8 Energy Storage

DWV Calls for Equal Treatment
PtG as Battery of the Energy Market Transformation
Reinventing the Energy Grid
Interview: Power-to-Gas Ready for the Market

16 Electric Transportation

Odyssey Into the Future
Hydrogen on Water
ThaiGer H2 Wins Eco-Marathon
German Automakers Fall Behind
Pressure Is Mounting

22 Research & Development

Synlight: Concentrated Solar Power to Produce H₂

23 Global Market

A Real Strategic Shift

28 Events

Discounts and Tickets

29 Business Directory



12 Interview: Kristina Haverkamp, dena



16 Fuel Cells for the Water



19 Emission-free Racing

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CONCENTRATION

Dear Readers:

I've been following the hydrogen and fuel cell industry for 20 years. In 1997, you couldn't even call it a niche market. Back then, many engineers didn't know the term "fuel cell" existed at all and hydrogen was just another element of the periodic table. Only a handful of companies were tinkering with metal hydride storage or phosphoric acid fuel cells.

Within a few years, the technology became the latest development everyone in the automotive and heating industry was pinning their hopes on. But nothing came of the ambitious plans businesses were announcing. Even years later, the situation hadn't changed.

When electric transportation became the next big thing, it ushered in a new era of technological progress and peaceful co-existence between fuel cells and batteries. In those days, the editorial team of HZwei – the German-language version of H2-international – made a conscious choice to add electricity-powered vehicles to the magazine to be able to give equal treatment to the various technologies.

It was during that time that the National Organization Hydrogen and Fuel Cell Technology was tasked with developing electric transportation in addition to H₂ and fuel cells. In Stuttgart, Peter Sauber Agentur expanded the scope of its fuel cell event, f-cell, to include the Battery+Storage, and in Hanover Tobias Renz added "Batteries" to the title of its shared booth for hydrogen and fuel cells.

Much has happened since then. Electric transportation has become established both in research and industry, and it now has its own trade shows, conferences and professional publications to show for.

It also offered another exciting avenue: energy storage, a field that is much closer than battery-electric vehicles to what the publishing house Hydrogeit Verlag used to focus on. We think it is now time for us to do some "spring cleaning" and redesign the content in this magazine.

Longtime readers might have noticed that unlike in the past, battery-powered cars were not at the center of the latest issues – except in Sven Jösting's stock analyses. Conversely, energy storage has gained in prominence over the past years, just as hydrogen has become an increasingly popular choice for storage beyond the gas and energy industry.

H₂ and fuel cell developments have become so commonplace that they can easily fill a quarterly publication. This November issue, which has grown to as many as 32 pages, provides proof of that. Of course, H2-international-

al will continue to inform about electric transportation (see pp. 26 to 38), but with a greater emphasis on fuel cell technology.

A similar trend can be observed in the trade show business. After the EVS30 (see October 2017 issue of H2-international) and a 6-year partnership with Landesmesse Stuttgart, Peter Sauber Agentur Messen und Kongresse said that it wants to go back to organizing the f-cell on its own. Landesmesse Stuttgart, on the other hand, will hold a new event on electric transportation called "elect!" from 2018. Peter Sauber will return the f-cell to the House of the Economy in Stuttgart, where it again intends to put more weight on H₂ and fuel cells.

Likewise, two event organizers in Munich are rethinking their approach. At the emove360° in October, electric transportation will have to share the limelight with connected and autonomous driving, while the Intersolar – which will take place just half a year later at the same location – intends to incorporate electric vehicles and charging infrastructures into their program. Energy storage has already become an increasingly crucial part of the accompanying events over the last three years, but is said to get its own hydrogen and power-to-gas booth in 2018 (see p. 5). Currently, the trade show is still looking for suitable partners.

The above proves that interest in hydrogen and fuel cells has not faded but intensified and not just in Germany but worldwide.

All I can say is that I'm looking forward to at least another 20 exciting years.

Best wishes,



Sven Geitmann
Editor of H2-international



ZSW GETS NEW BUILDING



ZSW, the Center for Solar Energy and Hydrogen Research, has seen the addition of a new building in the state capital of Baden-Württemberg, Stuttgart. It was officially inaugurated on July 5 in the presence of the state's economy minister, Nicole Hoffmeister-Kraut, and the mayor of Stuttgart, Fritz Kuhn. The expansion is said to house new analytical and coating equipment for PV systems and power-to-gas storage units. ||

H₂ORIZON BREAKS GROUND



On July 6, 2017, the same date as the 5th Annual Hydrogen Day, the German Aerospace Center, DLR, broke ground for the H₂ORIZON project. Planning took seven years (see October 2016 issue of H2-international) – now, the objective is to get the first hydrogen station in Lampoldshausen up and running before the end of 2018. A new research and demonstration plant is planned to be erected on 1.5 hectares of land to meet that target and not only outline how to proceed with sustainable hydrogen production from renewable sources, but demonstrate industrial-scale application. The investment by DLR and its project partner, ZEAG Energie, adds up to around EUR 10.5 million. Another 800,000 has come from the German state of Baden-Württemberg. Stefan Schlechtriem, director of the DLR's Space Propulsion division, explained: "In H₂ORIZON, the DLR combines its research know-how of space flight and energy to find valuable answers to socially relevant issues such as eco-friendly transportation and climate-neutral energy supply." ||

NEW INSTITUTE FOR ENERGY NETWORKS



Deutsches Zentrum
für Luft- und Raumfahrt
Institut für
Vernetzte Energiesysteme

Formerly known as Next Energy, the research institution based in Oldenburg, Germany, is now part of the German Aerospace Center, DLR,

and has been renamed Institute of Networked Energy Systems (DLR-VE, see September 2017 issue of H2-international). On June 28, DLR's council approved the integration of the institute, which is said to be continuing its progress in high-quality work and complementing the DLR portfolio, mainly in energy research. The German parliament had made EUR 42 million available late last year for establishing seven new DLR locations. The director of the research institution, Carsten Agert, said: "It's a great recognition of the work we've done so far and an immense boost to Oldenburg's energy research profile." DLR-VE's focus will be on developing a stable and efficient energy supply grid, i.e., on sector integration and storage, but also fuel cells – despite increasingly decentralized systems. No one had lost their job because of the change in ownership, the institute said. ||

→ www.dlr.de/ve

INTERSOLAR GETS SMARTER

Intersolar Europe is inching closer to becoming an energy storage platform. It was the fourth time that Munich's trade show on solar energy ran in parallel to the ees Europe – with 254 exhibitors on 17,500 m² Europe's most popular trade fair about batteries and energy storage, according to its organizers. Starting next year, the show will have two new pillars, Power2Drive for electric transportation and charging infrastructures and EM Power for smart energy production. The new "umbrella" under which all four energy trade shows will be combined will be called "The smarter E" – "in response to the exhibiting businesses' latest innovations, which are increasingly relying on integrated and smart networking systems and services," it was said.

THEsmarter
| EUROPE



Until now, barely any company from the H₂ and fuel cell industry had showed up for the event in Bavaria's capital in early summer. That could change next year between June 20 and 22. Sabine Kloos from Solar Promotion, the organizer, told H2-international that there would be "attractive opportunities to participate in a large, shared booth" on fuel cells, hydrogen infrastructure and power-to-gas. She explained: "The booth will be in an ideal spot in the middle of hall B1." Businesses and associations were invited to contribute to the design of this exhibition area, she added. ||

→ www.thesmartere.de

Theme: Energy Storage | Author: Sven Geitmann

DWV CALLS FOR EQUAL TREATMENT

Germany's Social Democrats Present Position Paper

The German Hydrogen and Fuel Cell Association, DWV, is committed to helping achieve equal treatment of renewable electricity-based fuel sources to that of biofuels under the law. In a recently published paper, it argues in typical German bureaucratese that hydrogen offered more advantages and fewer drawbacks than biogenic fuels and should at least be treated in the same way.

According to the Berlin-based association, such equal treatment would create incentives for the private sector to develop business models based on electrolyzers and power-to-gas systems in the foreseeable future. To the DWV, this would meet one of the essential requirements for storing large amounts of power. There were already enough solar and wind farms available, but it had become increasingly difficult to utilize their production.

One of DWV's board members and manager at Vattenfall Europe, Oliver Weinmann, explained: "Solar and wind energy have become the most inexpensive method to produce power." As an example, he mentioned French energy supplier EDF, who receives EUR 110 per megawatt-hour for the planned Hinkley Point C nuclear power station in the UK. By contrast, the price in wind farm bids was half as much. Since recently, bidders proposing offshore wind farms had been able to do without any kind of subsidy and still be awarded the contract, he said.

DWV's chair, Werner Diwald, said that the current legislative framework at EU level was a major hurdle to clear. In Germany, some groups in business and politics saw no need to change anything about the status quo or simply had no interest in doing so. Particularly the German environment and the economy ministry had been unwilling to listen to any advice and were pointing to European regulations.

Some concessions could be obtained through the European Hydrogen Europe industry association, Diwald added, but the change in legislation as called for by the DWV hadn't

happened yet – although only a few lines would need to be added to the text of the law.

ENVIRONMENT MINISTRY: FEAR OF ONE'S OWN COURAGE

The environment ministry – which as recently as 2015 had said hydrogen was "an option for a future energy strategy – sometime after 2050" (see October 2015 issue of H2-international) – seems to have done a 180-degree turn. For example, a position paper published by the ministry in March 2016 stated: "Only by using power-to-gas and/or power-to-liquid will there be any possibility of establishing renewable-only energy supply in the long term without utilizing biomass crops. Guaranteeing the longtime availability of power-to-gas and/or power-to-liquid is of paramount importance and must be considered when designing a transformation policy." Biomass is viewed as problematic because its use would put it in direct competition with food crops.

However, it's not like the ministry doesn't see any issues with power-to-X: "The current renewably generated surplus energy is far from enough to make power-to-gas or power-to-liquid plants economically viable." It fears that the operation of large-scale systems in Germany could lead to an increased use of conventional power plants, which "has to be prevented, as it would gravely endanger the objective of meeting the climate targets." It recommends putting only a limited number of power-to-gas and power-to-liquid systems into operation over the next years.

The DWV has criticized the ministry's perspective as being too shortsighted. Diwald believes that the energy grid would be much more sustainable if there were added measures to promote renewables and if their use were not artificially limited. He said that together, they would need to look for sensible options to avoid "stranded investments" in new power lines.

In the fall of 2016, Rainer Baake, state secretary at the environment ministry, who had always been extremely critical of hydrogen, admitted: "Power-to-gas is becoming increasingly important to us."

SOCIAL DEMOCRATS WANT GREEN HYDROGEN At least some politicians seem to have gotten the message. On June 21, 2017, the Social Democrats presented an 8-page position paper calling for "more renewables, more hydrogen and a climate protection act." Under the slogan "Invest in Job Growth, Innovation, Climate Protection and a Healthy Future," the authors state the need for "a considerable increase in the renewable expansion targets to include supply in the heat and transportation sector." Regarding the further increase in renewable production, the paper says: "We favor utilization over having to switch off renewable power plants."

