

H₂int.

Fuel cells:
Hope for heavy-duty
transport

Utilizing resources:
H₂ from wood residues
or as booster for biomethane

New storage solutions:
Mobile and stationary
innovations



Hydrogen gains momentum

How motorsport can accelerate
technology development

TRUSTED HYDROGEN INSIGHTS FOR 20 YEARS

Join our newsletter: quick insights,
expert voices, and must-see events



Fuel cell exploring new ground

Sometimes we plan our cover stories well in advance. And sometimes they simply find us – as was the case this time. Races featuring fuel cells and hydrogen engines are intended to accelerate technical development while also making the topic more appealing – and they have become increasingly common this summer and autumn. When a major organization like the Fédération Internationale de l'Automobile, or FIA for short, gets involved, it provides momentum. Attention, funding and the ambition of high-level development teams are then directed toward hydrogen technology. Formula Student Austria, on the other hand, sees itself primarily as a design competition for young engineers. For the first time, two hydrogen-powered vehicles competed there. And in the German city of Chemnitz, young people raced model cars against each other at the Hydrogen Grand Prix. The fuel cell makes it possible to use electric motors with their high torque without having to deal with the limitations of battery capacity. There is no doubt that a lot will happen in this area over the next few years.

But motorsport alone will not bring the technology to a breakthrough. The battery sector is not standing still – its range and performance are steadily increasing. Automotive suppliers, stack manufacturers and vehicle producers are making it very clear: they no longer want to bet on fuel cells in passenger cars, and even in the case of smaller commercial vehicles, they are being very cautious.

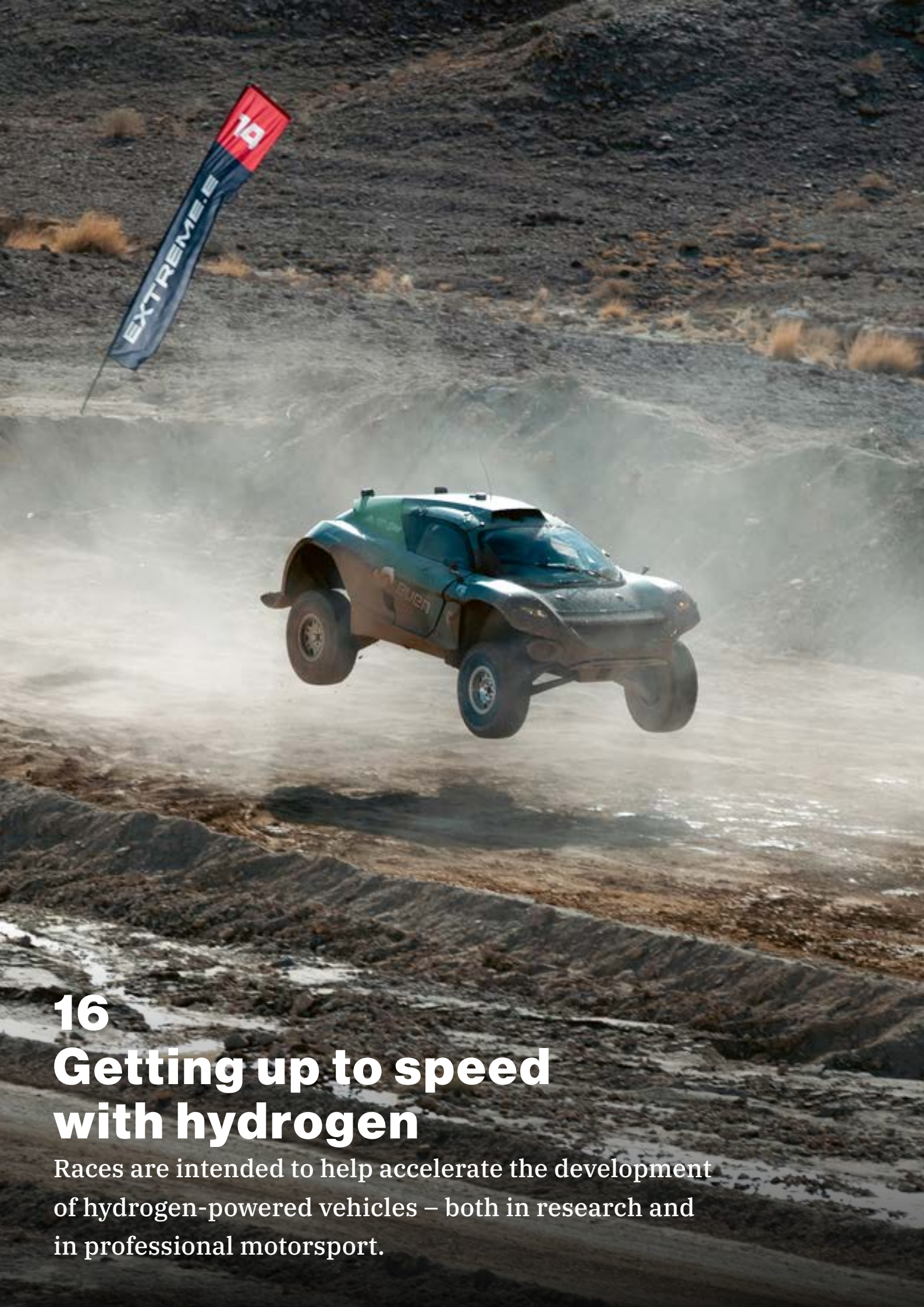
Fuel cells certainly have several advantages: fast refueling, independence from overloaded power grids, longer ranges – for now. But those who become too focused on “their” technology and its benefits can easily overlook innovations from competitors. In the late 2000s, providers of solar thermal power plants were very confident that photovoltaics would never catch up with them in terms of cost and storage capability. They laughed at suggestions about the steep learning curve of the competing technology – until it won the race.

Even today, new solar thermal power plants are still being built. And yes, storage capability is one of the arguments in their favor. They did not become the number one technology for solar power generation – but they found a niche in which they can play to their strengths.

Where can the fuel cell demonstrate what it is capable of? Some manufacturers are now looking for new applications: high power and long distances in the automotive sector, container-based power supply solutions, backup systems. In recent years, there has been significant progress in scaling both the systems and the factories. And in view of the growing hunger for energy and the increasing importance of resilience and security, one or more broader applications are likely to emerge.



Eva Augsten
Editor in chief
augsten@hzwei.info



16

Getting up to speed with hydrogen

Races are intended to help accelerate the development of hydrogen-powered vehicles – both in research and in professional motorsport.



© Sergey - stock.adobe.com

- 40 **Platinum recycling**
How improved resource efficiency reduces the incentive for reuse.



© Daimler Truck AG

- 28 **Fuel cell trucks**
For heavy loads and long distances, many manufacturers continue to rely on hydrogen.



© Daniel Reinhardt

- 11 **Interview with Jan Rispens**
“The EU’s additionality requirement should be abolished!”

News

- 6 Reports
6 Column: What’s up, Hyfindr?
10 Hydrogen Market Update: Course set for maritime transport
11 Interview with Jan Rispens: “The EU’s additionality requirement should be abolished!”

Cover story

- 14 Motorsport: “We are accelerating the transition”
20 Formula Student Austria: Fuel for pioneers

Best practice

- 24 Green hydrogen as a booster for biomethane

Mobility

- 28 Hydrogen propulsion for trucks: Manufacturers are ready
32 Hydrogen stations for trucks and buses: New momentum in the west of Germany

Technology

- 36 Hydrogen from wood residues
40 Raw materials: Platinum recycling will not be a guaranteed economic success
43 Mobile storage: Hydrogen in the nano grid
46 Stationary storage: Between pressure tank and cavern
48 Production technology: Looking further upstream
51 Products
52 Fuel cells: High performance, heavy loads

Sections

- 3 Editorial
56 Company directory
61 Preview
61 Imprint

What's up, Hyfindr?

CHINA PROVIDES CLARITY



Hyfindr Managing Director Dr. Björn Lüssow
shares insights and encounters from
the international hydrogen community.

Stakeholders in the hydrogen industry in Germany and China share a common goal: to finally bring this industry into economic reality. But while the sector in Germany has long and increasingly loudly been calling for government funding, in China, a single sentence is often enough to set everything in motion.

I experienced how things can work during a visit to China this summer. While visiting a hydrogen innovation center in Shanghai, one of my conversation partners asked me:

**“Did you hear Xi Jinping’s speech yesterday?”
“No,” I replied. “What did he say?”
“He mentioned hydrogen in one sentence – and today,
all hydrogen stocks in China have risen sharply.”**

I asked to see the exact wording of the excerpt from the speech. Xi Jinping said it was necessary “to promote the development of energy sources such as wind power, photovoltaics, and hydrogen energy in order to build a new energy system.” A statement made in the coal-dominated region of Shanxi – and yet understood as a national signal with immediate effect.

The very next day, my conversation partner received invitations to high-level business meetings. Within just a few days – that was the plan – new projects were to be launched, investments reprioritized, and strategies adjusted. No discussion about subsidies. No waiting loops. The direction is clear, and that is enough to trigger movement.

I am not advocating for a one-to-one adoption of Chinese practices; our business culture is different, and that’s perfectly fine. But this example shows how powerful clarity can be. China responds adaptively – quickly, with focus, and strategically.

Germany, too, finally needs clarity. Do we want hydrogen to play a substantial role in the future energy mix – or not?

If the answer is “yes,” then this direction must be communicated in a visible, comprehensible, and reliable manner. Not tomorrow. Now. ○



The high-temperature electrolysis system has been integrated into the processes of the Neste refinery in Rotterdam. © Sunfire

Sunfire commissions the world's largest high-temperature electrolyzer

At the Neste refinery in Rotterdam, the world's largest high-temperature electrolyzer (SOEC) has been commissioned in an industrial environment. The 2.6 MW system was supplied by Dresden-based manufacturer Sunfire and is part of the EU-funded MultiPLHY project.

As part of the EU demonstration project MultiPLHY, the project partners Neste, Sunfire, CEA and Engie have commissioned the world's largest high-temperature electrolyzer (SOEC – Solid Oxide Electrolysis Cell) in an industrial environment. The system has been integrated into the processes of the Neste refinery in Rotterdam and is intended to replace fossil-based hydrogen with green hydrogen.

The electrolyzer consists of twelve modules, achieves an electrical output of 2.6 megawatts and produces more than 60 kilograms of green hydrogen per hour. The system operates at a process temperature of 850 °C. By utilizing process heat from the refinery, the system achieves an electrical efficiency of up to 84 percent (based on lower heating value, LHV, AC), according to Sunfire. The hydrogen processing unit (HPU) was supplied by SMS Group.

The next step will be a test program to validate the performance characteristics of the technology under real-world conditions. The aim is to demonstrate the industrial applicability and economic viability of SOEC technology. The project is coordinated by the French research institute CEA. Engie is responsible for the techno-economic assessment.

Jukka Kanerva, Senior Vice President Renewable Refining at Neste, emphasizes: “The MultiPLHY project has provided Neste with valuable experience and insights into the industrial production of green hydrogen.”

Sunfire CEO Nils Aldag states: “The MultiPLHY project demonstrates that our innovative technology can be integrated at industrial scale.”

Pierre Olivier, Head of the Hydrogen Lab at Engie, sees high-temperature electrolysis as a way to “make green hydrogen more affordable – while also improving the global energy efficiency of various industrial processes.”

The project is funded under the Clean Hydrogen Partnership (formerly Fuel Cells and Hydrogen 2 Joint Undertaking) through grant agreement No. 875123 by the EU's Horizon 2020 program, as well as by Hydrogen Europe and Hydrogen Europe Research.

Sunfire, based in Dresden, develops and manufactures electrolyzers based on alkaline and solid oxide technologies. SOEC technology is considered particularly efficient when waste heat is available. In the EU project GrInHy2.0, an efficiency of 84 percent was demonstrated in 2022. For the next generation (GEN 3), Sunfire expects an efficiency of up to 89 percent. ○

Hylane launches real-world operation of 40-ton truck with 800 km range

Hylane has brought the first hydrogen truck equipped with a Bosch fuel cell module into Germany's road freight transport sector. The 40-ton truck from Iveco is operated by logistics company Schäflein for the Bosch plant in Nuremberg – as part of a rental model.

The Cologne-based company Hylane has brought the first hydrogen truck equipped with a Bosch fuel cell module into Germany's road freight transport sector. The 40-ton truck from Iveco is operated by Schäflein and transports products for the Bosch plant in Nuremberg.

The vehicle is used within a usage-based rental model. Schäflein rents the truck from Hylane, which handles procurement, registration, maintenance, insurance and regulatory compliance. The truck is expected to cover around 12,000 kilometers per year on fixed routes.

The fuel cell module for the Iveco truck comes from the Bosch plant in Stuttgart-Feuerbach. The vehicle has a range of up to 800 kilometers. Five hydrogen tanks with a pressure of 700 bar hold up to 70 kilograms of hydrogen.

The fuel cell system delivers over 200 kilowatts of power and supplies an electric axle. Two battery packs serve as energy buffers. The total output of the drive system is 400 kilowatts. The vehicle's gross weight is up to 44 tons. In addition to reducing CO₂ emissions, the operation also serves to collect data for the further development of fuel cell technology.



The people behind the joint project by Bosch, Iveco, hylane and Schäflein. © Hylane

The information gathered during operation is intended to feed into future drive systems.

The fuel cell module currently in use has been nominated for the Deutscher Zukunftspreis (German Future Prize). According to the company, this highlights the technical maturity of the solution.