Immediately thereafter, the authors talk about the "development of a legislative framework to promote the use of 'green hydrogen,' for example, for storage through so-called power-to-X methods."

They also stated that this paper was to serve as an outline of party policy "toward an environmentally friendly Germany by the middle of this century." During the next legislative session, the Social Democrats' Bundestag faction intends to pass a national climate protection law that it said would be implemented based on broad consensus among society's members. Explicit mention was made of a strategy for sector integration, especially in environmental, transportation, economic and agricultural policies.

The Social Democrats even confronted the delicate issue of European emissions trading and recommended revising the rules, as the current excess of emissions certificates prevented any progress on that front. They expressly contemplated negotiations about minimum CO₂ prices at European level. Estimates by experts from the field suggest that one-fifth of all certificates would have to be taken off the market.

CHRISTIAN DEMOCRATIC UNION: H₂ IS INDISPENSABLE

Likewise, hydrogen has found its way into policy discussions among members of the Christian Democrats. Enak Ferlemann, parliamentary state secretary at the German transportation ministry, explained in June: "Investment, cooperation and innovation are the three pillars of our hydrogen strategy. Hydrogen and fuel cells in transportation are an indispensable alternative and addition to battery vehicles, which have their power and range limitations. It is how we will meet our objective of more freedom of movement at lower emissions."

GREENS INTENT ON PROMOTING POWER-TO-GAS On behalf of the Green Party, Julia Verlinden, spokesperson for energy policy, said about hydrogen and power-to-gas: "We see this technological pathway as an important component of transforming the energy industry – in all areas." And

PRICE PER KILO OF H₂ DWINDLES

Jörg Wind from Daimler explained during the 5th Hydrogen Day on July 6 in Lampoldshausen that the automaker expected hydrogen to cost around EUR 8 per kilogram in 2020 and that the price would go as far down as EUR 6 by 2030. He pointed to a 2012 study titled "Long-time Scenarios and Strategies for the Deployment of Renewable Energies in Germany in View of European and Global Developments" published jointly by the environment ministry, the German Aerospace Center and Fraunhofer IWES.

further: "We intend to gradually replace oil products over the next two decades and use economic incentives to facilitate the entry into green transportation based on electric vehicles. We aim to promote power-to-gas, meaning fuels produced by renewable electricity. [...] Instead of limiting wind energy production, eco-power should be utilized in a sensible way on-site. It could be stored in hydrogen and fed into the natural gas grid or be transferred directly through storage units into heating systems."

Dietrich von Tengg-Kobligk, the Green's advisor on climate and energy issues in Brandenburg's state government, explained: "Investment in power-to-gas and similar technologies is being slowed down by the power market's current high excess capacities and low prices." He added: "The relatively low overall efficiency of power-to-gas and the potentially short annual full-load cycle of electrolysis systems – considering available surplus in renewable power – lead to high costs that restrict the range of sensible uses [...]"

→ Umweltbundesamt, Integration von Power-to-Gas/Power-to-Liquid in den laufenden Transformationsprozess, März 2016

Theme: Energy Storage | Author: Sven Geitmann

POWER-TO-GAS AS THE BATTERY OF THE ENERGY MARKET TRANSFORMATION

Zukunft Erdgas Sees Great Potential

For years, renewables and fuel cells powered by fossil energy sources have been worlds apart, something that is changing – at least when it comes to natural gas. Many companies have realized that there are indeed areas in which both industries could benefit from collaboration. Several large associations have already started to emphasize commonalities instead of differences, especially regarding energy storage.

Years ago, the German Technical and Scientific Association for Gas and Water gradually took to the idea of incorporating hydrogen and power-to-gas into their energy strategy (see the January 2011, April 2012 and January 2014 issues of German-language magazine HZwei). Meanwhile, the Zukunft Erdgas advocacy group has begun to express opinions that go in the same direction. The theme running through the news conference it organized in late June was that the coal industry was now the "bad guy" and natural gas could be the "yin to the renewable energy's yang." Timm Kehler, managing director of Zukunft Erdgas, said: "Our objective is to help a bit with dispelling the oft-heard notion in politics that fossil and renewable energy carriers don't go together."

The lobbying organization sees the role of natural gas expanding from energy production to storage. Kehler said that "renewables need reliable partners to balance their natural volatility." He added: "It takes relatively little time to start >>



Fig. 1: Ferlemann (right) in discussion with Olaf Lies

"Our energy market transformation is facing storage difficulties and power-to-gas is key to the largest energy storage in Germany. [...] Power-to-gas is a technology we see as the battery of a future energy market."
Timm Kehler, board member at Zukunft Erdgas

up and switch off natural gas plants. They can be relied on to balance fluctuations in renewable power output even at short notice and emit half as much CO₂ than brown coal power stations. And at 60 percent, they have an extremely high efficiency."

The association drew special attention to the gas grid's storage opportunities for renewable energies (total length: 500,000 kilometers or 310,686 miles) thanks to power-to-gas. It made natural gas "the best supporting option for transforming the energy market," as renewable power could not only be fed into the grid and stored there – even seasonally – but also be delivered through the network.

POWER-TO-GAS CASE STUDY At an event in Berlin, Zukunft Erdgas presented a new study that said, fittingly, power-to-gas had "great potential for bringing about a successful transformation of the energy sector." For this Delphi survey, the association had nymoen strategieberatung send questionnaires to around 30 power-to-gas plant operators. Nine of them participated.

The industry professionals expect power-to-gas technology to make "significant inroads regarding efficiency over the next 10 years and lead to a 50 percent or higher reduction in costs by 2030." The technology itself was making good progress, but "regulatory hurdles" were hampering development, as power-to-gas systems had not been made part of the energy infrastructure, meaning consumer fees and charges applied.

When the study was presented, Kehler also announced the simultaneous start of a marketing campaign called "Greener than you think." And hastened to add: "The fuel cell is extremely important to further innovations."

"We believe that transforming the energy sector by only relying on electricity is the wrong avenue to pursue, economically. It will merely lower acceptance. We regret that there are those such as state secretary [Rainer] Baake who very clearly want to take us down this path."
Constantin H. Alsheimer, CEO of Mainova

THE REGULATORY AGENCY'S

DOGMA During the concluding roundtable, Constantin H. Alsheimer repeated a question he had recently asked Jochen Homann, president of the Federal Network Agency: "Why isn't there any request for bids to set up a pilot power-to-gas plant, at least in northern Germany, to convert wind energy into gas and transport it through the grid to the south? This kind of project would make it apparent relatively quickly where the biggest chunk of the cost goes and whether the system could be scalable. Why isn't there even an attempt to implement this?"

Homann had replied that he didn't want to divert political attention from the Ultratrans, meaning the planned high-voltage lines. And Alsheimer said to him: "That's a dogma costing us a lot of money. It's not a technology-neutral approach, not good for competition and a very regrettable development."

ZUKUNFT ERDGAS The advocacy group of the German natural gas industry represents importers, regional and municipal energy suppliers, and industry associations. One of its bylaws reads: "The purpose of this association is to jointly promote the production and deployment of natural gas, biogas, their mixtures, liquefied natural gas, hydrogen and synthetically created methane as well as end user, grid and storage technologies. This includes, but is not limited to, activities in marketing, sponsoring, advertisement, public relations, political communication and support of scientific work." Two-thirds of the systems included in the study are operated by members of the group. ||

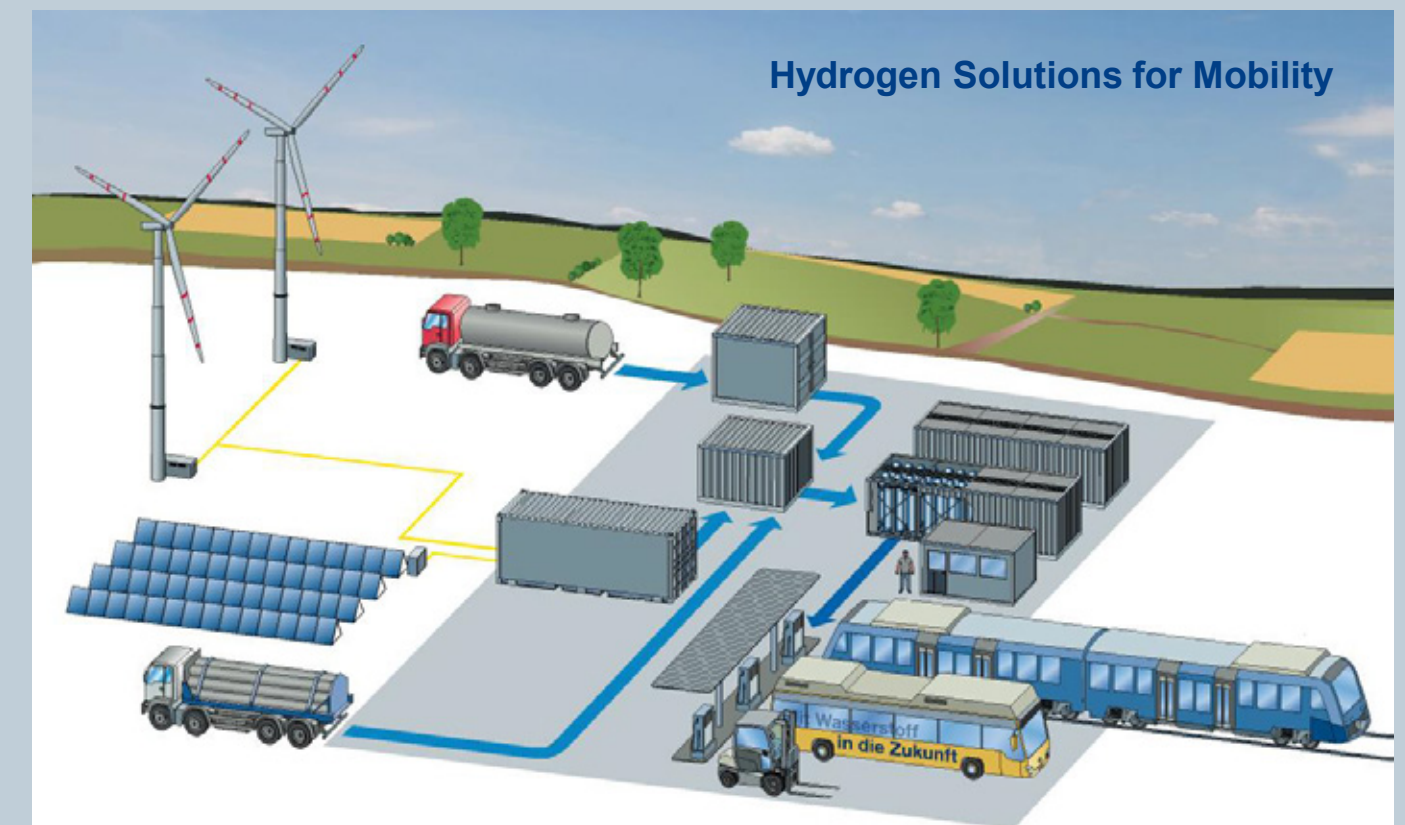
"We need to harvest the energy provided by stormy and sunny weather alike, so that we won't be freezing in winter. The only way forward is power-to-gas." [He drew parallels between future energy supply and agriculture, saying that corn basically consists of solar energy and is harvested and stored in summer to get one through the winter.]
Stephan Bauer, manager of the Underground Sun Storage at RAG Austria



Fig. 2: Timm Kehler

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Theme: Energy Storage | Author: Sven Geitmann

REINVENTING THE ENERGY GRID

dena's Annual Power-to-Gas Conference

Nearly 120 attendees met for the annual power-to-gas strategy conference on June 20 in Berlin, where the German Energy Agency, dena, previewed a new road map to call for greater openness to new technologies and the improvement of energy storage policies. Another important agenda item was the introduction of hydrogen and synthetic methane to the fuel and heat market. Christiane Golling, project manager at dena, showed in detail how to establish a power-to-gas infrastructure to advance the transformation of the energy grid.

While several months ago, power-to-gas had been debated as purely a vision for the future, it has meanwhile become clear that the technology will be needed much earlier than expected. Golling stressed this aspect in her speech. Not only does she see great potential for the use of excess power, but also for meeting base demand, specifically where viable alternatives are non-existent, such as in heavy-duty, maritime and airplane operations.

Specifically, dena called for the full implementation of the European Fuel Quality Directive, or FQD, into German law. Ac-



Fig. 1: Strong women abound during the final speech of the evening: Gabriele Schmiedel, Kristina Haverkamp and Kathrin Goldammer (from right)

According to the European Commission's adoption proposal from October 2014, fuel emissions are to be cut by 6 percent until 2020 compared to 2010. But it is up to the individual countries to decide how to meet this target. In addition to adding biocomponents to conventional fuels or switching from gas and diesel to hydrogen or electricity, emissions can also be reduced when creating fossil fuel products. This third avenue could be pursued through the use of certification, but would lead to the continued reliance on fully conventional technology and a missed opportunity for changing to more future-proof pathways.

"The comparatively high number of surcharges and fees added to the power price creates significant drawbacks for this energy carrier. It will be up to the new parliament to design a legal framework that is free of any technology bias and to remove any regulations that discriminate against or needlessly hinder the development of power-to-gas systems and their products."

Andreas Kuhlmann, chief executive of dena

The German Energy Agency clearly favors the way promising a more sustainable grid in the future and has requested the introduction of a sub-quota for alternative fuels in the federal law limiting pollution levels in Germany. Golling also pointed to the decarbonization of building stock, something that has shown much less progress than had been expected. She explained that the current retrofit rate was at a mere 0.5 percent and not at 2 percent, as had been hoped. There was already talk of a "sluggish heat market transformation." Promoting the use of hydrogen and synthetic methane in the new bill on energy efficiency in buildings and recognizing renewable gases in industry as part of GHG emissions trade could lead to improvements when replacing a fossil fuel such



Fig. 2: Golling explained: "There is demand for power-to-gas – both in Germany and worldwide."

as natural gas with power-to-gas products. dena sees other deployment opportunities in refineries and in fuel cell vehicles in logistics, mass transit and railroad operations.

MATURE TECHNOLOGY Germany is currently the leader in power-to-gas projects, as more than 30 are being or have already been built (installed capacity: above 20 MW). Corporations such as Siemens, however, are still looking abroad to develop power-to-gas plants, as Gabriele Schmiedel, head of Siemens' Hydrogen Solutions division, illustrated. Her work mainly focuses on the northern European nations, as power prices are well below the ones in middle Europe and regulations provide more flexibility. Schmiedel explained: "The decarbonized world does not comply with the structures in place. We need to create a new energy grid. [...] Going down the H₂ route will offer many options." You could see how motivated she was to let actions follow words when she added: "Electrolysis is a mature technology, dammit. You learn by doing. It's time to put a plan into motion."

INCENTIVES TO REDUCE CO₂ Inserting "incentives to lower CO₂ emissions" into the debate was a conscious decision on dena's part. The agency said that they were certainly an effective means of jump-starting the political discussion about sector integration.

There have been others who have called for a workable system in CO₂ emissions trading. Before Germany's general election, it was not only the Social Democrats (see p. 6), but also someone such as Johannes Teyssen, CEO of E.ON, who urged for taking decisive action and adopting minimum CO₂ charges. Teyssen told *BIZZenergy*: "Nothing is as efficient as a standardized and sensible CO₂ cost structure."

INTRODUCING MINIMUM CO₂ COSTS Several EU members have begun to see it that way too. Both France and the UK have implemented a minimum price level for carbon dioxide. The British had already voted for the measure in 2010 and since 2013, the Carbon Price Floor has been in effect in the UK. Initially, it was at EUR 18 per ton and has meanwhile been upped to EUR 20.5 and is said to increase to EUR 34 by 2020. France's counterpart, Composita Carbone, will rise to EUR 56 per ton by 2020 and EUR 100 by 2030. The regular price in emissions trading has long since been at around EUR 5 a ton (EUR 14 at issue date). ||

"You also need to have the courage to say goodbye to the old."
Hamburg's environment senator, Jens Kerstan
(see fig. 1; second from right)

hydrogen and fuel cells

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Theme: Energy Storage | Author: Sven Geitmann

POWER-TO-GAS READY FOR THE MARKET

Interview with Kristina Haverkamp, dena's Managing Director

The German Energy Agency, or dena for short, is an independent company in which the federal government owns a 50 percent stake. By its own account, it is a “center of excellence for energy efficiency, renewables and smart energy systems,” although it had focused on centrally controlled supply under the management of its first director, Stephan Kohler. In 2011, attempts were made to include more innovative, decentralized technologies through launching the Power to Gas Strategy Platform alongside partners from science and business. Since then, dena has organized an annual conference on the topic (see p. 6). H2-international spoke with the current managing director of dena, Kristina Haverkamp, about power-to-gas and the company's priorities.



Kristina Haverkamp

H2-international: Ms. Haverkamp, for two years you've been one of the two managing directors of dena, the other being Andreas Kuhlmann. What work arrangement do you have?

Haverkamp: Mr. Kuhlmann and I collaborate closely in directing the company. But, of course, we each have different areas that we focus on. While he is primarily in charge of managing dena's activities portfolio and strategic direction, I oversee mainly corporate communications and administrative tasks

as well as the divisions on transport systems and international cooperation. My experience in European business and environmental policy has served me well in this capacity.

H2-international: Where do you see your focus?

Haverkamp: The transformation of the energy market is really an exciting, high-profile project and dena is playing a key role in its implementation. We're looking at the entire infrastructure and provide an important contribution to meeting the energy and climate policy targets of the German government by bringing politics and business closer together. We make it possible to have a more inclusive dialog at home and abroad, develop strategies to meet demand and present concrete examples of how we can successfully transform the market. I see my most crucial task as one of advancing dena's objectives in these areas in collaboration with Mr. Kuhlmann and our entire staff.

Stephan Kohler, dena's first managing director, went into consulting after leaving the company. His temporary replacement was Ulrich Benterbusch between October 2014 and July 2015. Andreas Kuhlmann used to work for the German Association of the Energy and Water Industries before he became managing director of dena in July 2015. Kristina Haverkamp joined the company as second director in October two years ago.

H2-international: In 2015, dena's Power to Gas Strategy Platform gave politicians detailed recommendations for action. The most important item on the agenda now and then: a fast implementation of the EU regulations revised in 2014 through the German act on limiting air and noise pollution. But nothing has happened since then. Could you tell us why?

Haverkamp: That's not entirely true. There has been some progress toward implementation and we've already seen the first results from it, such as the introduction in May of the 37th federal regulation on limiting pollution levels. It ensures that power-based renewable gases can count toward the GHG reduction quota, meaning that businesses who are subject to the quota can purchase hydrogen or synthetic natural gas produced through power-to-gas to fulfil their minimum CO₂ reduction target.

More progress is in sight: The 38th regulation is being debated in the department as we speak and is expected to be passed by the federal cabinet this summer. It sets a minimum alternative fuel target for 2020, which will rise incrementally by 0.5 percent as per the EU Fuel Quality Directive. This sub-quota is intended to guarantee the use of alternative and innovative fuels such as hydrogen and SNG from power-to-gas.

H2-international: Item four of your altogether five potential ways to impact development is the extension of tax incentives for natural and liquified gas. Item five is freeing energy storage from the burden of consumer charges and fees. What difference is there between those two? Why has the fourth already been implemented, but the fifth hasn't?

Haverkamp: Over the past years, dena has been calling for an extension of the tax credits alongside its partners from the Power to Gas Strategy Platform, the Natural Gas Transportation Initiative and the Biogas Partnership. We were ultimately successful; the incentives – which help a vital power-to-gas market – will continue through 2026.

To reply to the second part of your question: Calling for the removal of consumer surcharges and fees is something that concerns the supply side of power-

to-gas systems, meaning the power market. It can help cut the cost of renewable gases and make products more competitive, and German politicians have indeed taken a small step into the right direction. Power-to-gas systems that are used as power storage facilities don't have to pay any renewable surcharge on the electricity they're getting. And the energy industry act will make sure their operators pay no grid fees for the first 20 years. But the use of power storage for reconverting electricity is one of these business models that will only become relevant over the long term. Power-to-gas solutions that are more commercially viable today, such as the use of energy low on CO₂ in the heat, transportation and industrial sector or as a service, should also get a chance on the market.

H2-international: What can you already cross off your to-do list?

Haverkamp: When dena launched the Power to Gas Strategy Platform in 2011, our objective was to create an effective long-term opportunity for exchanging ideas and experiences across industries, making power-to-gas an item on the agenda of politicians and professionals and devising recommendations for action. We've accomplished all of it. Power-to-gas has become a hot topic. Interest from politics and business has increased steadily. For many years, the strategy platform has been a go-to point for stakeholders and anyone interested in the technology – be they from politics, business, science or associations, educational institutions or citizens' initiatives – to get an overview of the current situation and establish a dialog between all parties.

H2-international: And what are you focusing on at present?

Haverkamp: We're currently devising a power-to-gas road map. It will show applications and the steps necessary to make power-to-gas a powerful technology in an integrated energy network. A short summary is available on our website (<http://bit.ly/2WlzeET>). The entire roadmap is going to be added soon.

H2-international: Your aim is 1,000 megawatts of power-to-gas capacity in Germany by 2022. Do you still believe this to be a realistic target? This summer, the figure was at 20 megawatts.

Haverkamp: The target you're referring to is from an issues paper that was published in November 2013. We believe that it will be necessary in the coming years to have more power-to-gas systems in markets that are easy to access. Power-to-gas has left the R&D stage and is ready for market entry, or more precisely on the way to growth. To offer customers a technologically and economically viable high-quality product, you need to have knowledge of several plant designs and how these plants perform in regular operation. In the capital goods market and industrial equipment manufacturing, it is common to ask for several years of experience involving everything up to mass production. This will lead to another decrease in investment and operating costs.