"We are pleased that, together with Bosch and Schäflein, we can demonstrate how hydrogen mobility works in everyday life," says Hylane Managing Director Dr. Sara Schiffer. The goal is to make zero-emission trucks available in a simple and economically viable way.

Andreas Hewel, Head of Fleet and Customer Operations at Hylane, adds: "The momentum and collaboration with Bosch and Schäflein were exceptional and show what is possible when companies from different industries and sectors work together on sustainable solutions." ○

From Power to Performance – Containerized

New: Containerized DC power supply solutions for hydrogen production and electrolysis.

Our turnkey POWER STATION systems deliver 100 kW to 5 MW with Switch Mode or SCR technology – plug & play, efficient, and scalable. Backed by over 35 years of expertise and a global service network, plating electronic ensures maximum efficiency and reliability for your hydrogen projects.



Discover our new container solutions here.



21/22/23 OCT 2025
HAMBURG MESSE
GERMANY

Stand:
4F30

info@plating.de www.plating.de



Daimler Truck celebrates successful customer trials with fuel cell trucks

A mood of optimism and determination prevailed on September 2 at the Neckarhafen in Stuttgart, where five logistics companies, including Amazon and Holcim, reported on their one-year experiences with their fuel cell trucks. In total, the companies had covered 225,000 kilometers with their Mercedes-Benz GenH2 Trucks and had refueled around 15 tonnes of subcooled liquid hydrogen (sLH2 standard) during 285 refueling stops in Wörth am Rhein or Duisburg.

In this pilot phase, during which the trucks were integrated into regular operations at all five companies, each vehicle had a dedicated supervisor from Daimler Truck who was available around the clock throughout the year. As a result, the availability of the trucks was 80 percent – although the companies would prefer a rate of 99 percent.

Michael Scheib, who heads vehicle development at the manufacturer, is confident that this figure can be achieved in the medium term: “We need to reduce the maintenance effort per truck anyway if we want to have 100 fuel cell vehicles on the road by the end of 2026 and already 500 by the end of 2029.” The good news, he said, is that none of the issues were due to conceptual design flaws, but mostly related to software – for example, when a driver was unable to restart the system without assistance.

The question of economic viability is more critical. Roger Haschke, who is responsible for the fleet of 120,000 vehicles at concrete and cement manufacturer Holcim and outsources all transport of building materials to subcontractors, stated: “Hydrogen becomes marketable at a price of €2.50 to a maximum of €5 per kilogram.” Currently, the price per kilogram is between €10 and €15. The refueling infrastructure also needs to be expanded, said Scheib, “when I think of 1,000 or 10,000 fuel cell trucks on Germany’s roads.” Regarding vehicle costs, one key factor is to design the service life of components in an economically viable way to enable cost-effective production. In other words: which part should ideally last 1.2 million kilometers, and which one should be replaced after 400,000.

As early as the fourth quarter of 2025, five more logistics companies will each put a GenH2 Truck from Daimler into operation. The aim is to gain broader experience across different applications and move closer to series production, which can then also be scaled in workshops and in the training of mechanics. All parties involved confirm the technical suitability of the trucks, which can travel 1,000 kilometers on a single tank. Their drivers, some of whom were present on site, praised the driving comfort, performance, and low noise levels. The driver from the Geislingen-based freight company Wiedmann & Winz said: “The GenH2 stands up to any comparison with diesel or electric drives.”



Nevertheless, all users emphasize that they remain open to different technologies. Their fleets also include the Actros, the electric variant from Mercedes-Benz. Thomas Hollad, head of transport at Air Products – which also operates the refueling station in Duisburg and transports liquefied gas or hydrogen – said the company is ready to expand the refueling infrastructure and is looking for partners to do so. Hydrogen, he said, is an efficient energy storage medium. All stakeholders are also looking to the EU and the Bundestag, the Federal Parliament of Germany, as much depends on the political framework. Scheib assured: “We are not backing out of this technology anymore, we are going full speed ahead.” **By Leonhard Fromm**

Moritz Lege (right), authorized signatory at Wiedmann & Winz, with Salvatore Bilecci – the driver who operated the GenH2 for one year.

© Leonhard Fromm

SIAD and Brembo invest in fuel cell start-up Hydrospace

The Italian companies SIAD and Brembo have made financial investments in the start-up Hydrospace. Both are investing up to one million euros each. The company develops solid oxide cells for converting hydrogen into electricity and heat, as well as for reconverting renewable energy into electricity. Hydrospace was founded by Petroceramics and hydrogen expert Fabrizio Gualandris, who holds several patents in the field of hydrogen technologies. The technology is based on proprietary ceramic materials and optimized manufacturing processes. The goal is to create a modular and scalable platform that enables higher energy density while reducing production costs. In its second fiscal year, the company aims to reach break-even and achieve an annual production capacity of one million cells. Initial collaborations with international partners are already in place.

Petroceramics is a company specializing in technical ceramic composite materials with applications in the automotive, aerospace, and defense industries. SIAD is an international provider of industrial gases and engineering services, while Brembo describes itself as a global leader in high-performance braking systems. **By Leonhard Fromm**

Norway: Two new hydrogen ferries to enter service in 2026

Torghatten Nord and Norwegian Ship Design are developing two hydrogen ferries that are scheduled to operate on the route between Bodø and the Lofoten Islands starting in 2026. The vessels are expected to consume up to six tonnes of green hydrogen per day.

The Norwegian ferry operator Torghatten Nord, together with Norwegian Ship Design, has developed two new hydrogen ferries that are to be deployed on the route between Bodø and the Lofoten Islands from 2026. The crossing takes three and a half hours.

The two double-ended ferries, each 117 meters long and with a gross tonnage of 8,500, are designed to carry 599 passen-

gers and 120 cars. This makes them the largest hydrogen-powered vessels in the world. They are named "Røst" and "Moskenes" and are currently being built at the Myklebust Verft shipyard in Norway. The hydrogen systems, including 32 fuel cells per vessel, will be installed on the upper deck between the two bridges.

The required green hydrogen will be supplied by the company GreenH. The production facility in Langstranda near Bodø is expected to provide six to ten tonnes of hydrogen per day. According to the operator, the daily hydrogen consumption per vessel will be between five and six tonnes.

The ferries are part of a 15-year contract between Torghatten Nord and the Norwegian Public Roads Administration (Statens Vegvesen). The contract, which has a volume of 4.98 billion Norwegian kroner (approximately 496 million euros), came into effect on October 1, 2025. It will run for 15 years.

In addition to the newbuilds, the two existing vessels on the route, "Værøy" and "Landegode", will be converted from LNG to bio-fuels. They are to be used during the peak tourist season in the future. The development of the new ferries is considered a significant step towards the decarbonization of maritime transport in Norway. ○



Hydrogen from Africa only viable with political support

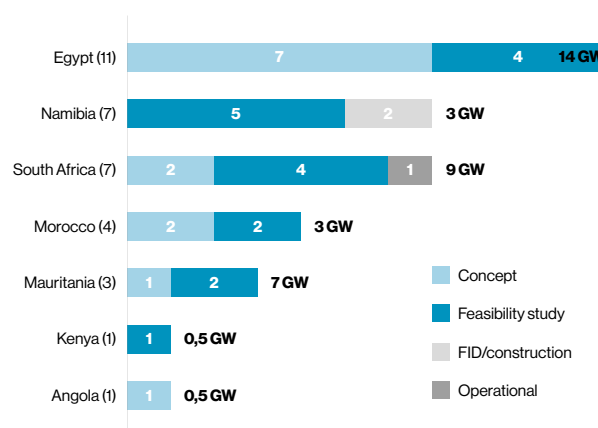
A study published on the Nature website in June examined the competitiveness of hydrogen imports from Africa to the EU – with sobering results. Without political backing from European countries, hydrogen from Africa remains too expensive, the study concludes.

The analysis is based on geospatial models used to calculate the levelized cost of hydrogen (LCOH) and evaluates four financing scenarios. According to the study, the lowest production costs for green hydrogen from Africa, exported in the form of ammonia, range between €4.20 and €4.90 per kilogram. Only through government-backed de-risking measures could individual sites reach a competitive level of around €3.20 per kilogram. According to the study, this could be possible in Mauritania by around 2030.

Only 2.1 percent of the sites examined could be competitive under current interest rate conditions with de-risking. However, many of these are located in politically unstable regions such as parts of Western Sahara, central Algeria, or the border area between Sudan and Egypt. In these areas, investment guarantees from international organizations such as the Multilateral Investment Guarantee Agency (MIGA) are scarcely available, further limiting the feasibility of large-scale projects. Another issue is the mismatch between project size and national economic capacity. For example, the planned Aman hydrogen project in Mauritania requi-

res investments of around USD 40 billion – four times the country's gross domestic product in 2021. Additional challenges include a shortage of skilled labor for wind energy development, water scarcity in certain regions, and high levels of foreign debt in many African countries.

The Nature authors therefore recommend targeted political support, tied to conditions such as local value creation and industrial use of hydrogen. Countries with existing industrial structures such as Morocco, Egypt, South Africa, or Kenya could benefit more from this than, for example, Namibia or Mauritania. ○



Electrolysis capacity by country and status.

Course set for maritime transport



In the coming weeks, a decision will be made in London on whether the international community will send a signal for a global hydrogen ramp-up in the shipping sector.

The venue: London. For several months now, negotiations have been underway at the International Maritime Organization (IMO) on the IMO Net-Zero Framework. In April, an outcome was reached that is to be officially adopted in October. The key elements: a new fuel standard for ships and a global mechanism for carbon pricing.

To anticipate the result: despite some weaknesses, the IMO framework establishes a legally binding system for reducing greenhouse gas emissions in global shipping. If implemented carefully, it could have a significant impact on the development of green fuel markets worldwide, comparable to quotas for SAF in aviation.

The outcome in April was not a foregone conclusion. Influential countries such as India opposed the framework. It was only when major companies from the renewables sector made it clear to the Indian government what opportunities quotas for domestic production of green fuels could offer that the government began to support it. Other countries, such as China, also recognized the potential of a quota system for ramping up a global market for green derivatives and advocated for the initiative in many lengthy background discussions in London.

Striking the right balance is crucial to securing the approval of as many IMO member states as possible in October. The planned IMO Net-Zero Fund is therefore intended to combine incentives for “zero or near zero” (ZNZ) fuels with support for a just transition, including payments to particularly affected coun-



STEFAN KAUFMANN
Attorney Dr. Stefan Kaufmann advises national and international companies and investors in the hydrogen sector. From 2009 to 2021 and from 2024 to 2025, he was a member of the German Bundestag for the CDU party. From 2020 to 2022, he served as Innovation Commissioner for Green Hydrogen at the Federal Ministry of Education and Research. For H2international, he will regularly report on current developments in the energy carrier of the future.

tries. To send a positive signal and generate a beneficial effect on the ramp-up of the hydrogen economy in Germany, the definition and premium rules for ZNZ fuels must prioritize scalable and truly near-zero-emission solutions such as green ammonia. Support must focus on those green fuels that will be needed in the long term and are currently difficult to scale due to a lack of demand.

Nevertheless, not all member states are satisfied with the outcome from April. Some are trying to block or weaken the agreement and delay its implementation. Several oil-exporting countries reject the plan and are promoting LNG for maritime transport. Countries that are heavily dependent on shipping for trade fear rising inflation, particularly in energy, fertilizer, and food prices.

The U.S. government recently joined forces with petro-states to threaten other IMO members who intend to vote for the Net-Zero Framework in October with severe countermeasures. An unprecedented move. On the other hand, many island states abstained from voting in April. They consider the process inadequate for protecting vulnerable countries from the impacts of climate change. In the coming weeks, supporters of the IMO framework must mobilize further international backing. In particular, Denmark (holding the Council Presidency) and Germany should demonstrate leadership together with the EU. At present, the EU member states are coordinating their position under the leadership of the European Commission. A good development! ○

“The EU’s additionality requirement should be abolished!”

Interview by Monika Rößiger

Jan Rispens, head of the Renewable Energy Hamburg Cluster (EEHH), looks ahead to the Hydrogen Technology World Expo in Hamburg and discusses how the hydrogen ramp-up could be accelerated.

H2international: The “Hydrogen Technology World Expo” will take place in Hamburg from October 21 to 23. The hydrogen trade fair was already a great success in 2024. And this year, it appears there will be even more participants?

Jan Rispens: Yes, the rented exhibition space alone is 30 percent larger this year than before. And the number of exhibitors has also increased significantly. So there is a great deal of interest in taking part in this trade fair. It has also been extended from two to three days, because two days were simply too short. In this respect, the Hydrogen Technology World Expo will be a leading trade fair for Europe. And, I believe, also worldwide.

What can we expect?

What we will definitely see at this trade fair is that the technology has matured even further. Electrolysers, compressors, storage systems – in other words, technical development is progressing.

What might be different from last year?

I think the wheat has been further separated from the chaff. There may be less euphoria, but in return more real orders and contracts.

Now, Hamburg is not the only location for hydrogen trade fairs. How does the Hanseatic city compare internationally, for example with Rotterdam?

Yes, there are other trade fairs and events. There is also the European Hydrogen Week in Brussels. But I believe the trade fair with the highest technology content is the Hydrogen Technology World Expo in Hamburg. It showcases concentrated German technological expertise, plus European and international know-how.

What else does Hamburg have to offer in terms of hydrogen and renewable energy, apart from being a trade fair location?