A stepwise market entry contributes a great deal to making technology available at low cost when it is required in the gigawatt range typical of the energy industry. We still have a long way to go, but this is mainly due to the cautiousness of plant operators and investors and a legal situation that doesn't benefit power-to-gas at all. There's still much to do – as our roadmap will show.

What's important in market introduction is to approach the easier target markets first. They offer opportunities over the short and medium term and sustainable operation after little time has passed. Applications that can be marketed quickly and effectively, meaning ones for which the success rate has already been gauged through pilot projects, can be found in the power market, energy infrastructure projects and low-carbon energy supply for transportation, heat and industry.

H2-international: During the annual dena conference, you tried to give a strong voice to power-to-gas and urged for the swift adoption of new policies. To be honest, I was surprised by such a frank assessment of the situation, as dena is at least partly a government organization. Has there been a strategic shift over the last years, possibly motivated by a change in management?

Haverkamp: I'm a bit unsure what you mean. We've always been committed to advancing power-to-gas solutions and have for a long time stressed over



Kristina Haverkamp

and again that it can be a vital component for successfully transforming the energy market. For example, we have used the Power to Gas Strategy Platform since 2011 to partner with a variety of organizations – from private-sector companies to associations and research institutions – to prepare the market introduction of power-to-gas and develop new business models. There has been no change in strategy.

H2-international: Alright, let's move on. You used to work for the EU in Brussels on energy and environmental matters and are viewed as an expert in European economic policy. Do you think that in the foreseeable future, hydrogen can become a fuel as popular as others are today across Europe?

Haverkamp: To establish hydrogen as a fuel option in Europe, it will need joint efforts at EU level. There have already been several measures to promote its use, for example, the Renewable Energy Directive. It is planned to introduce a binding sub-quota for advanced fuels, such as power-based ones, and create opportunities for the use of renewably sourced hydrogen in refineries. The Fuel Cells and Hydrogen Joint Undertaking is likewise making a significant contribution to the advancement of the technology throughout Europe. As a public-private partnership, it has advocated for H₂-based transportation since 2008 and has already launched and successfully completed a great many projects.

But we will need more from the EU, for example, a European strategy on the related infrastructure. >>

Europe needs to have an even more intensive debate about uniform standards on hydrogen mixtures, the future use of the natural gas grid, a widespread network of stations to recharge and refill electric vehicles and, of course, synthetic fuels.

H2-international: What is your take on the hydrogen and power-to-gas potential in a next-generation energy grid?

Haverkamp: The increased utilization of electricity from renewable sources in all sectors is creating big challenges for the energy grid. In 2016, Germany's yearly demand across all sectors added up to 3,718 terawatt-hours, 80 percent of which was met by fossil fuels. Even at 2 percent in annual energy savings, the power needed in 2050 would be as much as around 1,870 terawatt-hours provided mostly by volatile renewable sources. A complete electrification of the heat, industrial and transportation sector would lead to a considerable increase in power demand and energy flow, making it necessary to expand capacities in transmission and distribution.

A well-adapted and well-positioned power-to-gas infrastructure can serve as an important means to provide supply security, counter demand fluctuations and guarantee the viability of a mostly renewable-based energy grid. Power-to-gas can reduce shortages in power supply, generate baseload, secure capacity and be used as seasonal storage. It will also be needed whenever there is no other technological option and the direct use of renewables is not possible. One example is heavy-duty, maritime and air transportation; another is base compounds and chemical products.

Power-to-gas will be required the earlier, the more other components haven't gained widespread acceptance or don't meet people's expectations, for example, during the current expansion of the power grid or when undertaking complex projects for the insulation of building stock.

H2-international: When do you think will we be able to speak of an established hydrogen economy in Europe?

Haverkamp: The 2050 policy targets for the transformation of the sector have been set. They will bring fundamental change to markets and business areas in all industries. At the

current time, there is no consensus on what infrastructures, grids and overall conditions will be required over the coming years. But one thing is clear: The future energy grid will be much more diverse, whether we're talking about energy carriers, producers or consumers. Hydrogen can become one of its components – even a vital one in some markets, such as transportation.

One of the things we examined as part of our pilot study called "Integrated Energy Transition" was the importance of storing renewable electricity in synthetic gas or fuels and, subsequently, using available infrastructures for distribution and storage. The outcomes of the study will certainly help answer your question more profoundly than is possible at present.

H2-international: I've been looking for someone who can represent the industry, who is committed to making hydrogen and power-to-gas part of the political discourse. Think of Hermann Scheer, the "inventor" of the Renewable Energy Sources Act, who was advocating for the increased use of renewables in general. Do you know someone who could fill that role?

Haverkamp: I don't think that we need someone like this for hydrogen and power-to-gas. What we do need is an engaging exchange of ideas between all stakeholders to combine forces and devise persuasive strategies for adding value to an integrated energy grid. Each of the stakeholders is important to the process because only with much hands-on experience will we succeed in marketing hydrogen, SNG, power-to-liquid and power-to-gas to decarbonize the industry. This also brings us to initiatives such as the Power to Gas Strategy Platform, initiatives which are immensely important for offering stakeholders an opportunity to get in touch with others in the business, identify barriers to market entry and think up recommendations for action.

H2-international: My last question concerns the recent change in dena's shareholder structure. In early July, it was reported that the private-sector shareholders, Deutsche Bank, DZ BANK and Allianz, had returned their shares to dena, effective retroactively from Jan. 1, 2017. What was the reason for this development?

Haverkamp: The German government needs a strong energy agency to design and implement the transformation of the market, an agency that has accumulated much expertise in all that it has been tasked with, established a network in politics and business, and has prompted innovative ideas and the right amount of know-how. Even today, dena meets all these requirements and more. The change in ownership guarantees that the government can make increased use of dena's knowledge base in the future. The Federal Republic of Germany and the KfW bank are now the only shareholders with voting rights. None of this will affect any of dena's business areas. We will continue our extensive involvement in the design of the energy transformation, bring together people from politics and business and help Germany meet its energy and climate targets.

H2-international: Ms. Haverkamp, thank you for our interview. ||

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Theme: Electric Transportation | Author: Sven Geitmann

ODYSSEY INTO THE FUTURE

Energy Observer: Around the Globe by Solar-Hydrogen



Fig. 1: Catamaran powered by clean engine technology

Since this summer, the Energy Observer, a solar-wind-hydrogen catamaran, has been roaming the seas. After nearly four years of preparation, the ship was christened in July and the crew could set off on their journey. The initiators of the project plan to be at sea for nearly six years and stop in around 50 countries to inform about renewable energies, showcase sustainable technologies and demonstrate their potential. The focus is on energy autonomy.

The idea for the journey was born in 2013 when Frédéric Dahirel approached Victorien Erussard, an officer in the navy and a frequent participant in regattas, about the design of a solar-powered catamaran. This prompted Erussard to buy the racing boat that had won the Jules Verne Trophy in 1994 for EUR 500,000 together with Jérôme Delafosse and hire a crew.

Meanwhile, the team of seafarers, designers and engineers has grown to 50 and Erussard is now captain of the Energy Observer. Delafosse, a filmmaker and diver, was appointed expedition leader. Funding came primarily from Nicolas Hulot, France's new environment minister and president of the Foundation for Nature and Mankind, and Florence Lambert, managing director of CEA-LITEN, the Innovation Laboratory for New Energy Technologies and Nanomaterials.

SOLAR, WIND AND HYDROGEN One of the first tasks of the crew was to turn the racing boat in Saint-Malo, France, into a solar-powered catamaran. Originally 24.4 meters or 80.1 feet long and 12.8 meters or 50 feet wide, it was ultimately extended to 30.5 meters or 103.3 feet and the sails were replaced with PV modules, wind turbines and an electrolyzer combined with a fuel cell system.

In addition to the 21-kilowatt solar cells measuring 130 m², the 30-ton ship was equipped with two vertically installed wind turbines of 1 kW capacity each and a towing kite. The latter is thought to reduce energy demand and –

at optimal orientation – make power generators out of the 41-kilowatt electric motors. The created eco-power will be used in the onboard electrolyzer to produce hydrogen from saltwater at 4 normal cubic meters per hour, which is why the ship also has a desalination unit based on reverse osmosis.

The H₂ gas will leave the electrolyzer at 30 bars or 435 psi, be compressed to 350 bars or around 5,000 psi and stored temporarily in two pressure vessels that each can hold 4,322 liters (= 62 kilograms) to supply the 22-kilowatt fuel cell at nighttime or when the wind isn't blowing. The two hulls contain 106-kilowatt-hour lithium-ion batteries to provide electricity at 24, 220 and 400 volts. Average hourly speed is projected to be 15 to 19 kilometers or 9 to 12 miles (at a maximum 78 kilometers or 48 miles per hour).

A JOURNEY FOR THE FUTURE The first time the boat was put into water was on April 14, 2017. Captain Erussard showed up only shortly before the launch, as his second son was born the same day. He said: "Watching the ship touch down in the water for the first time was an exhilarating moment. From now on, we will all begin testing these new technologies, especially the electrolyzer and the fuel cell." Delafosse added: "It was a unique and emotionally overwhelming experience. The launch will mark the start of our odyssey into the future."

From their home port in the French Bretagne region, Dahirel and Erussard set off for Paris at 8 a.m. on June 26. On July 4, the adventurers reached France's capital, where the Energy Observer was christened two days later by its sponsor,

"This project reflects the changes that need to happen on a global scale."
Nicolas Hulot, a sponsor of the Energy Observer

sors, Hulot and Lambert. Others in attendance were the mayor of Paris, Anne Hidalgo and Bertrand Piccard, adventurer and president of the Solar Impulse Foundation.

The crew anchored in Paris until July 15, after which they made another stop in Boulogne sur Mer before they had to return home for a "quick fix," as they put it. In late August, they continued with their own "Tour de France" to Cherbourg-en-Cotentin, Nantes and Bordeaux. Their subsequent goal is to reach the Mediterranean Sea and potentially make a stop in Hamburg, but presumably not before 2019. There will reportedly be more than 100 stops during the entire journey, which has been broadcasted live over the internet since Day 1 and can be tracked online.

BERTRAND PICCARD The Energy Observer project was inspired by Bertrand Piccard's and André Borschberg's journey around the world in their electricity-powered aircraft. Named Solar Impulse 2, it had around 17,000 solar cells, four electric motors, a wingspan of 72 meters or 236 feet and an average speed of 58 kilometers or 36 miles per hour. Piccard and Borschberg took off from the capital of the United Arab Emirates, Abu Dhabi, in March 2015 and returned on

IN COMPARISON: SOLAR CATAMARAN

The MS Turanor PlanetSolar made it around the world in 585 days from 2010 to 2012. Back then, the weight of the batteries alone added up to 11 tons, and while both ships are comparable in size, the Turanor weighed nearly three times as much as the Energy Observer.

July 26 last year. It took them nearly 510 hours to fly 40,000 kilometers or 24,855 miles based on solar energy only. Their late touchdown was caused by a battery failure, which forced them to wait nine months until they could resume their flight. Still, Ban Ki Moon, then secretary general of the UN, congratulated them on their achievement and said: "It was a historic day for humanity." Piccard might be ending his journey, he added, "but the journey to a sustainable world is just beginning." ||

→ www.energy-observer.org

→ <http://energyobserver.geovoile.com/tourdumonde/2017/tracker/?lg=en>

Theme: Electric Transportation | Author: Sven Geitmann

HYDROGEN ON WATER

List of Fuel Cell Boats

As a clean yet effective energy source, hydrogen can be used to not only power vehicles on the road and in the air, but also propel vessels on the water and deep below the surface. So far, however, attempts to design a fuel cell vessel for travelling on rivers, lakes and oceans have been few and far between. Even though no such ship has made it onto the market yet, it's not as if the maritime industry cannot point to many years of developing alternative systems.

The first-ever German fuel cell boat was the Hydra designed by Christian Machens and his former company etaing. It used an alkaline fuel cell, which – as Heinz J. Sturm reports – is still functioning. Sturm took over etaing and the ship back

in 1999/2000 and uses the fuel cell unit in educational programs at the Climate Technology Center in Bonn, Germany.

FROM SMALL BOAT TO LARGE CRUISER Another attempt to utilize fuel cells in maritime applications was undertaken by Walter Pelka, who constructed a small wooden boat powered by hydrogen. He received a special f-cell award for his H2Yacht 540 in 2005.

The Alsterwasser launched in Hamburg in August 2008 as part of the Zero Emission Ships project also attracted much interest (see the April 2006, October 2008 and January 2015 issues of German-language magazine HZwei). This fuel cell ship could transport up to 100 passengers across the Alster river. The line was shut down in fall 2013 because there was no longer a refueling site available. And then there was the ASV Roboat, an autonomously navigating sailboat equipped with a solar system and a fuel cell to extend its range.

In the summer of 2009, e4ships, the third showcase project of the National Innovation Program Hydrogen and Fuel Cell Technology, breathed new life into the industry at its launch on the AIDAluna (see the October 2009 and October 2014 issues of German-language magazine HZwei and the March 2017 issue of H2-international). It promoted R&D work on yachts and cruisers, although in the beginning it focused on onboard energy supply.

ENERGY TRANSFORMATION PUT INTO PRACTICE The most recent example from Germany is the MS Innogy, a steamship used for day trips and powered by a methanol fuel cell. It was developed during a project called green-fuel, which was launched by the innogy energy utility in late 2016 and involved the purchase and conversion of the >>



Fig. 1: Hydra in operation

MS Inselstadt Ratzeburg passenger ship previously running on Lake Baldeney in Essen, Germany. Instead of diesel, the ship now uses methanol for testing the viability of this alternative fuel.

The methanol is produced carbon-neutrally through renewables by first extracting carbon dioxide from the ambient air at the regional hydroelectric power plant. The CO₂ is subsequently combined with water and renewably generated power to form methanol. The electric propulsion system will only release as much carbon dioxide during operation as has been extracted for production. The EUR 2 million project was partly funded by innogy SE and Europe's "Green Capital," Essen.

Since July 2017, there has been a container at Baldeney dam for the carbon-neutral production of 5 liters of methanol per day from water, eco-power and air. Since this isn't enough to power the ship – 150 liters will only last 4 hours – renewable fuel is additionally imported from Iceland.

"Carbon-neutral maritime propulsion that won't do any more harm to our environment is not some dream for the future, but energy transformation put into practice."

Frank-Detlef Drake, head of strategy and R&D at innogy

FUEL CELL FERRY ON THE ERDRE A smaller-size version is the Jules Verne 2 ferry. It is 10 meters or 33 feet long and 3.8 meters or 12.5 feet wide and was launched into water in June during the Hydrogen Days in Nantes, France. It later started making regular runs on the Erdre river, permanently replacing the 20-year-old La Mouette ("Seagull"). The H₂ riverboat was developed as part of the 5-year NavHybus project in France and is equipped with two Symbio FCell fuel cells. The fuel cell supplier's co-founder, Pierre-Yves Le Berre, explained: "The most crucial advantage is the ferry's lack of carbon dioxide emissions." It also provided more flexibility by offering one week in full operation instead of half an hour and comparatively quick recharges. "Another practical feature is the use of process heat for the fuel cell to achieve comfortable cabin temperatures," Le Berre said.



Fig. 3: Submarine with fuel cell hybrid engine – HDW Class U212-A

SIX SUBMARINES IN SERVICE

Fuel cells aren't only used on the surface, but also deep below. In the fall of 2016, the German military received the last of six submarines type U212-A. Numbered U36 and measuring 57 meters or 187 feet in length, it was brought into service at the naval port in Eckernförde, 12 years after the U31 (see January 2007 issue of German-language magazine HZwei). The six vessels, worth EUR 2.6 billion in total, are non-nuclear versions manufactured by ThyssenKrupp Marine Systems, formerly Howaldtswerke-Deutsche Werft or HDW, and possess a hybrid propulsion system that combines a diesel generator and a fuel cell. Large H₂ metal hydride storage ensures that the submarine can be deployed for several weeks and mostly independent of any outside air supply.

Considering the above, the Energy Observer (see p. 16) is just one of many very special watercraft, although it may be the most impressive ship in the fuel cell category to date. ||

18



Theme: Electric Transportation | Author: Sven Geitmann

THAIGER H2 WINS ECO-MARATHON

Racing as Education

Racing around the track in small-size H₂ cars might look like fun, but it has a serious purpose. An event like this is designed to impart crucial engineering know-how, prompt design ideas, solve technical issues, encourage improvisation and, most of all, promote deep immersion in a new technology. This and much more is being offered at competing events such as the Shell Eco-marathon and the Formula Student. And, besides, working on a real-life racing car is certainly much more interesting than listening to someone speak in an overcrowded seminar room.

There are several racing events for alternative engine fuels and prospective engineers from different age groups, from high school to university students. The most well-known of those would be the Shell Eco-marathon. There, it's all about energy efficiency, as the driver with the most economical vehicle will win. It was first hosted in France in 1985, held on the Lausitzring track in Germany between 2010 and 2012 before being moved to Rotterdam, Netherlands, for three years. 2017 was the second year in which it took place in London, UK.

The event ran in parallel to the Make the Future Live festival from May 25 to 28 and there were 15 teams from Germany among the 171 from 24 countries. A regular is the group from the Stralsund University of Applied Sciences – which came in second place in 2016 and was this year's winner among fuel cell prototypes after the last points were awarded. With one cubic meter of hydrogen, the ThaiGer VI could have gone for around 880 kilometers or 547 miles, further than the then leading vehicle from Turin. The students said that their success in the Queen Elizabeth Olympic Park had partly been possible thanks to a redesign of the car's SuSy fuel cell by balticFuelCells.

The team from Stralsund also received special recognition for the vehicle's very aerodynamic carbon body – at 22 kilograms, it was the most lightweight construction among the competition. Third place in the same category went to another German team, NAOB from the Nicolaus August Otto Berufskolleg in Cologne (268 kilometers or 167 miles per cubic meter). Likewise, two German teams using battery-electric cars made it onto the podium in their respective categories: The TUfast Eco Team from the Technical University of Munich scored second place and Evi Neuruppin from the Evangelische Schule Neuruppin came in third in UrbanConcept.

RACE ON HOCKENHEIMRING A comparable competition is the Formula Student, although the emphasis is not on energy efficiency but on who has the best package of design, performance, funding and unique selling point. The race organized by the Association of German Engineers took place from August 8 through 14 on Hockenheimring. Overall, 115 student teams from 24 countries competed in it with their self-designed cars.

Despite intensive, long-term planning, team Starcraft from TU Ilmenau could not participate, as one of its vehicle's

lithium-ion batteries caught fire during preparations and the entire car, on which work had just been finished in late May, went up in flames inside the workshop in Langewiesen. The result was one totaled car, a second one damaged and EUR 250,000 pulverized. Still, the students said that they would be back on track next year.

GOOD CAREER OPTIONS

Marcus Mrozek from IAV, an engineering services company and a partner and sponsor of Formula Student, explained: "We as a company know what the market expects over the coming years and can incorporate those expectations into the students' developments. In turn, they will have good opportunities for getting a job with us or another automotive business."

COMPETING ON WATER This year also saw 18 teams from grades 8 through 12 competing in zero-emission ideas in northern Germany. As you may expect from Hamburg and Schleswig-Holstein, their proximity to the ocean made this a contest between maritime vessels, or models of fuel cell ships to be precise. Powered by nothing more than hydrogen, the small student-designed boats had to go 10 meters or 33 feet on water in as short a time as possible. This year was the tenth in which the Hanse-Werk grid operator organized this fun-filled boat race. It took place in mid-July and awarded prizes endowed with overall EUR 3,600. ||

19

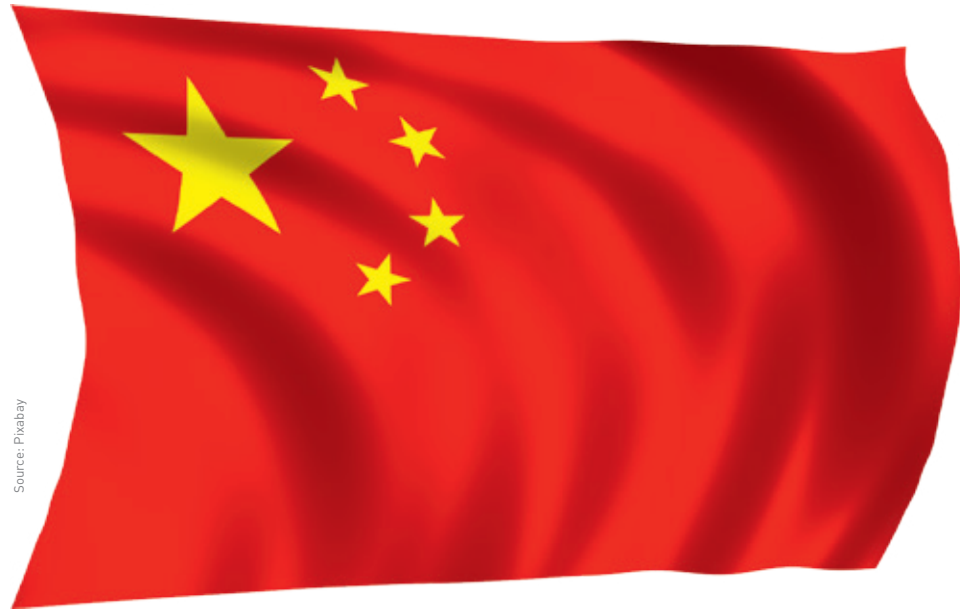


Fig. 1: Professor Thomas Luschtinetz (left) and the ThaiGer H2 racing team

Theme: Electric Transportation | Author: Sven Geitmann

PRESSURE IS MOUNTING

Automakers Need to Deliver



Source: Pixabay

The current standard in all things transportation is China. It makes policy with which even automakers in Germany need to comply if they want to keep their foot in the door. Air pollution in many large Chinese cities is so high that politicians have been forced to take drastic measures. It is the reason why the government is providing massive amounts of subsidies to promote electric transportation, which has led to half of all electric vehicles worldwide being manufactured in China – and driven there as well. But that's not all: The People's Republic could soon implement a production quota, earlier than most had hoped.