Hamburg is firmly committed to becoming a hub for green hydrogen. Both for the production of green hydrogen and for its import. This naturally includes the expansion of renewable energies. For a city-state, Hamburg is very ambitious in this area, I think. For example, the Hanseatic city is developing wind farms on its own land, such as in the port or in the outskirts. So there is a lot of ambition behind it, even if this is only possible on a smaller scale in a city-state compared to a territorial state.



What are the plans of the newly elected Senate in Hamburg, consisting of Social Democrats and the Green Party, for the energy transition?

Hamburg aims to become much better in the field of solar energy than in the past. The city administration also says it wants to work with businesses, industry and the housing sector to install significantly more solar modules than in recent years. I believe something is starting to move here.

And in the hydrogen sector?

The goal of decarbonising industry with green hydrogen is also being pursued further, and the ambition remains strong. Hamburg is also providing substantial financial support for this. For example, for the IPCEI projects aimed at building a green hydrogen economy, Hamburg is contributing around EUR 220 million in funding, in addition to federal funds.

What exactly is planned and how is it to be implemented?

This is being driven primarily by the municipal companies Hamburger Energiewerke and Hamburger Energienetze. They are 100 percent owned by the city. Hamburger Energiewerke is developing a 100 megawatt electrolyser at the Moorburg site together with the company Luxcara. Hamburger Energienetze is building a 40-kilometre pipeline network to transport hydrogen to key energy customers in the port.

The government is also supporting the private sector in switching to hydrogen. For example, the operators of tank farms and terminals, to enable the import of green fuels. There is currently an application for approval of an ammonia terminal. A positive decision is expected soon. In addition, work has begun to convert tanks currently storing fossil oil into methanol tanks. The city is supporting this with fast-track approval procedures, and you can sense a high level of motivation from the administration. I would say Hamburg is doing everything it can to enable the import of green hydrogen and green fuels into Germany.

Let's turn to federal policy: There is no clear course on hydrogen. And the rapid expansion of renewables is even being called into question – what can we expect?

On the one hand, I can understand that a new government wants to take stock of the finances first. On the other hand, it must be said that the rapid expansion of renewables is essentially a no-regret measure. There's not much you can do wrong. Even if the expansion targets are reached earlier. On the contrary, that would only be beneficial, especially with regard to hydrogen. However, the whole process could perhaps be made more cost-efficient.

ABOUT JAN RISPENS

Since 2010, Jan Rispens has headed the Renewable Energy Hamburg Cluster (EEHH), an industry network in the Hamburg metropolitan region with around 300 companies and institutes. Since 2021, EEHH has been building its own cluster segment for the hydrogen economy, which now has around 80 members. Jan Rispens, born in the Netherlands, where he completed a degree in electrical engineering, previously worked for Greenpeace Germany and the German Energy Agency. From 2002 to 2010, he served as managing director of the Wind Energy Agency Bremerhaven/Bremen e.V. (WAB). He is a member of the advisory board of the "Hydrogen Technology World Expo".

In what respect?

In terms of infrastructure. If the expansion of infrastructure is slowed down now and it later turns out that the infrastructure is fully utilised and many green electricity suppliers have to be curtailed – that can no longer be corrected in the short term. That's why I believe we must not lose momentum in expanding infrastructure. This applies to electricity grids as well as to the emerging hydrogen networks. Today, we are unfortunately losing a lot of valuable green electricity because the power lines to southern Germany are overloaded and cannot be built quickly enough.

Then there's the discussion about gas-fired power plants. Should they initially run on natural gas or be hydrogen-ready from the start?

The most important thing is that we get a decision on gas-fired power plants quickly. We want to shut down coal-fired power plants with a total capacity of 30 gigawatts. Once they are gone, we need a replacement for dark doldrums, especially in winter. As the EEHH Cluster, we would prefer to have highly flexible gas-fired power plants that we initially operate with natural gas and later gradually with hydrogen.

“Hourly balancing and additionality make hydrogen 50 percent more expensive than necessary.”

Do we need 20 gigawatts, or could the coal-fired power plants be replaced with less capacity?

Twenty gigawatts is, I think, quite a lot, but I consider ten gigawatts to be quite appropriate. That was also the plan of the current coalition government, which applied to the European Commission in Brussels for state aid approval. The framework conditions for the power plants should now be created quickly. In my view, most companies that will build these gas-fired power plants are likely to be interested in making them H2-ready. Otherwise, they would have a “stranded investment” in ten or twenty years. So they will make sure to build a gas-fired power plant that can later be operated with hydrogen in various blending ratios. Perhaps even up to one hundred percent hydrogen.

What is the current state of the technology?

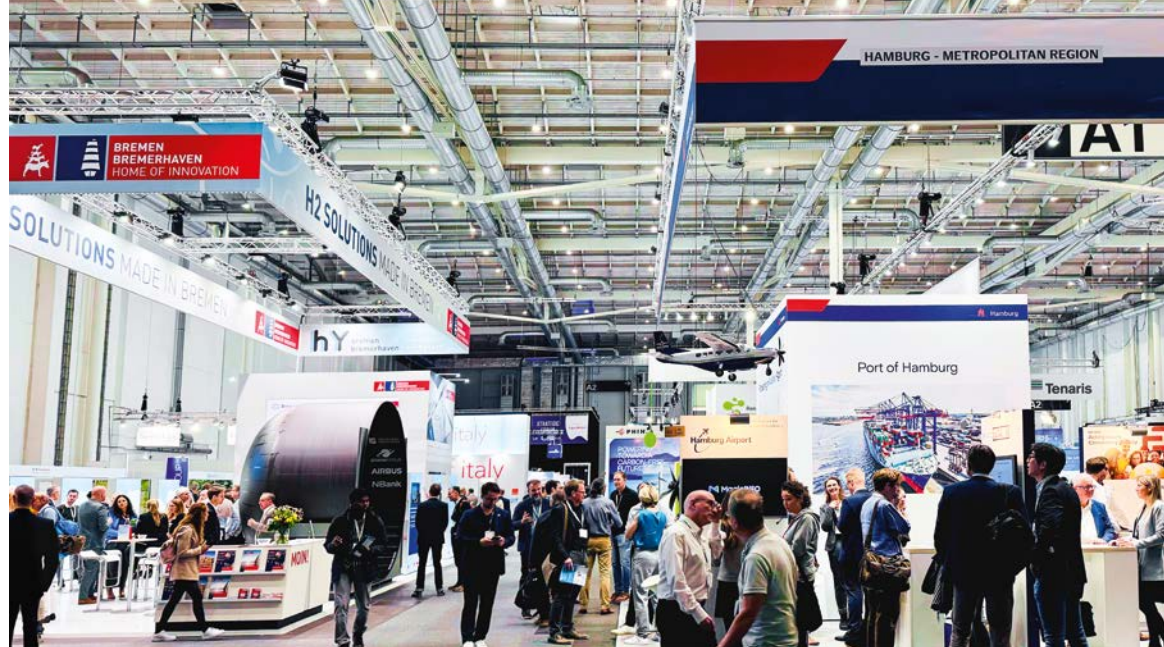
Well, turbines are already available at the prototype stage, both in Japan and in Germany. For all gas-fired power plants currently being planned, investors are considering how the plants can be operated in ten or twenty years and whether that will also work with hydrogen. This also applies to the gas and steam turbine plant being built by Hamburger Energiewerke on the Elbe island of Dradenau.

Nevertheless, there is currently a sense that the hydrogen ramp-up is stalling. Projects are being postponed or cancelled altogether. What could be the reason?

The main problem is the Delegated Act of the European Union, the RED II and III directives, which aim to introduce hourly balancing relatively quickly. In order to balance the electricity from wind farms or solar plants on an hourly basis, this electricity must also be purchased via PPAs. Until 2030, monthly balancing is still permitted. But since most projects are un-

The hydrogen trade fair in Hamburg already attracted great interest last year.

© Monika Rößiger



likely to be completed before 2030, they will immediately fall under the hourly balancing requirement.

That means that ...?

... much larger quantities of green electricity must be purchased than with monthly balancing, in order to cover the demand for electrolysis at all times on an hourly basis. Green electricity purchased long-term via PPAs with guarantees of origin is relatively expensive. The hourly balancing requirement from 2030 therefore makes the hydrogen produced even more expensive.

There is also a second criterion, the so-called additionality. Another obstacle?

Yes, because it means that I may only use electricity from new wind farms or new solar plants for electrolysis. But the market for new wind farms and solar plants is complicated. I would have a much wider choice if I could source electricity from all green power providers. That is, from both old and new renewable energy plants. That would be significantly cheaper. Many old wind farms no longer receive EEG subsidies and their operators are offering their electricity on the market. But due to the additionality requirement, electrolysis operators cannot use this offer.

“The additionality requirement could be abolished entirely. Why should an electrolyser only be allowed to use electricity from new wind and solar farms? That makes no sense at all!”

These are two major obstacles to the hydrogen ramp-up?

Absolutely. Hourly balancing and additionality make hydrogen about 50 percent more expensive than necessary. An industrial company that wants to decarbonise its production using green hydrogen is already facing the challenge that this is two to five times more expensive than hydrogen from natural gas. And if hydrogen becomes another 50 percent more expensive due to these two regulations, that is an extreme investment barrier. This is also the main reason why many potential buyers are not investing now, but waiting.

But these regulatory brakes could be removed relatively easily, couldn't they?

Definitely! The additionality requirement could be abolished entirely. Why should an electrolyser only be allowed to use electricity from new wind and solar farms? That makes no sense at all and does not apply to EV charging stations, data centres or any other sector of the economy. So why only for electrolysers? I see no ecological benefit in it.

There is another reason why I would abolish it. If the European countries achieve their expansion targets for renewable energy, the share of renewables in the electricity mix will already exceed 80 percent by 2030. Then additionality no longer matters, because the CO2 intensity of the electricity will have become very low. As for hourly balancing, we should therefore extend the deadlines to 2035 or even later. That means monthly balancing should be allowed until at least 2035. By that time, the share of renewable energy in the electricity sector in the EU will already be very high. In Germany, it is even expected to reach 100 percent. For an electrolyser operator, it will then no longer matter whether balancing is done monthly or hourly, and whether the electricity comes from old or new wind or solar plants. In this respect, this solution would be simple and ecologically justifiable in my view. But this also requires recognition in Brussels that with the current overly rigid regulation, the EU will be in a pretty poor position in terms of the hydrogen ramp-up by 2030. ○

ABOUT THE “HYDROGEN TECHNOLOGY WORLD EXPO” 2025 IN HAMBURG

More than 1,000 companies, 20,000 participants and 300 speakers have registered this year for what is, according to the organisers, “the world’s largest supplier trade fair for hydrogen technologies”. Exhibitors and speakers will present technical solutions, production facilities, components and innovative materials along the entire hydrogen value chain. From production to application in mobile or stationary systems, transport and storage. Manufacturers of electrolysers, fuel cells and CO2-neutral fuels will offer their expertise for infrastructure and services.

Motorsports

“Racing can accelerate change”

Interview: Eva Augsten



On October 9 and 10, the FIA's Extreme H off-road race took place in Saudi Arabia for the first time. CEO Ali Russell and Rob Atkinson from Siemens spoke with H2international about how such races can accelerate developments in the automotive industry.

H2international: Driving with hydrogen already requires a range of specific safety measures even for standard buses and trucks, and many people still feel uneasy. How do you handle such an explosive gas in racing?

Ali Russell: When people hear hydrogen, they think of explosion. During our races you can see that you can have crashes and there are no mishaps, no explosions. The technology works and is safe. People have been racing with combustible fuels for generations and explosions are simply not a big topic.

Of course the sport itself is incredibly dangerous, so we need to make it as safe as possible. That is why safety aspects like seat belts and side mirrors originated in racing. ➤





LEFT: At the Extreme E in Saudi Arabia in February 2024, the solar system supplied part of the energy for the event.

© Andrew Ferraro / LAT Images

RIGHT: The trail follows the ridge of the Tuwaiq Mountains in the Saudi Arabian desert.

© FIA / Birgit Dieryck

Hydrogen is an industry in its infancy. We show that it works from a performance point of view. If it can work in the Atacama desert and in the Arctic, it can work anywhere. We also see ourselves as a platform to help businesses like Siemens, Hyundai, Stellantis and General Motors to move forward.

“There are no mishaps,
no explosions.”

How do the Extreme E and Extreme H races differ from Formula 1?

Ali Russell: The Extreme H format is an off-road race like the Extreme E. It is very different from Formula 1. We want to connect to younger people. It is way more dynamic. It is a multi-car race and also a rally against the clock, incredibly easy to understand. We have 50 / 50 men and women driving.

We have had 13 years of Formula E and the Extreme E race has now turned into Extreme H. There are a lot of similarities between those two. When we started Formula E, no one believed in it, people distrusted the technology. They feared they would be electrocuted or there would be battery fires. It probably was the same when horse carriages were replaced by cars.

We use the same electric vehicles like in Formula E. Instead of the battery we now have a fuel cell on board. In the future hydrogen combustion engines might participate in the same competition.

There are three different races. The first one is a rally against the clock, from one point in the sand to another and back, then you switch drivers and repeat. The second race is a 1:1 knock-out competition. The third round is a multi-car race, everyone starts at the same time and whoever crosses the line first wins.

Rob Atkinson: It is a very watchable form of racing, much more interesting than the long Formula 1 races, only about 20 minutes per race. There is a lot more action and also information in the format.

Russell: There are eight teams with eight cars and sixteen drivers, one male and one female driver in each team, like

ABOUT ALI RUSSELL, EXTREME H, FIA AND SIEMENS

Sports manager Ali Russell is Managing Director of both Extreme E and Extreme H. During the first two seasons, he worked as Chief Marketing Officer for the event.