One country where the announcement of a quota has caused great unease is Germany, as the design of the related policy could have serious consequences for the domestic automotive industry. It came as no surprise then that there had been several rumors making the rounds and many attempts to intervene on the industry's behalf.

Initially, the plan was to set the share of electric – or at least, hybrid – vehicles sold by each manufacturer to 8 percent from January 2018. It was to rise by 2 percent each year thereafter and non-compliance would result in a penalty.

When Sigmar Gabriel went on his first visit to China in his new capacity as Germany's foreign minister in May, German associations injected themselves into the debate and even Chancellor Angela Merkel felt the need to mention the quota when meeting China's Premier Li Keqiang. In response, Beijing seemed willing to consider other options and the German automotive industry had new hope that they would get more time and fewer restrictions. One car expert, Ferdinand Dudenhöffer, subsequently explained: "The carmakers are gaining valuable time that they should use to the best of their abilities."

In June, however, it was said that the rules were not going to be introduced later than planned, nor would they be watered down. This prompted several carmakers to jointly

write a letter to the Chinese government, discussing openly the possibility of a trade war. It seemed as if China was very much intent on following through with its policy proposals, but news outlets reported in late September that their implementation might be postponed by one year.

WHAT ABOUT EUROPE? Meanwhile, there are more and more voices within the EU calling for the establishment of a quota. As the Energate magazine reported this June, some of the staff from the office of EU Commissioner Maroš Šefčovič had floated the idea of targeting a mandatory electric vehicle share in new car sales. A spokesperson for the commission did deny the report in September, but two other German magazines – Handelsblatt and Climate Home – said shortly thereafter that the idea was not off the table. It was "increasingly clear" that there would be a decision in fall to establish an up to 15 percent minimum for sales in the EU from 2025.

Even in Germany, there have already been discussions about some type of mandatory share. In mid-August, during the election campaign, the Social Democratic candidate for chancellor, Martin Schulz, spoke in favor of it as part of a five-item agenda and announced on the Spiegel online web-

ALTERNATIVE FUELS

So far, the most popular alternative fuel is liquefied petroleum gas or LPG, which is offered by 7,000 stations across Germany. While 448,025 LPG cars had been sold until the start of 2017 and the number of new registrations jumped by 38.3 percent during the first half of the year compared to the same period in 2016, diesel car sales dropped by 9.1 percent and registration figures for vehicles powered by compressed natural gas (77,187 units / 900 stations) by 41 percent. The number of hybrids added up to 165,408; battery-only ones stood at 34,022.

HYDROGEN BREAKTHROUGH

The outlook for hydrogen vehicles seems pretty positive. At the beginning of the year, auditors from KPMG had published the "Global Automotive Executive Survey 2017," according to which 78 percent of all managers in the automotive industry fully or partly agreed with the statement that fuel cells would help electric transportation to succeed and 62 percent expected battery-powered engines to fail.

site: "We will put mounting pressure on the industry." In contrast, the Stern magazine had reported earlier that lobbyists from the automotive industry had spoken out against a quota and a much more ambitious electric vehicle program, on which the ministries had agreed in September 2015.

The amount of economic incentive, which was originally supposed to be financed through a bonus-malus system and not by using tax money to cover half of it, had been planned to go up to EUR 5,000. One expert working in the environment ministry, however, had warned that even this amount could be too low considering the difference in price between electric and fossil fuel vehicles.

DRIVING BANS IN SIGHT? Both the French and British government confirmed that they intend to ban sales of new fossil

fuel-powered cars by 2040. Likewise, the Austrian transportation minister announced a 2030 target of only zero-emission vehicles in new registrations. Additionally, metropolitan areas such as Athens, Madrid, Mexico City and Paris are planning to prevent diesel cars from driving into their inner cities from 2025.

In Germany, the Green Party and former environment minister Barbara Hendricks from the Social Democrats have called for a ban on selling any more cars powered by gasoline and diesel from 2030. Hendricks said at this year's eMobility Summit in Berlin that the exit from fossil fuels was doable and that by 2030, German engineers would "easily be able to design zero-emission vehicles." ||

ESSENTIAL INFRASTRUCTURE

Meanwhile, the EU Commission has reminded Greece, Ireland, Malta, Romania, Slovenia and the UK to submit their national strategy for setting up an alternative fuel infrastructure based on the 2014/94/EU directive. This includes the installation of both charging points for electric vehicles and refueling stations for natural gas and hydrogen. The Commission said: "Accelerating alternative fuel infrastructure deployment is indeed essential to clean and competitive transportation for all Europeans."

Theme: Electric Transportation | Author: Sven Geitmann

GERMAN AUTOMAKERS FALL BEHIND

Between 2013 and 2016, HZwei – and later also H2-international – provided readers with regular, detailed updates on the activities of the Electromobility Showcase program. The 145 projects that were part of this program were accompanied by research and monitoring to coordinate, analyze and publish results and have led to a final report consisting of 322 pages.

In the report, the authors lament that "overall, the electric vehicle options available on the market remain insufficient to satisfy the requirements of potential customers." They add: "German automakers focus on plug-in hybrids, whereas they do not offer any kind of purely electric vehicle in a segment as popular as the medium-size car one." Regarding infrastructure needs, they consider it "essential to set up fast-charge stations along freeways and highways immediately." They estimate public demand in 2020 to be around 36,000 for normal refills and 7,000 for fast charging. By contrast, the country showed only 5,836 normal and 153 fast-charge points by the end of last year. They also criticize the fact that "Germany has so far not witnessed the emergence of any sustainable business models for operating a refueling infrastructure."

Currently, the authors don't see Germany playing a lead role: "German carmakers have fallen dramatically behind businesses such as BYD, Tesla, Mitsubishi and Nissan on the global electric vehicle market. Expectations are that the picture will not change significantly during market ramp-up over the next years." The institute's recommendation is to offer electric vehicles primarily in the commercial sector



and as part of car-share offers for the time being. Later, they expect that the automotive industry "will undergo considerable restructuring," meaning that "the global share of electric vehicle sales will presumably grow from 9 percent to 31 percent between 2020 and 2030." And: "The disruptive nature of [Germany's] energy transformation can offer SMEs and start-ups new market opportunities, but will likely have a negative impact on automotive suppliers from the metal processing industry." Additionally, most of the authors share the opinion that "electric vehicles are not less safe than ones based on combustion engines." ||

Theme: Electric Transportation | Author: Sven Geitmann

SUN ON THE GROUND

Synlight: Concentrated Solar Power to Produce H₂

Since spring, the sun has been shining in Jülich at the push of a button and 10,000 times brighter than normal. It is in this town in the German state of North Rhine-Westphalia that the German Aerospace Center, DLR, inaugurated its Synlight system comprised of 149 high-output lights that can simulate concentrated solar power. The system is intended to help the researchers create solar fuels independent of disruptive changes in weather patterns inside a three-story building specifically designed for this purpose. The overall objective is to develop solar units that can produce hydrogen or other fuels at maximum efficiency.

What has been installed in DLR's new building was described by Bernhard Hoffschmidt, director of the Institute of Solar Research, as: "We're bringing that star down to earth." To do that, the institute set up a honeycomb-shape array of 150 xenon short-arc lamps as used in movie theaters, mounting them vertically on a tall support frame. But instead of them lighting up a motion picture, their mirrored reflectors of around one meter in diameter can be used to concentrate the rays on 20 by 20 centimeters (7.87 by 7.87 inches). This corresponds to a power concentration of around 10,000 kW/m², whereas the "original" can only provide sunlight at a maximum of 1 kW/m². Temperatures at the focal point can rise to more than 3,000 °C. Since the lamps can be controlled individually, they can be employed in as many as three different tests simultaneously, considerably shortening the time between new developments.

AN ALCHEMIST'S DREAM The high temperatures are intended to produce resources such as hydrogen in a sustainable way. Karsten Lemmer, executive board member at DLR, explained: "Solar-generated fuels offer great potential for long-term storage, the production of chemical base compounds and reductions in CO₂ emissions."

To create hydrogen, light is concentrated on a demonstration system containing a cerium oxide lattice. If steam is led into the reaction chamber, the oxygen it contains will combine with the metal at around 800 °C and will be absorbed by

it, so that hydrogen is the only product left. Hoffschmidt said that the gas was "an alchemist's dream," as "this high-energy fuel can be used to create virtually anything."

NORTH RHINE-WESTPHALIA

Johannes Rimmel, North Rhine-Westphalia's environment minister, stressed during the inauguration on March 23, 2017: "To meet renewable energy targets, we need to increase the use of mature products currently available to us. But the energy market won't see a transformation if we don't invest in innovative research, new technologies and global showcases such as Synlight." The state has supported the project with EUR 2.4 million; another EUR 1.1 million came from the economy ministry.

HOW TO MAKE SOLAR H₂ PRODUCTION MORE EFFICIENT

The most crucial advantage is a stable operation that cannot be guaranteed in a natural environment. "The light has been optimized to cover most of the sun's spectrum," Hoffschmidt explained. He also clarified that the lamps, whose combined output adds up to an impressive 1.5 megawatts, are only switched on for the short time it takes to conduct the relevant experiments.

Kai Wiegardt, who was greatly involved in overseeing the installation of the system, explained to H₂-international: "Our calculation is 1.5 megawatts times 500 hours per year, once the system is in full use. That is a lot, say, when you look at the energy needs of a family of four and very little when compared to power plant production."

To Wiegardt, power consumption is a secondary concern. He's already thinking further ahead: "The aim of our research activities is to advance renewable use on a global scale. Our focus is on the earth's sun belt, whose rich solar resources are to provide value and prospects to the people living there. Based on our vision, we develop technologies and educate students and graduates. Synlight has been a unique tool for achieving these objectives and it will now be available to the global research community and industry." He added: "Improving the output of only one 100-megawatt solar system at 7,500 full-load hours by 0.1 percent will recoup our yearly power consumption. But, of course, we want to accomplish more than that."

By "more," Wiegardt means improving PV and electrolysis efficiency in H₂ production from, on average, around 20 percent and 80 percent, respectively. "We hope that we can get to market-ready industrial applications in around 10 years," he said. ||

Jülich has already seen the installation of a solar tower and more than 2,000 movable mirrors, called heliostats, and the site's research activities offers many opportunities for innovation in solar technology. Another demonstration system, a high-flux solar furnace, can be found at the DLR location in Cologne's Porz district.



Fig. 1: Work at Synlight reactor

Theme: Electric Transportation | Author: Sven Jösting

A REAL STRATEGIC SHIFT

Stock Market Analysis by Sven Jösting

More and more news reports, talk shows and interviews with leading politicians in Germany are making explicit mention of fuel cells – sadly, most of the time only in reference to the diesel scandal among the country's automakers. Still, it's a clear sign that people are becoming aware of the technology's potential. Pierre-Etienne Franc, secretary general of the Hydrogen Council, has said recently: "The years 2020 to 2030 will be for hydrogen what the 1990s were for solar and wind. It's a real strategic shift."