Extreme E is an electric SUV off-road racing series. The event also addresses the issue of climate change and climate protection, as well as other sustainability topics – for example, through gender-balanced teams consisting of one man and one woman. The races have taken place in remote locations, including the Arctic, the Atlantic coast of Senegal, the deserts of Saudi Arabia, and a former coal mine in Scotland. The format also includes information on climate protection, reaching an audience that is usually not closely engaged with this topic. In fall 2025, Extreme E will become Extreme H. The race format will remain the same, but instead of battery-electric drives, fuel cell electric drives will be used. The first race will take place in Saudi Arabia.

The formats Extreme E and Extreme H are backed by the Fédération Internationale de l'Automobile (FIA), the international motorsport governing body that also holds the naming rights and sets the rules for Formula 1, among others. Siemens hosted a preparatory meeting for the first Extreme H race in June 2025.



Ali Russell and Rob Atkinson at the preparatory meeting at Siemens in Amberg in June 2025. © Siemens



Focus



ABOVE: Pressurized hydrogen is transported to the venue by trailer trucks. © FIA / Aemilia Cumberland

RIGHT: Andreas Bakkerud and Catie Munnings from Team Hansen. © FIA / Birgit Dieryck

BOTTOM: Eight mixed teams of 16 drivers competed in the first Extreme H motorsport event.

© FIA / Aemilia Cumberland



in the Wimbledon mixed doubles. This is unusual in racing, normally there are 97 % male drivers. The time gap between the best male drivers is about two tenths of a second. When we started the mixed teams four years ago, the time gap between men and women was about four seconds. This has gone down to one second. So we proved that if the women have access to the same tools and same coaching and you put them in the same team so the members can help each other to become faster*** there is real progress. This is a really positive by-product of our racing and we want to work together and share these results.

“When we started Formula E, you had to switch cars because the battery did not last”

When we started Formula E, you could not drive really fast, you could not even finish the race with the same car, you had to switch cars because the battery did not last. Within three seasons we increased the energy density and efficiency went up from about 30 to 35 percent to 98 to 99 percent. We worked on the battery management and through its testing and development in Formula E, Jaguar has been able to optimize energy usage and improve battery performance in its own vehicles, leading to a 20% range increase in its I-PACE model.

Siemens is one of the companies that has big bets in the hydrogen economy.

Atkinson: We did a lot of design work on fuel cells and the cars for Extreme H and now work with the OEMs on their fuel cells. We want to be an enabler for the hydrogen industry. We do not sell the destination; we sell the journey.

This is why we hosted the organizational meeting for the Extreme H in June here in Amberg. And it really brought us to a next level of understanding. We do not have all the answers yet, but everybody at the event knew the challenges very well and was super committed. So we got a completely different view on the whole matter. This is why one year of racing equals ten years of R&D. Racing also brings forward stationary systems. A so***-***called Hydrogen Power Unit by Geopura provides 80 % of the site power for the event and the system has evolved. Geopura started with one hydrogen system per year, now they make more than 40, mostly used for broadcasting in rural areas without electricity grids. Their approach to the market is really innovative. They do not sell the power units but provide electricity as a service. So there is less risk for the customer. Siemens is helping in scaling up. We delivered the automation to control the power units and help make everything more cost effective.

Russell: We can be a communication platform. There is not only F1, but also NASCAR and IndyCar races. There are famous drivers like Lewis Hamilton, Nico Rosberg, Jimmie Johnson and Michael Andretti. Together we can reach a billion people.

We think mobility can evolve to be more sustainable. We do not need to go back to horse carts and sailing boats. If we work together we can grow much quicker.

So far, from a consumer perspective, sustainability is not attractive enough. Motor racing can make sustainability much more attractive. ○

SUSTAINABILITY IN MOTORSPORT: WHEN THE RACE CARS ARRIVE BY TRAIN

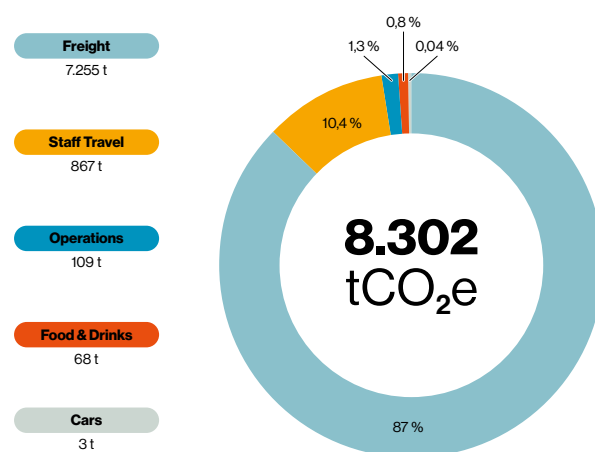
Extreme E was an off-road racing series featuring electric SUVs. The event also addressed climate change and climate protection, as well as other topics from the UN Sustainable Development Goals – for example, through gender-balanced teams consisting of one man and one woman. The broadcast format includes information on climate protection. In Extreme H, the race format remains the same, but instead of battery-electric drives, fuel cell drives are used. The off-road races take place in remote locations, which so far have included the Arctic, the Atlantic coast of Senegal, the deserts of Saudi Arabia, and a former coal mine in Scotland. The first race of Extreme H will take place in Saudi Arabia.

In both Extreme E and Extreme H, the FIA is also working to reduce the event's emissions. During the race itself, the cars account for a negligible share of emissions – well below one percent in the most recent Extreme E season in 2024. The largest share of emissions (91 percent) is caused by transporting materials, followed by team travel (just over 5 percent). On-site operations account for around 3 percent.

Initially, emissions were mainly reduced by using hydrotreated vegetable oil (HVO) as fuel for the generator, but over the years, the share of hydrogen has increased. The FIA covers this share with a fuel cell system from Enova. A water-methanol mixture is used as fuel. The electricity from the fuel cells is stored in a second-life battery system from Zenobe and distributed on site via a microgrid. In addition, solar power is generated locally. In the fourth season of Extreme E in 2024, just over half of the energy came from hydrogen, 10 percent from solar power, and the rest from HVO. In this year's Extreme H, HVO is intended to serve only as a backup.

To address the CO₂-intensive transport of race cars and equipment, the organizers are experimenting. At some events, a specially converted ship, the RMS St Helena, was used. However, it has since been sold. For the Hydro X Prix in July 2024, the 70 freight containers with 21 race cars and other equipment were transported by train from Portland in southern England to Dumfries and Galloway in Scotland.

The environmental organization BUND criticized Extreme E as greenwashing – primarily because it allegedly damages sensitive landscapes. The organizer responded by pointing to comprehensive environmental assessments.



Source of greenhouse gas emissions (in CO₂ equivalents) at Extreme E © NEONBOLD

Formula Student Austria

Fuel for pioneers

By Niels Hendrik Petersen



For the first time, two hydrogen-powered race cars competed at Formula Student Austria. This marks a new chapter for the event organizers. Safety aspects were a particular focus.

The atmosphere at the racetrack is already something special: “Of course, everyone wants to get the most out of their own car, but if a screw is missing, you can easily ask another team for help,” says Jasmijn Oude Nijhuis, spokesperson for the HyDriven Twente team from the Netherlands. This combination of healthy rivalry and collaboration makes Formula Student an inspiring learning and testing environment for students from around the world.

The Dutch team’s technology differs from that of the other participating teams. “It was a unique experience to take part as the first and only hydrogen fuel cell car, but it was also true for the competition itself, as a new race car and a new fuel require an entirely new set of rules,” she says, describing the challenge they had to overcome.

Ultimately, it is the responsibility of each team to ensure that their car is approved for competition. This makes the event both intense and educational. Every mistake becomes immediately visible, every decision counts. Nijhuis believes hydrogen is a serious option for the energy transition: “Our goal is to make this technology visible and to inspire others to explore new and sustainable solutions.”

Hydrogen refueling station with up to 350 bar

The race took place at the end of July 2025 at the Red Bull Ring in Spielberg, Austria. With 58 teams and a record number of 1,800 participants from 16 countries, the event was already a success. For the first time, two race cars powered solely by hydrogen took to the track. Another highlight: the newly installed hydrogen refueling station with up to 350 bar, which the organizers set up and commissioned in just 20 hours – including a test refueling. “Two years ago, we started the H2 Concept Challenge to prepare Formula Student teams for the new H2 project and to develop a new set of rules,” explains Steffen Schmitt, Head of Hydrogen Formula Student Austria (FSA). The HyDriven Twente team competed with a fuel cell. As the second H2 team, Ka-RaceIng from Karlsruhe converted an existing race car from E85 to hydrogen. FSA sees itself as a design competition that trains future engineers – combustion engines are therefore still permitted. “We want to be as open to technology as possible,” emphasizes Schmitt. However, the combustion engines are CO₂-neutral in balance, as they are powered by synthetic fuels or green hydrogen. “Over the past three years, we’ve had a steady number of participants in the Hydrogen Concept Challenge, where teams can present their future hydrogen-based powertrain concepts to technical experts,” Schmitt reports. Some of the participants also have concrete plans to build a hydrogen-powered car. Currently, at least three additional teams are in

the process of acquiring a hydrogen tank for their future hydrogen combustion engine or at least have a budget for it. They are currently in the selection process. “We expect three to five combustion engine teams and one to two fuel cell vehicles in 2026.”

H2 race car weighs 55 kilograms more The race car from Ka-RaceIng not only impressed its own team. The goal of the Karlsruhe team was to present a hydrogen-powered combustion engine. In the end, the car was able to participate in all dynamic disciplines of the competition. Particularly surprising was the relatively low overall weight of the vehicle. It weighed only around 220 kilograms. “You have to keep in mind that the hydrogen tank and an additional frame structure designed to protect the car in the event of a crash added about 55 kilograms compared to a conventional combustion engine from 2019,” explains Schmitt. The Karlsruhe team demonstrated that constructing a hydrogen vehicle with an acceptable total weight is possible. Converting an existing race car with a conventional combustion engine to hydrogen operation requires partners who provide materials or financial support, with the hydrogen tank and safety components such as on-tank valves ▶



TOP: The newly installed hydrogen refueling station delivers up to 350 bar.

© FSA

LEFT: Ka-RaceIng from Karlsruhe opted for a hydrogen-powered car

© FSA

(OTV) being the most expensive parts. “A completely new build would cost in the six-figure range, so we allow the use of existing chassis in the Hydrogen Rules,” says Schmitt. This is intended to lower the entry barrier for teams – allowing participants to focus on the necessary modifications for hydrogen operation and the implementation of the powertrain and tank. However, placing the 350 bar tank was a challenge for both teams. HyDriven Twente opted for structural side pods, with the hydrogen tank on one side and the high-voltage battery on the other. Ka-RaceIng removed the existing rear wing and installed a crosswise frame structure at the rear to house the hydrogen tank. Overall, sourcing a hydrogen tank certified to automotive standards with a two-kilogram capacity was another challenge for the participating teams.

New rulebook for H2 race cars For the organizers, creating a new rulebook for the competition with appropriate boundary conditions, as well as providing hydrogen and refueling infrastructure, was both a challenge and uncharted territory. “In addition to the 140 pages of the Formula Student Rules, we worked with five other events last year to develop and publish the 40-page Hydrogen Rules,” explains Schmitt. These cover all hydrogen-specific topics, from the standard and size of the hydrogen tank, to all additional sensors that teams must integrate into the so-called shut-down

circuit, to regulations for structural side pods. The refueling infrastructure was implemented with the company Maximator Advanced Technology, and the utility Wiener Energie provided a trailer with green hydrogen. FSA is the first racing event at the Red Bull Ring where H2 vehicles compete. Future races can now build on proven safety concepts. The teams also have a lot to learn. In cooperation with LIFTE H2, the organizers offer a Hydrogen Safety Officer (HSO) training course. Participants learn how to handle hydrogen safely and gain basic knowledge about hydrogen tanks, valves, and other safety components. Compared to fuel cell vehicles, combustion engines pose significantly fewer technical challenges.

Vehicle details must be submitted in advance

In preparation for the race, teams must submit the Hydrogen Safety File (H2SF). In this document, they describe the tank system and powertrain and provide all necessary data sheets and test certificates. This allows the organizers to assess the development process and provide constructive feedback. On site, a hydrogen detection device can identify faults in the hydrogen system during refueling. While the teams are working on their cars in the pits, the hydrogen tanks are safely stored outdoors in a fenced-off area. “We placed great importance on ensuring that teams source the central H2 components – tank, OTV, and



pressure regulation – from industrial partners who comply with all tests and regulations,” he emphasizes. Many other parts of the race car are self-developed, but for such a critical component, the organizers want to avoid that. The safety concept has worked very well so far. In the future, only a few adjustments will be made to everyday work with hydrogen. The new H2 rules are scheduled for publication in mid-October. ○

FOR THE NEXT GENERATION:

HYDROGEN GRAND PRIX IN CHEMNITZ

The race cars in Chemnitz, Germany were a size smaller than those at Formula Student. At the world final of the Hydrogen Grand Prix at the end of August, more than 60 student teams from 23 countries competed with self-developed H2 race cars in model car format.

The Fraunhofer Institute for Machine Tools and Forming Technology (Fraunhofer IWU), together with Horizon Educational and the H2 GP Foundation, organized the world final. The teams competed in four classes: Sprint, Stock, Hybrid, and Prototype. The goal was to complete as many laps as possible within a set time using radio-controlled, hydrogen-powered model vehicles. In addition to driving performance, team spirit, design, innovation, presentation, and pit strategy were also evaluated.