BALLARD POWER: HOW TO BECOME PROFITABLE

A second-quarter loss of USD 1.2 million or USD 0.01 per share is one thing, but a more than 50 percent year-on-year jump in revenue to USD 26.1 million is quite another. Canadian-based Ballard (Nasdaq: BLDP) managed to push the gross margin to 38 percent, so that earnings before interest, taxes, depreciation and amortization were at positive USD 1.1 million. That's plus USD 0.4 million through the first half year. Revenue grew by 45 percent to USD 49.2 million during the same period.

The stock market has meanwhile rewarded these good second-quarter results with higher quotes. It was the first time in the company's history and – as Ballard said – the first time for a fuel cell business worldwide to end a quarter on a positive EBITDA. This leads me to predict that we will see the company in the black (regarding earnings) for more than just these three months. Cash and cash equivalents added up to an impressive USD 68.1 million. CEO Randy MacEwan expects an excellent outlook in all business areas and target markets: "We're well positioned to deliver a strong second half; we have a record order book and robust sales pipeline."

Particularly China is stepping on the gas. Broad Ocean – a large Ballard customer and shareholder – upped its already ambitious growth forecast another time. And representatives from the PRC's biggest port operator are looking for someone to purchase around 60,000 tons of hydrogen per year and have been in talks with the Canadian business about a possible agreement.

STACK PRODUCTION STARTED IN CHINA The production of fuel cell bus stacks in cooperation with Guangdong Synergy – 6,000 per year in 2017 and likely 20,000 in a few years' time – began after the manufacturing facilities were inaugurated on Sept. 5. The first stacks were produced for purposes such as testing and quality assurance. Output will be ramped up throughout the rest of the year to a three-shift cycle on five days a week. It would be interesting to know what Ballard generates in revenue per stack and which margin it receives. I don't know the actual figures, but I bet they are something like USD 10,000 to 30,000 at 10 to 30 percent per stack. You can easily see what that would mean.



Fig. 1: Share price development of the six companies we look at in this month's issue

The demand is definitely there. Ballard has been co-operating with 13 bus manufacturers on 13 projects. China grants RMB 1 million in subsidies for each electric bus equipped with batteries and/or fuel cells and one of its cities, Shanghai, pays RMB 1.1 million. That's around 50 percent of today's prices for these types of buses. Since the grants for battery-only versions will be cut by 20 percent by the end of this year, fuel cell buses are becoming the more attractive option.

EUROPE SLOWLY PUSHES FORWARD – USA FALLS BEHIND

In Europe, fuel cell bus deployment is reaching the bidding stage. The initial target is said to be 291 vehicles, for which Ballard believes it has a good chance to be chosen as a stack supplier. Additionally, metropolitan areas such as London have launched a series of initiatives to replace their entire public fleet of buses. In the States, the situation is a bit different. There are plans by individual communities and businesses – such as L.A. Metro, which intends to get 200 fuel cell >>

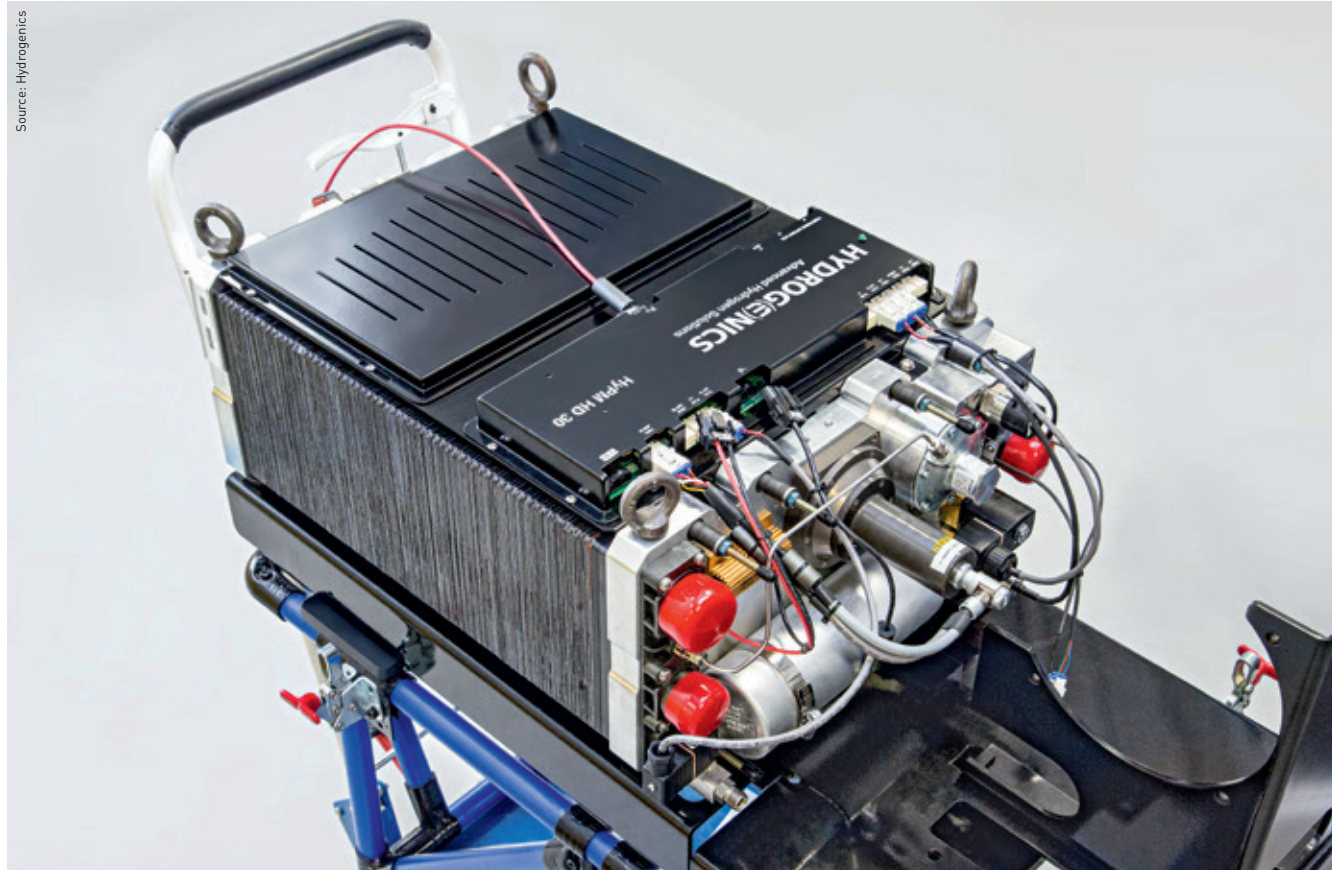


Fig. 2: HyLYZER® 400-30 electrolyzer

buses on the road by the end of 2019 – and some states, such as California. But there doesn't seem to be widespread awareness of the fuel cell's potential, although the specifications – 20 hours continued use at a radius of 250 miles or 402 kilometers – provide a strong argument in favor of deployment. It was said during Ballard's conference call that the United States were at risk of falling behind in commercial-stage applications.

PROTONEX DISAPPOINTS – AT THE MOMENT Ballard's subsidiary Protonex, which manufactures drones and other equipment, has so far not fulfilled expectations. But the company's outlook lets one imagine it to have a great future. It was said during the call that Protonex had reached a critical turning point in fuel cell growth, which was a reference to the bids for supplying the U.S. Army with the technology. It would take a long time until contracts could be awarded because of the many checks that need to be run first. While all of this means that progress will not be made as fast as one would like, things will definitely advance – still in 2017, I believe. Besides Boeing, Protonex also has another – still unnamed – big-league customer. And it was revealed that it had been in negotiations or informal talks with a big logistics company or a company with a large logistics operation. I'm just speculating here, but this potential customer could be Amazon. The corporation has already been collaborating with Plug Power and indirectly with Ballard, which delivers stacks to Plug.

MATERIALS HANDLING – ANOTHER PARTNERSHIP IN SIGHT Through its subsidiary GenSure, formerly ReliOn, Plug Power has set up its own fuel cell stack production and has ordered an ever fewer number of stacks from Ballard, as you can glean from looking at the relevant revenue figures. Ballard, on the other hand, has been involved in Plug's forklift retrofit project since the beginning, which has given it unfettered access to the

outcomes of the stack research. I think that the cooperation will continue to a lesser degree, but will soon be a lower priority for Ballard. Indeed, parts of the call transcript could lead you to believe it had been able to win over another, possibly much bigger partner for stack use in logistics. My bet is on Toyota Tsusho, with which it is collaborating closely without having provided any details on their agreement (potential contract values). With nearly USD 80 billion in revenue, the Toyota subsidiary is the world's leading forklift truck manufacturer. Should Ballard go down this route, I think it would create better supply opportunities for fuel cell stacks than the ones Plug could provide, despite the latter's sale of 15,000 systems to date.

FUELCELL ENERGY: IT HAS BEGUN

Finally, there are the agreements you could hope for: Three contracts requesting the supply of overall more than 39.8 megawatts were awarded to FuelCell Energy (Nasdaq: FCEL) by Long Island Lighting, NY. The contracting arrangement to supply power and heat to 40,000 residential units will run for 20 years. Another contract was awarded by Korea Southern Power for a 20-megawatt system. FuelCell Energy has said that these new bookings exceeded USD 1 billion. The recent capital raise and the issue of warrants, plus the option to exercise them at some point, add up to a theoretical amount of currently USD 73.8 million in available liquidity (equity), which has laid the perfect groundwork for financing the business's share in this and other projects in the future. Additionally, FuelCell Energy issued preferred stock convertible into common shares (at a rate of USD 1.84 per share) adding up to a nominal value of USD 33.5 mil-

lion, which corresponds to a net amount of USD 28 million. In my book, it gives the company a very good chance to finally win out on the Beacon Falls project. And Exxon could soon come to the decision to deploy FuelCell Energy's carbon capture technology at several facilities worldwide after their joint demonstration project. What's interesting is that the third-quarter net loss of USD 17.8 million attributable to common shareholders and posted on Sept. 7 only resulted in a short-term drop in prices, which rallied to a positive close at the end of the day. A good sign of how the stock market views the company and its future.

The above are "visions" which – if they become reality – could boost the price considerably and, I believe, return it to the above USD 5 quotes at which shares were traded as recently as 2016 or even top them. Projects such as the Long Island one can provide a steady revenue and profit stream, which traders will factor in when evaluating the company. And technologies to produce clean energy are regarded as a base component of many applications, markets and regions worldwide. FuelCell Energy is among the leaders in the field, even though the market cap of below USD 100 million doesn't reflect this yet.