Celebrating together, the teams from HyDriven Twente (blue) and Ka-RaceIng.

© FSA



Looks very much like Formula 1: Team HyDriven Twente (blue) and Ka-RaceIng (yellow).

© FSA

SCHUBERT  SALZER



Safe shut-off. Reliable control!

Benefit from the advantages of H2 valves by Schubert & Salzer:

- ultra compact
- precise control
- safe shut-off

Discover more at:

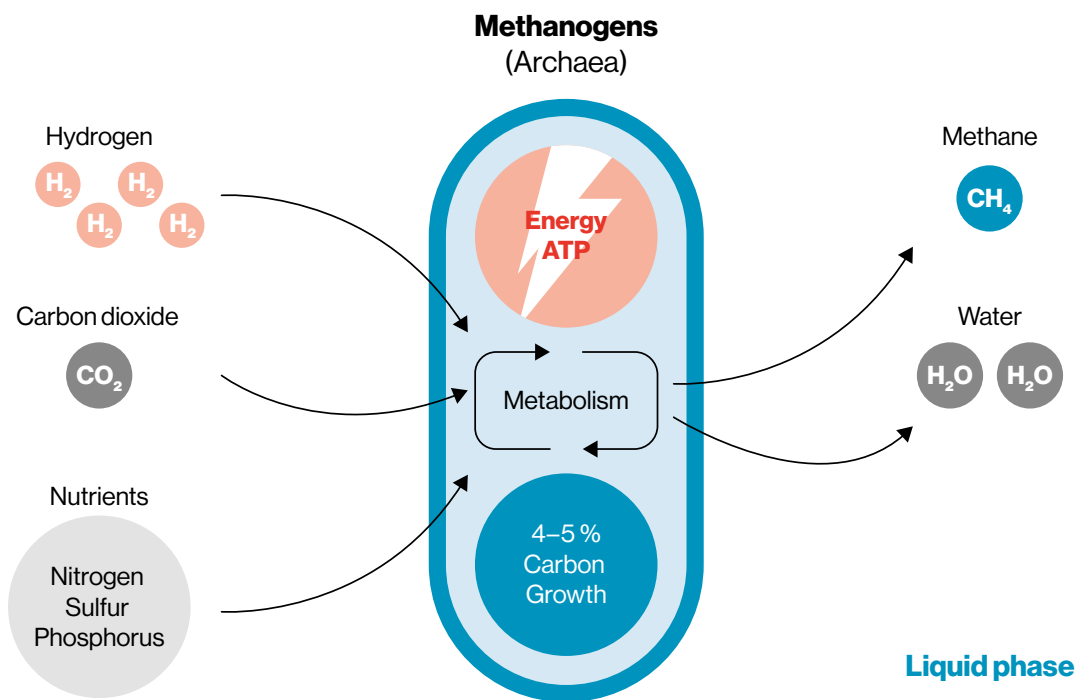
Hydrogen Technology Expo
21 - 23 October 2025, Hamburg
Hall B7, Stand 7E70



www.schubert-salzer.com

Green hydrogen as a booster for biomethane

By: Marcel Schröder, Anna-Maria Jeske



At the Bützberg biogas and composting plant (BKW), green hydrogen will be used in the future to increase biomethane production. This innovative approach opens up interesting prospects for large cities such as Hamburg on their path to climate neutrality – a field report.

The Bützberg biogas and composting plant has been processing organic waste from Hamburg households' green bins into high-quality compost for many years. In 2011, a biogas plant was added, which dry-ferments pre-treated organic waste in individual cycles to produce sustainable raw biogas. The raw biogas is upgraded and fed into the local gas grid as biomethane.

Since then, a total of 7,500 households have benefited from this sustainable energy – and the potential is far from exhausted. After

30 years of operation, we are currently building a second composting hall to increase processing capacity to up to 90,000 tonnes per year.

CO₂ savings already during the research phase

The large-scale approach gives the project supranational significance for hydrogen-based sector coupling in Germany and Europe. Our hydrogen research project is part of the joint project "Norddeutsches Reallabor" (NRL – North German Living Lab), which is funded by

**Biological methanation
by methane-forming
microbes (archaea).**

© NEONBOLD

the Federal Ministry for Economic Affairs and Energy (BMWi). The aim is to test a transformation pathway for an integrated energy system that can help reduce CO₂ emissions in northern Germany by 75 percent by 2035. The measures we have planned during the project period alone can save up to 330,000 tonnes of CO₂ per year.

The North German Living Lab is supported by more than 50 partners from industry, science and politics. The model region includes the Federal States of Hamburg, Schleswig-Holstein, Mecklenburg-Western Pomerania and the city of Bremerhaven. Together, they are cooperating in an energy transition alliance to stimulate economic momentum through innovation and thus strengthen northern Germany as an industrial location.

Power-to-gas (PtG) technology offers an option for converting surplus electricity into gaseous energy carriers and feeding them into the natural gas grid. Our subproject within the North German Living Lab investigates the synergies that can be achieved by producing hydrogen at a site where organic waste is digested and biomethane is fed into the grid. For this purpose, a new electrolysis plant with associated hydrogen infrastructure was built. We are examining both the material flows and the seasonal organic waste and its conversion, depending on process conditions, potential CO₂ savings and costs.

When we submitted the funding application at the beginning of 2021, we were unable to find a comparable project of this type of methanation. We therefore assume that these investigations into biological in-situ methanation are being carried out for the first time. In-situ (Latin: "on site") means that methanation takes place during the production of biogas. In contrast, ex-situ methanation takes place in a downstream facility. Our results are being incorporated into publications on the use of hydrogen technology in organic waste treatment plants, in order to make the scientific and economic potential accessible to other municipalities as well.

Green hydrogen increases biomethane yield Using power-to-gas and biological methanation, the yield of biomethane is expected to increase by up to 20 percent. This means that the same amount of fossil natural gas can be saved in the gas grid. The CO₂-free hydrogen produced is added to the fermentation process of the organic waste. This allows a significant portion of the biogenic CO₂ contained in the biogas to be converted into methane and also fed into the gas grid as synthetic biomethane. The described metabolic process takes place within the operating parameters of the fermentation plant. The biological decomposition of organic waste (fermentation) occurs in four steps:

1. Hydrolysis breaks down the biomass into sugars, amino acids and long-chain fatty acids.
2. Acidogenesis converts the broken-down biomass into organic acids and gases.
3. Acetogenesis processes the acids and gases into acetic acid, hydrogen and carbon dioxide.
4. Methanogenesis finally produces raw biogas (methane, carbon dioxide, hydrogen sulfide).

The electrolysis plant has a connected load of one megawatt. The stack consists of 129 cells (manufacturer: Plug Power). The production capacity is approximately 200 normal cubic metres per hour at an outlet pressure of around 36 bar, with a gas quality of 5.0. This allows for direct use in fuel cells. This pressure also corresponds to the storage pressure of the downstream storage unit. However, for use in the biogas plant, the hydrogen pressure must be reduced to 250 mbar using a gas pressure control system.

At the Bützberg biogas plant, fermentation is controlled in three different phases. Each phase differs in duration, the supply of percolate liquids (carrier fluids for the various microorganisms from the four decomposition processes), the duration and volume ➤



The Managing Director of Stadtreinigung Hamburg, Prof. Rüdiger Siechau (second from right), with the project team in front of the new electrolysis plant.

© Stadtreinigung Hamburg/Thorge Huter



SRH Managing Director Rüdiger Siechau and Katharina Fegebank, Senator for the Environment, Climate, Energy, and Agriculture, at the commissioning of the electrolyzer. © Stadtreinigung Hamburg/Thorge Huter

of raw biogas flushing to loosen the compacted organic waste in the fermenter through percolation, as well as the duration and volume of hydrogen input.

The electrolysis plant has a connected load of one megawatt. The stack consists of 129 cells (manufacturer: Plug Power). The production capacity is approximately 200 normal cubic metres per hour at an outlet pressure of around 36 bar, with a gas quality of 5.0. This allows for direct use in fuel cells. This pressure also corresponds to the storage pressure of the downstream storage unit. However, for use in the biogas plant, the hydrogen pressure must be reduced to 250 mbar using a gas pressure control system.

Research under full-scale operating conditions

In parallel with the tendering, procurement, planning and construction of the electrolysis plant, we used the time for laboratory tests at the Hamburg University of Technology (C.R.E.M. Institute). Here, we were able to obtain the first successful measurement results demonstrating biological methanation using



Marcel Schröder
Project engineer at
Müllverwertung
Rugenberger Damm



Anna-Maria Jeske
Deputy press officer
at Stadtreinigung
Hamburg AöR

the in-situ method at a biogas plant on a laboratory scale. After completion of the new hydrogen infrastructure at the biogas plant, we were able to reproduce the measurement results from the laboratory tests using pressurised hydrogen cylinders.

Since summer this year, research operations have been running in 14 fermenter boxes. The process parameters for fermentation and the supply of green hydrogen will vary significantly in order to determine the best possible process control for biological methanation. A computer-based process model supports us by making predictions under different process conditions.

Research at the full-scale facility will continue until March 2027. There are already ideas for follow-up projects, including a dedicated hydrogen filling station, a hydrogen refuelling station, and the extraction of heat and oxygen.

The biogas and composting plant is a facility operated by Müllverwertung Rugenberger Damm (MVR) GmbH, which is a subsidiary of Stadtreinigung Hamburg AöR. [o](#)

- ✓ **Motivierte und effiziente Fachkräfte trotz Fachkräftemangel und Volllastbetrieb**
- ✓ **Senkung der Betriebskosten dank weniger Ausfallzeiten**

Mit Geleitwort von Joachim Butz, Ehrenvorsitzender
Fachverband Sanitär-Heizung-Klima Baden-Württemberg



Herausgegeben von Kurt Landau

Gesundes Arbeiten in der Gebäudetechnik

1. Auflage, 2023, 257 Seiten,
Gebunden oder E-Book, € 49,-



Warum dieses Buch?

Alle Infos und Bestellung unter:
www.gentnershop.de/gesundes-arbeiten-in-der-gebaeudetechnik

AUCH ALS E-BOOK
Jetzt bestellen!

Gentner 

The manufacturers are ready

By Leonhard Fromm

Primarily Daimler, but also Volvo, Kawasaki and several other truck manufacturers continue to rely on hydrogen propulsion for heavy loads and long distances. There have been some changes in this area.



Winter testing of the Mercedes-Benz GenH2 Truck in Switzerland © Daimler Truck

Six million trucks are on the road across Europe every day, covering 300 billion kilometers annually and consuming 60 million tonnes of diesel. They require 700 TWh of energy per year and emit around 200 megatonnes of CO₂ annually. At least, these are the figures provided by Daimler Truck in 2024.

Since hydrogen engines and fuel cell drives still offer advantages over battery-electric propulsion for long distances and heavy loads, truck manufacturers are relying on this technology to decarbonize their vehicles.

Cellcentric aims to set standards In 2021, Daimler Truck joined forces with the Volvo Group to cooperate on fuel cell technology, share costs and, above all, establish a certified standard that the entire industry will ultimately have to adopt. In March 2021, Volvo acquired a 50 percent stake in Daimler Truck Fuel Cell for €0.6 billion. Together, they founded the company Cellcentric, whose business purpose is to develop, produce and market a fuel cell system for long-haul trucks. Since then, 700 experts have been working for the joint venture in the southern German cities and towns Nabern, Stuttgart-Untertürkheim, Esslingen, and as well in Burnaby, Canada. The experts have generated 700 patents.

In June 2024, Cellcentric launched pilot production of fuel cells in Esslingen – directly on the B10 highway, with 10,300 square meters of production and storage space including offices and 100 employees. The first fuel cells are being installed in truck prototypes. At the same time, a high level of automation is to be developed, ensuring high quality and future recyclability, with the aim of enabling large-scale production in nearby Weilheim starting in 2026.

Reference project for supply chain development

Since this year, the German Federal Ministry for Digital and Transport, along with the Federal States of Baden-Württemberg and Rhineland-Palatinate, has been supporting Daimler Truck with €226 million to build a fleet of 100 hydrogen trucks. This fleet is scheduled to enter continuous operation from the end of 2026 with five reference customers, including Amazon. The funding covers two-thirds of the costs. This is permissible under EU law, as it qualifies as an Important Project of Common European Interest (IPCEI). These trucks are being built at the Daimler plant in Wörth. Their deployment will provide operational and maintenance experience.

The reference project is also intended to enable the development of a supply chain: the electric drive axles come from the Daimler plant in Kassel, the “Teck Tower” from Mannheim, and the fuel cells from Cellcentric in Esslingen. Part of the assembly is also carried out at the Daimler plant in Gaggenau.

Subcooled hydrogen to reduce costs The basis for the project is the further developed GenH2 Truck tractor unit, which is already being produced in Wörth. A key factor in the funding decision was the variant using subcooled liquid hydrogen (sLH₂), which is said to be significantly more cost-effective and powerful than gaseous compressed hydrogen. Cooling to around -260 degrees Celsius is intended to prevent boil-off and enable pressure-free refueling, while also reducing volume.

This should allow the vehicles to match conventional combustion engines in terms of performance and range, as Daimler Truck demonstrated in September 2023 under real-world conditions on public roads with a range of 1,047 kilometers. So far, one liquid hydrogen (sLH₂) refueling station is available in Wörth and one in Duisburg, which should be sufficient for the five reference customers.