ITM POWER: 20 TONS OF H₂ PER DAY

ITM Power (London: ITM) based in the UK was able to increase bookings by GBP 4.87 million to GBP 23.54 million. Projects for which contracts should be awarded soon have a combined value of GBP 16.67 million, so that the expected backlog is at around GBP 40 million. An intriguing product development is ITM's recent showcase of a 50-megawatt electrolyzer design at the Las Vegas trade show. It is said to make it possible to produce 20 tons of hydrogen per day. That would be a new benchmark, as the use of hydrogen in electric transportation requires powerful electrolyzers to meet rising demand for H₂. In late August, the British-based business won the bid on a 10-megawatt hydrogen production facility for Shell and a project in cooperation with Van Hool, a bus manufacturer from the Netherlands. The stock market shared my positive mood and the stock price rose temporarily to as much as 100 percent above previous levels. To me, ITM seems like one of those yet-to-be-discovered fuel cell gems and could turn into a lucrative takeover target.

HYDROGENICS: PROFIT TAKING AFTER BEING ON A ROLL

Hydrogenics (Nasdaq: HYGS) has a full schedule with USD 151.2 million in backlog for several types of fuel cell applications, from truck conversion kits (Scania in Norway) to bus stacks in China to H₂ refueling stations and power-to-gas systems. A loss of USD 5.7 million (minus USD 0.45 per share) in the second quarter can be considered a temporary slump, as the company said that some shipments had been moved to the third. Hydrogenics intends to stick to the high-growth forecast it had published for the entire year. What's clear is that the company is in a strong position, especially after the latest capital infusion by a Chinese-based corporation. The current price drop can be interpreted as a response to the previous quick rise from USD 4.50 to more than USD 11.

PLUG POWER: THIRD QUARTER TO DELIVER RECORD FIGURES

The deal with Amazon – which basically acquired a stake in Plug Power (Nasdaq: PLUG) through warrants and, at the same time, placed orders to have its forklift trucks retrofitted – may be the reason why Walmart has agreed to a change in the terms for its large Plug booking, which will improve the situation for the latter. Walmart was the first big Plug customer to request forklift conversions and an H₂ refueling infrastructure at its logistics centers. The caveat was that Plug agreed to a leasing model which required the deposition of a certain amount of capital as collateral despite the leasing rates apparently not covering costs. Now, everything is said to change. Walmart is expanding the scope of the contract to 30 centers overall and has accepted to remove the need for restricted cash. It can also receive a stake in its fuel cell supplier by purchasing up to 53 million shares in tranches at preset terms through warrants at no cost. This will provide Plug gradually with fresh capital – depending on when warrants are exercised (price at over USD 2 per share). And the best side effect is that the new, improved terms will allow it to reduce interest rates to single digits.

Whether being both a large customer and shareholder is a good thing is another matter. Just like for Amazon, it's good business for Walmart, as Plug secures bookings that positively impact revenue and, subsequently, may be reflected in the stock price. Both corporations could then convert the warrants into shares and sell them at a profit. Plug receives a cash infusion and both Amazon and Walmart may get the money back that they spent on Plug bookings – a strategy where I think everyone is a winner, although the old shareholders will have to agree to a stock dilution. But since only rising share prices will make the entire plan work >>



Fig. 3: H₂ refueling station in warehouse

for all parties involved, the advantages do seem to outweigh the negatives. It will close the chapter on uncertain times for Plug, so the company can focus on its potential for growth.

FIGURES AND OUTLOOK Second-quarter figures proved disappointing: USD 22.6 million in revenue at a loss of USD 0.19 per share based on GAAP or minus USD 0.10 per share including warrants. But the prospects sounded promising: The third quarter is said to see the installation of 3,000 GenDrive systems and 10 H₂ gas stations. The target for the entire year is USD 130 million in revenue, with a gross margin of 8 to 12 percent as a realistic estimate. The installation target is 5,600 GenDrive units in 2017 and 25 H₂ filling stations. Unrestricted cash flow is thought to reach USD 25 to 35 million. With regard to bookings, USD 325 million is seen as attainable. Cash reserves are planned to hit USD 130 million, possibly through exercised warrants.

TESLA: FAR REMOVED FROM RATIONAL ARGUMENTS

In early July, the first Model 3 cars finally left Tesla's factory, an occasion that resulted in great enthusiasm among analysts and shareholders alike. Initial production was limited to 30 units – 20 for employees and 10 for test drives. Custom-made versions, maybe? It doesn't look like actual series production, but the event was an effective PR tool to launch the new mass-produced electric vehicle.

The share price had seen a drastic and quick fall from USD 380 to USD 310 sometime in between. Goldman Sachs changed its forecast and now sees a correct or fair price at USD 200 within six months instead of USD 190, but that didn't deter investors from pushing it to new heights based on what they imagined the new model to accomplish. Many journalists and analysts have compared Model 3 to Apple's iPhone gold mine. According to CEO Elon Musk's ambitious plans, production is to be increased to 5,000 units per week this year and to 10,000 thereafter. We will have to wait and see.

In the meantime, there has been an update on the number of Model 3 preorders based on the USD 1,000 deposit.

SOLARCITY

SolarCity's two founders, cousins of Musk's, have left the Tesla subsidiary – the CTO in July. Tesla had acquired the company for around USD 2.6 billion in a stock swap including existing liabilities of about USD 3 billion. SolarCity's shareholders have been able to make a nice windfall profit by exchanging their shares for Tesla's at plus 50 percent since the takeover. Did the acquisition of SolarCity merely provide a safety net in the face of a possible bankruptcy?

Musk initially spoke of more than 500,000 units, but when deducting cancellations, the figure is closer to 455,000. Not bad at all. However: How are potential buyers going to know a) when the USD 7,500 tax incentive is no longer up for grabs, and b) if new commercially available battery-powered vehicles by other manufacturers couldn't offer a lower price and higher range, and c) whether delivery can even be expected in 2018 or 2019? We will know the answers to these questions in 12 to 24 months. But let's assume for the moment that prepayments for all Tesla models add up to around USD 603 million; that would mean fewer Model S and X are being ordered. Tesla (Nasdaq: TSLA) has also introduced discounts, for example, USD 3,000 for Model X, saying that increased profit margins were enabling the company to take this step. You could come to a different conclusion, as it has already been the second discount since April.

Revenue rose to USD 2.79 billion in the second quarter, but net loss was at USD 336 million. On top of this, the calculations include USD 100 million in zero emission vehicle subsidies, meaning the loss per share seems closer to USD 1.94 than USD 1.33 if you exclude the USD 0.61 contribution from ZEV incentives.

Cash and cash equivalents reduced by USD 1 billion to USD 3 billion in the second quarter. Please also note that a good USD 2 billion are said to be invested in, for example, Model 3. At the same time, accrued liabilities and accounts payable increased to around USD 3.8 billion. Vehicle inventory rose to USD 2.43 billion (+ 51 percent) year on year – all figures that should make you think twice and could be interpreted in many ways. Considering the need for more

capital, Tesla has already made the wise choice of issuing debt securities totaling USD 1.8 billion. These are junk bonds, though. The overall debt rose to USD 8.1 billion. Interestingly enough, the Moody's rating agency immediately commented to welcome the move. It saw the danger of Tesla not being able to meet growth targets based on its own cash reserves in the amount of USD 3 billion and its credit lines worth USD 1.9 billion. Tesla has now acted accordingly. But the interest burden that had already been as high as USD 108 million in the second quarter, is increasing steadily by over USD 90 million per year. Why is there no issue of shares or convertible bonds? Junk bonds not only garner bad ratings, but they require less information to be issued. Well, take a guess. And Goldman Sachs could have not placed any shares if the price had been "fairly rated" at 50 percent below what they imagined it to be.

As said above, the investment firm has now raised the previously lowered price target to USD 200. After all, they are the lead underwriter in the consortium placing the junk bonds. Nothing to see here...

A BET WITH AUSTRALIA The first Gigafactory for batteries hasn't even been completed, but plans are to start construction on another two or as many as three soon enough, as Tesla's CEO announced in one of his many tweets. There are even said to be new vehicle designs in the pipeline, for example, a Model Y SUV and trucks or buses. He also said that he intended to manufacture directly in India and China. And then he pledged to complete a 100-megawatt power storage plant (129 MWh) within just 100 days in South Australia by December 2017. Should it not be finished in time, he – meaning Tesla – would bear the cost, which was estimated at USD 50 million. The partner in implementing the project was reported to be French-based Neoen. It remains unclear whether the deal is part of a public or private bid request.

ANALYSTS DISAGREE Morgan Stanley analyst Adam Jonas sees Tesla at USD 317, but with the potential to rise to USD 526 in a bull case scenario. One of the reasons for the latter would be the recently announced increase in Model 3 production next year from 90,000 to 120,000. Additionally, new products such as truck tracking systems could create added potential for growth. The Baird investment banking group set its new price target to USD 411. Aswath Damodaran, a professor of finance from New York, whose forecasts have been proved right on numerous occasions, thinks the shares would be fairly valued at USD 192, while Goldman Sachs has them at USD 200. My vote is with the latter two, as the current market cap only reflects the best possible development and ignores the risks.

CONCLUSION Soon – maybe not in 2017, but in one or two years – Goldman Sachs could or should be proved right, as as a market cap of nearly USD 60 billion already includes any developments that may have a positive impact on the company's outlook. Even regarding a system such as the autopilot, Tesla faces the question of whether it can create revenue from it in the short term or whether this is something that will take years to accomplish.

In the third quarter, the company will have to jump through a lot of hoops. Another capital raise before the middle or end of 2018 or another debt increase (credit facilities and bonds) won't be necessary for the time being, but could happen. It wouldn't be the first or second time Tesla initially

denies intending to raise fresh capital and then follows up with exactly such a request a little while later. A loss of USD 500 million or over USD 3 per share in the third quarter – because of investments in manufacturing, the Gigafactory and the charging infrastructure – is already being talked about on online forums.

Tesla relies solely on the battery. It's the reason for my rather skeptical assessment, as fuel cells will prove to be fierce competition or a good addition to batteries due to their being continually enhanced and because of the way hydrogen, specifically green hydrogen, is being generated, stored and supplied (network of H₂ refueling stations). The fuel cell can also be used to extend the range of vehicles, especially passenger cars. Batteries do see improvements in energy density, capacity, cost-effectiveness and other areas, but then there is the dependency on important raw materials, such as cobalt and lithium, and the long charging times. Additionally, they create much hazardous waste, don't show a seriously impressive lifespan and their operation is influenced by outside factors, such as changes in temperature and power-hungry peripheral units.

In my opinion, a battery-only solution will leave you with more questions than answers. Other manufacturers will counter Tesla's offerings by developing their own electric and hybrid cars including fuel cells. There's an expiration date on Musk's first-mover advantage. The German automotive industry would be well advised not to rely on batteries alone when it comes to electric transportation, but promote fuel cells, for which there are new global markets emerging in China, Japan and Europe. ||

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.



Fig. 4: Unveiling Model 3

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German Hydrogen and Fuel Cell
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12203 Berlin, Germany,
Phone +49-(0)30-398209946-0, Fax -9, www.dwv-info.de



Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

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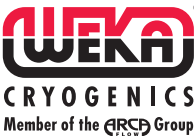
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