Expanding refueling infrastructure requires co-operation

Infrastructure is just as important for battery-electric vehicles as it is for hydrogen trucks. Fortunately, energy providers are investing in charging infrastructure in line with the growth of the zero-emission vehicle (ZEV) fleet, according to Daimler. In addition, operators are making advance investments to secure future markets.

Hydrogen infrastructure is more complex. For sLH₂ refueling stations, Daimler has been working with Linde Engineering since last year. Their technology enables 80 kilograms of hydrogen – enough for 1,000 kilometers of range – to be refueled in ten to fifteen minutes. Daimler Truck aims to build a supply chain for liquid hydrogen together with Kawasaki Heavy Industries. The companies signed a memorandum of understanding for this in 2024.

As for gaseous hydrogen and buses, Daimler Buses has been cooperating with H2 Mobility Deutschland since 2024. According to Gorbach, only 50 hydrogen refueling stations were available across Europe in 2024. The need, according to Daimler Truck board member Andreas Gorbach, will be 2,000 by 2030. This would require 25 new hydrogen refueling stations to be installed each month.

Some regions and municipalities are also advancing hydrogen infrastructure. Since April 2025, the municipal utility Stadtwerke Stuttgart (SWS) has invested €50 million in the production of green hydrogen at the Stuttgart port, €16.6 million of which is funded by the region, the EU and the Federal State of Baden-Württemberg. Starting in December 2026, 1,200 tonnes of hydrogen per year are to be produced here using electricity from wind and solar power. This fuel will be used to refuel fuel cell-based buses, trucks and inland vessels. The amount corresponds to four million liters of diesel, which would have emit- ➤



Mobility

ted 15,000 tonnes of CO₂. Via seven kilometers of pipelines, which are now being laid along the Neckar River, the hydrogen will be transported from the Green Hydrogen Hub Stuttgart (GH2S) with its four electrolyzers to the respective refueling stations. These are located at the SSB bus depot in Gaisburg, at the Neckar port in Hedelfingen, and at a truck refueling station in Obertürkheim. According to SWS Managing Director Peter Drausnigg, there were five times as many requests for hydrogen as SWS can ultimately supply. In addition, the waste heat generated during electrolysis will be used to supply 1,200 households. The Federal State of Baden-Württemberg is planning two more hubs in the Ulm-Reutlingen and Rhine-Neckar regions.

Operating costs must come down Starting in 2039, Daimler Truck plans to offer only CO₂-neutral commercial vehicles in Europe, the USA and Japan – in line with the agreement with Kawasaki to decarbonize freight transport. Whether this will succeed depends on technology, costs and infrastructure. Daimler Truck already has a battery-electric drive on the market with the eActros 600.

However, both technologies still need to improve in terms of cost. Daimler Truck board member Andreas Gorbach says: “Trucks are capital goods that must pay off over their entire

service life.” If the 600-kWh battery alone is already twice as expensive as a diesel powertrain, the ZEV must demonstrate its advantages in operation. In 2024, the cost per kilowatt-hour at the charging station was still €0.70, and hydrogen cost between €10 and €15 per kilogram. Gorbach: “The alternatives become attractive at €0.40 and €4 to €5 respectively.”

Therefore, in the interim, truck tolls and diesel taxes on the one hand, and government subsidies on the other, must offset the price difference. A CO₂-based toll must be introduced across Europe, and around 20 percent of the revenue should be invested in the development of charging stations and hydrogen refueling stations, according to a blog post by Gorbach. The automotive executive also says: “In general, mobility must become more expensive because we have to factor in the environmental costs.” ○

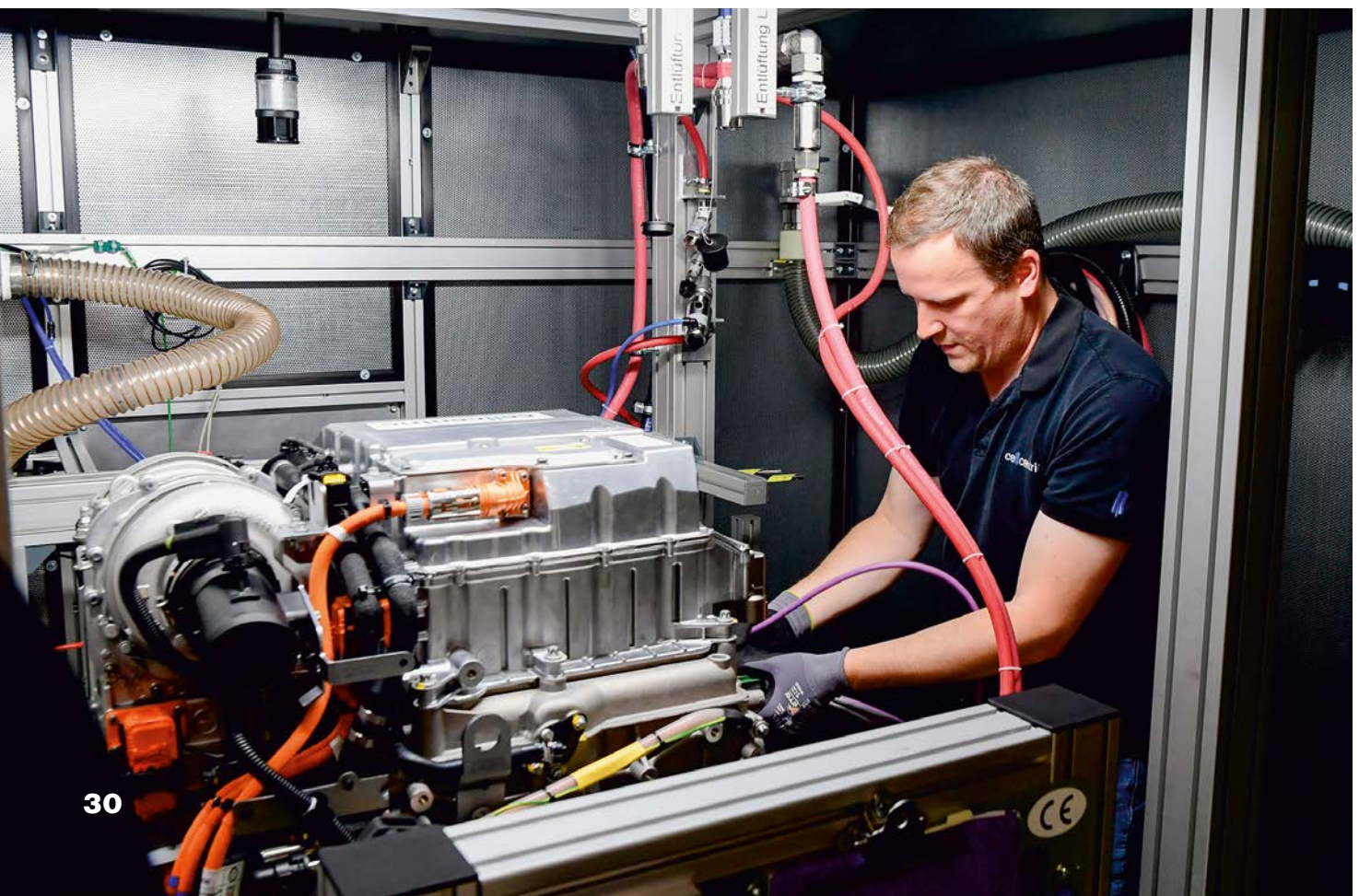
Final test of the fuel cell system at the Cellcentric plant.

© Cellentric / KD Busch.com

Leonhard Fromm

Freelance journalist

Read how Daimler Truck celebrated the pilot launch on page 8 of this issue.



HAUSTECHNIK BINGEWATCHEN

haustec TV ist der Video-Kanal der
Gebäudetechnikbranche. News,
Reportagen, Fachinterviews und mehr.
Von Profis für Profis



Scanne jetzt den QR-Code und
entdecke haustec TV!



New momentum in the west of Germany

By Claus Bünnagel

The current hotspot for the development of a nationwide hydrogen refueling infrastructure for buses and trucks in Germany is clearly the western part of the country. The station concepts differ significantly from one another.



LEFT: Delivery to REVG by trailer – currently at 200 bar, in the future at 380 bar.

© Claus Bünningel

RIGHT: Rare insight: The heart of the Düsseldorf refueling station, the compressor by Hoerbiger.

© Claus Bünningel



In Düsseldorf, H2 Mobility officially opened Europe's largest hydrogen refueling station at the end of May 2025. It has been in actual operation since early August. The project was funded with €4.3 million through the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP – Phase II 2016–2026) of the Federal Ministry for Digital and Transport. The total cost of the facility was around €7 to €7.5 million. Currently, Air Liquide still supplies the hydrogen via 380-bar trailers from its electrolyzer in Oberhausen. However, starting in 2026, hydrogen will be supplied by a 2 MW PEM electrolyzer operated by the municipal utility Stadtwerke Düsseldorf, located nearby. The electricity comes from the adjacent waste incineration plant. Half of it is considered green electricity, as statistics show that about half of household waste consists of biomass. The main customer for the public H2 Mobility refueling station is Düsseldorf's public transport operator Rheinbahn, which operates a nearby depot in Lierenfeld. Rheinbahn currently uses 20 Solaris Urbino 12 hydrogen buses and plans to expand its hydrogen fleet to around 30 units. Other users will include municipal service providers, logistics companies, tradespeople, and even private individuals. Specifically, these currently include a waste collection vehicle of the type Enginius Bluepower 2738E 6×2/4 and several Hyundai Xcient Fuel Cell trucks, primarily used by the food retailer Rewe. The station features three dispensers with a total of six nozzles, all of which can be operated simultaneously.

Testing with cold hydrogen At this station, hydrogen can be refueled at 350 bar (for buses and trucks) and 700 bar (for passenger cars), as well as at 500 bar, cooled to –20°C. The latter is currently available in a test and pilot phase at the same price as 350-bar hydrogen. At present, prices at the Düsseldorf station range from €13.55/kg (350 and 500 bar) to €15/kg (700 bar). However, it should be noted that, according to H2 Mobility, these prices are close to the purchase cost.

The redundant dispensers with cooling unit, hydrogen control system, control unit, and payment system are in-house developments by H2 Mobility. They are equipped with a sliding swing door, allowing the cooling unit to be easily pulled out for maintenance. The entire facility is designed to dispense 2 to 5 tonnes of hydrogen per day, with the future fleet of 30 Rheinbahn fuel cell buses alone accounting for a daily demand of around 750 kg. A special feature is the Hoerbiger compressor developed in cooperation with Ariel. It is the first commercial version, following a prototype previously used by Wiener Linien.

The H2 refueling station on Höherweg is not expected to be the last in the state capital



of North Rhine-Westphalia. Another station is planned at Düsseldorf Airport, as revealed by Mayor Stephan Keller during the opening of the H2 Mobility facility at the end of May.

Hydrogen fleet in Kerpen is growing – and needs a refueling station A bit further up the Rhine in Kerpen, on the southwestern outskirts of Cologne, the public transport company REVG Rhein-Erft-Verkehrsgesellschaft is already operating in an environmentally friendly manner. Since the end of 2024, its 111 former diesel buses have been running on HVO100. This already fulfills the quota for clean buses under the EU-wide Clean Vehicles Directive (CVD). However, the CVD also requires that within the 65% quota, 37.5% of vehicles must be zero-emission by 2030. This cannot be achieved with fuel made from hydrotreated oils and fats.

For this reason, the Rhein-Erft district decided back in 2019 to switch to hydrogen buses in the future. In the first phase, 26 Solaris Urbino 12 hydrogen buses were procured, each equipped with a 70 kW Ballard fuel cell. The timing was favorable: the Federal Ministry for Digital and Transport approved funding of €7.48 million before >

Mobility

North Rhine-Westphalia's Minister for Energy and Economic Affairs, Mona Neubaur (left), officially inaugurated the Düsseldorf station in May. Everyone else had to wait until August for actual refueling to begin.

© Claus Bünnagel



the subsidy program for electric and hydrogen buses was discontinued in early 2024. This corresponds to approximately €288,000 per vehicle, roughly covering the additional cost of the fuel cell buses compared to equivalent diesel models, which REVG Managing Director Walter Reinartz estimates at around €300,000 per unit. The acquisition of seven hydrogen articulated buses is also planned. Together, they are intended to gradually replace diesel vehicles with expiring lease contracts.

Two pressure levels, two storage systems Naturally, the growing hydrogen bus fleet also requires an appropriate refueling infrastructure. Therefore, by October 2024, a refueling station was built on the REVG depot in Kerpen by the neighboring logistics company Freund. It includes a 900-bar high-pressure storage system with a cooling unit (for temperatures down to -40°C), a 500-bar low-pressure storage system, and a compressor costing €1.5 million on its own. The high-pressure storage can supply only 15 kg of hydrogen fuel but is also used to refuel REVG's passenger car fleet with 700-bar hydrogen. The buses are refueled from the low-pressure storage, which can hold 50 kg.

To enable refueling of one bus every 20 minutes in the evening after their return from daily routes, the trailer-based hydrogen deliv-

eries by Messer SE from Krefeld – the world's largest privately owned specialist for industrial, medical, and specialty gases – must be expanded.

So far, two trailers per day deliver hydrogen compressed to 200 bar. One trailer holds 300 kg of hydrogen, enough for 13 buses at approximately 23 kg per bus. Assuming a consumption of 7 to 8 kg/100 km per bus, this allows for a range of 290 to 330 km – roughly the range of many of REVG's daily routes. The five type-4 tanks on the roof of the Solaris fuel cell buses, with a total volume of 1,560 liters, can hold up to 37.5 kg of hydrogen. When fully refueled, this enables the buses to cover even the 400 km of REVG's longest daily routes.

New trailers to deliver more hydrogen According to the original plan, 380-bar trailers were already supposed to be in use. However, technical issues have delayed their deployment – they are now expected to be operational in early autumn. These trailers can transport up to 1 tonne of hydrogen each and eliminate the need for additional compression of the fuel for the buses. To also supply the future hydrogen trucks of Spedition Freund, three such trailer units would be used: one being filled (a process that takes four to five hours), one in transit, and one stationed at the REVG depot at the refueling station.

Until now, the Messer Group has been supplying hydrogen from its production facility on the premises of Rain Carbon in Castrop-Rauxel. However, in early July 2025, ground was broken for a hydrogen facility with a 10 MW electrolyzer in the Brainergy Park Jülich, which is scheduled to begin operation in November. The electrolyzer technology is being supplied by the NEA Group from Übach-Palenberg, while Messer SE will handle the storage and distribution of the hydrogen produced from photovoltaic electricity.

Currently, REVG estimates hydrogen prices at between €14 and €18 per kilogram, in line with market rates. In the future, if large-scale electrolyzers with 25 MW capacity, such as those planned in the Belka project, can be used, prices in Frechen are expected to drop to €9 to €10 per kilogram, plus distribution and delivery costs.

In-house construction or turnkey solution Hürth is entirely different. Both are pioneers in hydrogen mobility in public transport. However, they pursue two different approaches. The two new hydrogen refueling stations in Mechernich and Bergisch Gladbach are being built and operated by the transport company itself at its own depots. They will be equipped with 2 MW electrolyzers to use electricity from wind and PV systems for in-house hydrogen production. The situation is different in Meckenheim and Hürth, where significantly more vehicles will need to be supplied than in Bergisch Gladbach and Mechernich. In these cases, land was sold by the two cities to RVK and Stadtwerke Hürth with the condition that other users must also have access to the hydrogen refueling stations – from municipal service providers and logistics companies to bus operators and private individuals with passenger cars. Following a tender process, Air Products was awarded the lease for the respective sites and is responsible for the entire process – from obtaining permits to construction, future operation, and hydrogen supply for the publicly accessible refueling stations. In other words, it is a turnkey solution for RVK and Stadtwerke Hürth. The design of the two new stations in Meckenheim and Hürth differs fundamentally from RVK's previous depot-based refueling model. Hydrogen is supplied by Air Products from its own sources using new 640-bar trailers. This supply solution eliminates the need to compress the hydrogen to 350 bar, as – simply put – the hydrogen flows directly from the trailer to the dispenser via pressure equalization. ○



At one of the three dispensers in Düsseldorf, 500-bar hydrogen can also be refueled.

© Claus Bünnagel



QUALITY SINCE 1912

MAGNET-SCHULTZ

Your Specialists for electromagnetic Solutions



Valves for Hydrogen

- High pressure valves up to 1050bar, NW 2,7mm
- Safety-Shut-Off-Valves up to 21bar, NW 8mm, pilot operated
- Flow Control Valves up to 25bar, NW 2,8mm
- Protection class up to IP6K9K
- Ambient temperature: -40°C up to + 125°C
- Low leakage values
- Various electrical connections and versions according to ATEX / IECEx on request



www.magnet-schultz.com

Hydrogen from wood residues

By Helge Kutzner

How can hydrogen be produced economically together with basic chemicals? This question, along with the technological possibilities up to implementation, was investigated by the project “AblaPyro”, funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK) – with promising results.

Regionally available biogenic resources such as wood residues and other woody biomass are often used inefficiently as fuel. Yet there are more efficient utilization pathways. The “AblaPyro” project demonstrates how these materials can contribute to the production of hydrogen and climate-neutral CO₂ through the scaling and targeted arrangement of already known and existing process steps. To this end, the construction of a demonstration plant was prepared.

This technology for producing “green molecules” is based on thermochemical gasification in a high-temperature fixed-bed gasifier. In this process, woody biomass is converted into a hydrogen-rich synthesis gas by adding steam at temperatures above 1,000 °C. The synthesis gas is then cleaned and cooled. In a water-gas shift process, the hydrogen content is further increased by converting the carbon monoxide contained in the gas. In the subsequent steps, the CO₂ content of the gas is separated and the hydrogen is purified.

H₂ for fuel cells, CO₂ for the food industry

When designing the process chain for the demonstration project, all process steps required for the operation of the plant as well as the entire necessary peripheral infrastructure were taken into account.

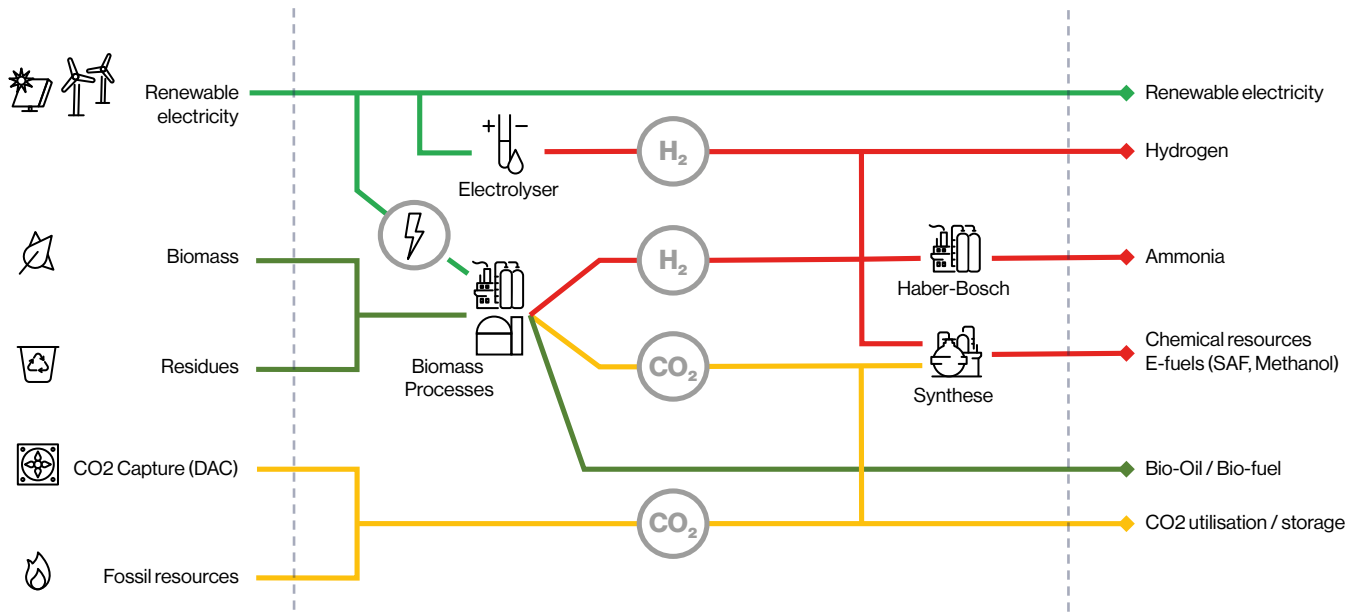
The process includes the following steps:

- Delivery of the various biomass fractions
- Gasification and processing of the resulting products
- Filling of the two resulting products:
 1. Liquefied CO₂ in a quality suitable for the food industry.
 2. Compressed gaseous hydrogen with a purity suitable for use in fuel cells.

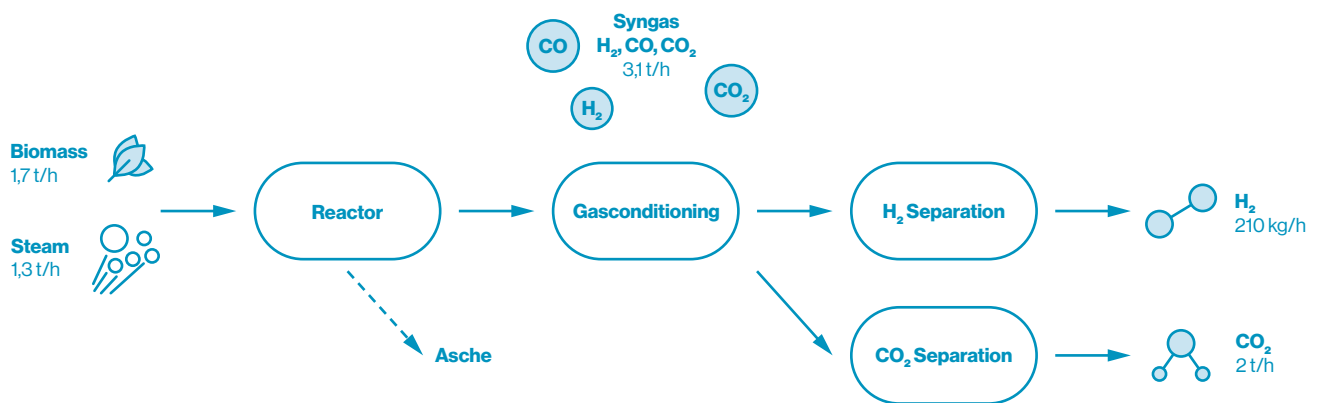
This process chain was classified as innovative and novel by the German Patent and Trademark Office and forms the basis for the granted process patent (DE102024101643B3). In parallel, TÜV SÜD Industrie Service GmbH validated the technical plausibility of the process. The project was planned in Lüneburg, which is part of the Hamburg metropolitan region and has a well-developed infrastructure. For the transformation of fossil energy carriers to produce climate-neutral base or fuels, both hydrogen and CO₂ are required. In particular, the chemical industry, the aviation sector, and international shipping face the challenge of defossilizing their required fuels while remaining competitive.

Baseload-capable plant produces hydrogen for €8/kg The principle of economy of scale was supplemented at an early stage by the influencing factors of biomass availability and the ability to market the produced products at competitive prices. As part of the research project, a production plant was designed to produce 1,600 t/a of biogenic hydrogen and 15,000 t/a of biogenic CO₂ from 22,500 t/a of biomass. The plant enables the production of hydrogen at competitive production costs of around eight euros per kilogram and is also baseload-capable. Unlike electrolysis, it does not depend on wind or solar power.

For the economic operation of the plant, trading in greenhouse gas (GHG) certificates (GHG quota) is also important. The biogenic hydrogen produced has negative emissions in the GHG quota system, resulting in additional revenues of three to seven euros per kilogram of hydrogen. Under certain conditions, hydrogen-powered trucks can already be operated today without additional costs using the hydrogen produced. The investment costs for a first-mover demonstration plant amount to just under 55 million euros. Given a calculated profit margin in the clearly double-digit range, the project is attractive to investors. ➤



Material utilization pathways © Bionon



Systematic setup © Bionon

Technology

Für den wirtschaftlichen Betrieb der Anlage ist auch der Handel mit Treibhausgas-Zertifikaten (THG-Quote) wichtig. Der produzierte biogene Wasserstoff verfügt über negativ anzurechnende Emissionen im THG-Quotenhandel, so dass Zusatzerlöse von drei bis sieben Euro pro Kilogramm Wasserstoff entstehen. Unter bestimmten Voraussetzungen können somit bereits heute wasserstoffbetriebene Lkw ohne Zusatzkosten mit dem produzierten Wasserstoff betrieben werden. Die Investitionskosten für eine First-Mover-Demonstrationsanlage belaufen sich auf knapp 55 Millionen Euro. Angesichts einer errechneten Profit-Marge im deutlich zweistelligen Bereich ist das Projekt für Investoren interessant.

The economic results were analyzed and validated as part of a comprehensive due diligence review by EY-Parthenon GmbH Wirtschaftsprüfungsgesellschaft. In addition to the business results for the demonstration project, project partner IfaS (Institute for Applied Material Flow Management at Trier University) also examined the impact of the project on regional value creation. The use of regional biomass, local infrastructure and supply chains in plant operation, as well as the regional use of the hydrogen produced, lead to high regional value creation.

The potential of biomass The social acceptance of the project was analyzed by the Competence Center for Renewable Energies (CC4E) at HAW and publicly discussed in panel discussions. The biomass used, as well as the electricity used to operate electrolyzers, is subject to the strict requirements of the Renewable Energy Directive RED III. This prevents the use of biomass from competing with food production, biodiversity, and sustainability goals. In addition, no additional sources of greenhouse gas emissions may arise from cultivation and harvesting.

Sewage sludge, waste wood, and non-recyclable plastics have passed initial test runs for synthesis gas production and offer a broad, economically attractive field of application for the technology. Another aspect that is still far too often overlooked is the production of climate-neutral, biogenic carbon in the form of CO₂. The use of climate-neutral methanol as a basis for fuels in aviation and shipping, as well as for basic chemicals, is becoming increasingly important for climate protection.

Operators of pilot and demonstration plants for the production of hydrogen derivatives are already asking how the required non-fossil carbon for operating their plants can be provided. The sustainable utilization of the biomass used in our demonstration project also includes the industrial use of the carbon it contains.

From feasibility study to implementation To implement the results developed in the project, a consortium of several companies has been formed: Bionon UG, A.H.T. Syngas N.V., and Bioenergy Concept GmbH. The goal of the consortium is to build and operate a demonstration plant. This is scheduled to go into operation in 2027/2028 and provide the necessary impetus for the hydrogen ramp-up in Lüneburg, enabling the region to develop into a hydrogen economy region. The further implementation of the project could become a win-win project for the region, the regional economy, and the participating companies and investors.

Biogenic hydrogen Hydrogen produced from biogenic feedstocks is referred to as “biogenic hydrogen”. From a regulatory perspective, it is classified as an “advanced fuel”.

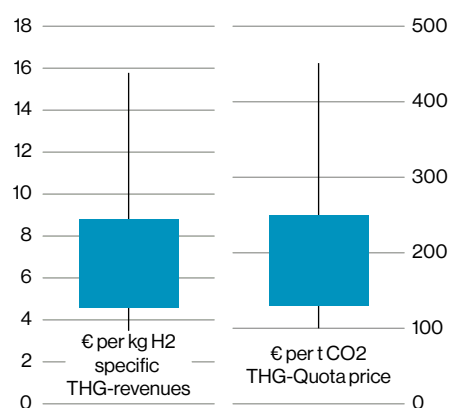
Possible production methods include biogas or biomethane production, pyrolysis, or biomass gasification.

The biomass to be used is clearly and strictly defined in RED III and in the 38th Federal Immission Control Ordinance (38. BImSchV). This means that cultivated biomass, such as maize, cannot be used. Land use changes due to biomass harvesting are also prevented.

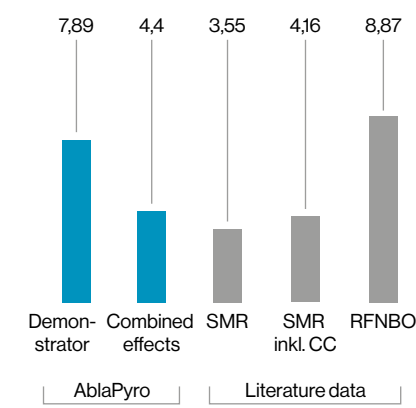
However, residues from forestry and forest-based industries can be used to produce biogenic hydrogen. These include green waste from landscape maintenance, sawdust, and damaged wood. Manure, slurry, nutshells, bagasse (cellulose-rich residues from sugarcane processing), and sewage sludge can also be used.

By capturing and industrially utilizing the contained CO₂ (CCU), for example in the production of marine and aviation fuels, biogenic hydrogen can achieve negative greenhouse gas emissions. Due to the increasing demand for climate-neutral fuels for the maritime sector and aviation, as well as for basic chemicals for industry, biogenic CO₂ will become increasingly important. In addition to direct air capture

CALCULATION EXAMPLE FOR THE GHG QUOTA
Hydrogen production costs €10/kg*
Transport to and operation of a hydrogen filling station: €4/kg*
Revenue from solid GHG quota (at €250/tCO₂): €8/kg
Sales price at the filling station: €6/kg
H2 truck fuel cost per 100 km: €54/100 km
(approx. €50/100 km for diesel – as of 2025)
*incl. profit margin



GHG quota revenues © Bionon



Hydrogen production costs [€/kg] © Bionon

10.6 percent of the energy content of fuels placed on the market must be climate-neutral. Those who do not meet this minimum quota must purchase CO₂ certificates through certificate trading. Those who sell more climate-neutral fuels and exceed the minimum quota can sell the excess share in the form of certificates. To meet the quota, the various production methods (e.g. RFNBO, biogenic hydrogen, and biodiesel) are weighted differently. The GHG savings of RFNBO are credited threefold, those of biogenic hydrogen twofold.

By capturing and industrially utilizing the biogenic CO₂, negative emissions can be achieved in the production of biogenic hydrogen, resulting in higher GHG savings than with RFNBO. This compensates for the disadvantage of biogenic hydrogen in multiple crediting. In the past, fraud cases led to a collapse in GHG certificate prices. As a result, hydrogen projects became uneconomical, or consumer prices rose to uneconomical levels. In the legislative process for implementing RED III, the loopholes that enabled fraud are now to be closed. To achieve this goal even more effectively, the "Initiative to Stop Climate Fraud" has published a position paper. (<https://carbonleaks.de/pressemitteilung-red-iii>)

In addition, the GHG legislation process should ensure that all climate-neutral options for activating the hydrogen market are fairly considered based on their emissions:

- Multiple crediting of biogenic hydrogen must continue.
- Biogenic hydrogen should be creditable not only for road vehicles but for the entire transport sector.
- A permanently effective GHG quota of €200 to €250 per ton of CO₂ equivalent is essential to provide the planning security needed for climate protection investments.

It is therefore all the more important that RED III and the laws to stabilize the GHG quota are passed quickly and come into force on January 1, 2026. ○



Helge Kutzner

Process engineer and managing director of Bionon

(DAC), it offers an additional path to climate neutrality.

Biogenic raw material sources are often not fully utilized today (heat and/or power generation without CO₂ utilization). These sources should be fully exploited through material conversion into "green molecules". Since biogenic hydrogen is produced independently of wind and solar power, it is baseload-capable and available at all times. The established regional infrastructure and supply chains for biomass also strengthen regional value creation.

Utilize instead of neglect! Biogenic hydrogen, biomethane, and biogenic CO₂ must finally receive the political and societal recognition in the energy transition that they deserve. Biomass alone is not sufficient to achieve climate neutrality. However, an energy transition that ignores biogenic processes and products will not be successful.

Strengthen biogenic hydrogen! Biogenic hydrogen is not to be equated with conventional biofuels. Its production processes are significantly more complex. In addition, the production plants are not yet widely established. Unlike conventional biofuels, the use of biogenic hydrogen does not result in local GHG emissions. The carbon contained in the biomass is captured during the production process and displaces fossil CO₂ in industrial processes.

To activate the market for hydrogen and green gases derived from biogenic residues, the following aspects should be considered in the legislative process for implementing RED III:

- Biogenic hydrogen must continue to receive multiple crediting in the GHG quota system.
- The minimum share of biogenic hydrogen (advanced fuel) that must be placed on the market must be increased.
- The scope of application of biogenic hydrogen in the GHG quota system must be extended to all vehicles, not just road vehicles, but also rail and waterborne vehicles
- GHG quotas must be extended at least until 2045.
- Differentiation between biogenic hydrogen and biofuels in their use as marine and aviation fuels, in compliance options, and in the crediting of GHG emissions

To make biogenic hydrogen (and biomethane) competitive with fossil feedstocks, they should receive multiple crediting of GHG savings in industrial material use under the ETS-2 Directive or the Fuel Emissions Trading Act (BEHG).

GHG quota trading: key market instrument for the hydrogen ramp-up

GHG quota trading: key market instrument for the hydrogen ramp-up GHG quota trading enables the economic operation of hydrogen projects without the need to keep production costs low through government investment subsidies. Quota trading leads to additional revenues from the sale of climate-neutral hydrogen and thus lowers sales prices, even with higher production costs. This increases consumer acceptance. This year,

Platinum recycling will not become a self-sustaining business

By Leo Diehl, Johannes Moll

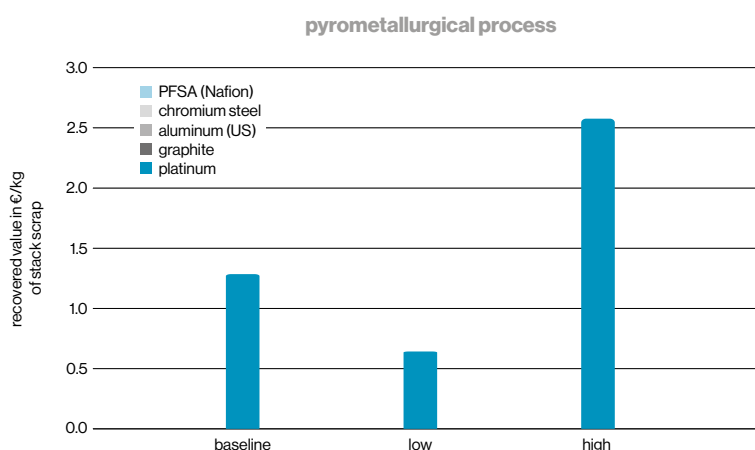
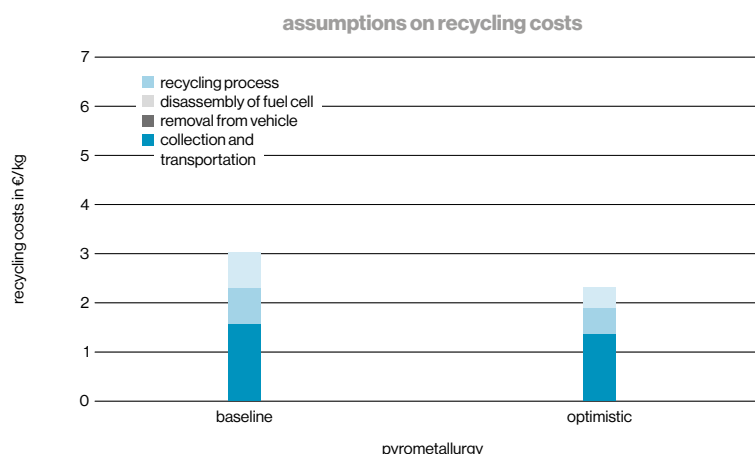
Raw material recycling is a crucial step towards sustainable economic activity. However, it depends on many framework conditions. One of them: How valuable is the platinum that can be recovered from a fuel cell?

Whenever we talk about critical resources, we also talk about recycling. The current global political situation has reminded us that recycling is not only sensible from an ecological perspective, but can also make a significant contribution to building more resilient supply chains. Supported by analyses from Ludwig-Bölkow-Systemtechnik GmbH (LBST, a consulting firm specializing in energy, hydrogen, mobility, and

sustainability), the Hydrogen Council, together with the World Bank, already provided an overview in 2022 of which critical materials are used in the hydrogen economy.

The focus was on the absolute scarcity of raw materials. However, this global perspective overlooks the challenges that Europe in particular faces if globalization continues to recede.





One thing is clear: only a Europe that has at least largely achieved a steady-state circular society will be capable of operating sustainably. Recycling is the decisive step in this.

Automotive industry: EU increases pressure, manufacturers resist European policy has been working for years on many levels to strengthen the circular economy. This includes not only recycling, but also minimum quotas and clear responsibilities for those placing products on the market, for example in the WEEE Directive for electrical and electronic equipment, the Battery Directive, and the End-of-Life Vehicles Directive. In practice, however, the rules have often been circumvented, including through illegal disposal and export. The entire European automotive industry has also failed to meet its responsibilities. In April of this year, the European Commission imposed antitrust fines of nearly €460 million because the automotive industry had, over a

period of almost ten years up to 2017, evaded its responsibility to ensure proper recycling of its vehicles. Particularly noteworthy is the justification used within the industry. It was broadly assumed that recycling was inherently profitable for scrap processors and that market-based interests would therefore “automatically” lead to sufficient recycling. As a result, the automotive sector saw no need to engage further with the issue.

Catalytic converter is the prime asset in vehicle recycling There is no doubt that entrepreneurs have been able to make money in the past by recycling vehicles with internal combustion engines. A key source of revenue has been, and continues to be, the potential material value—especially that of exhaust gas catalytic converters with their relatively high platinum and rhodium content. The advantage in recovering these precious metals lies in the use of the simplest recycling method: complete combustion followed by leaching, known as pyrometallurgical processing. This results in recycling costs of only €2.30 to €3.00 per kilogram of scrap. The main cost driver here is not the process itself, but the collection and transport of the scrap to the recycling facility.

However, things become more difficult with other components. For example, steels and copper streams become increasingly contaminated with frequent recycling and thus gradually lose value. They can then no longer be used in exactly the same applications.

To prevent such downcycling due to cross-contamination—or other causes—a recycling process must go through relatively complex technical steps. The best method for this is hydrometallurgical, i.e. leaching. The associated costs are higher, at around €4 to €5 per kilogram of scrap. In particular, the additional manual processing and the use of expensive leaching chemicals drive up the costs. In return, a wider variety of materials, including non-metallic ones, can be recovered.

Fuel cells: platinum content is key If vehicle catalytic converters are attractive to recyclers, does that mean fuel cell stacks from vehicles can also be recycled economically in the future?

To approach this question, the LBST team first estimated under which price scenarios and platinum loadings cost-covering recycling would be possible. In the base scenario, a stack was assumed with around 0.26 g/kW, roughly corresponding to the platinum loading of a first-generation Toyota Mirai.

The underlying recycling rates, i.e. technical efficiency, are particularly high for platinum. Regardless of the recycling method used, they are approximately 95–100%. However, this does not apply to components made of graphite, which can only be recovered using ▶

ABOVE: Estimate of recycling costs (based on published values for batteries) and recoverable value depending on different platinum price scenarios per kg of stack scrap.

© LBST

LEFT: Spent catalytic converter materials. High platinum prices and significant amounts of the metal in the converter make recycling comparatively attractive today.

© Sergey – stock.adobe.com

the hydrometallurgical method. Figure c shows that when using the pyrometallurgical process selected here as an example, the potentially recoverable value of a fuel cell stack lies almost entirely in the platinum used.

Raw material prices also influence the value of the recycled material—and these fluctuate. The development of raw material prices is broken down into three different price scenarios. The base scenario “Base” corresponds to today’s prices, around €32 per gram or €1,000 per ounce of platinum. “High” corresponds to historically high prices of €64 per gram, which is rather unlikely. “Low” corresponds to historically low prices of around €16 per gram of platinum. Assuming that internal combustion engines will increasingly be replaced by electric drives, this scenario is quite likely, as the peak in demand would then be surpassed. Depending on the platinum price, a value of between approximately €0.50 and €2.50 could be recovered per kilogram of dismantled stack scrap.

Stack recycling likely not economically viable

However, the amount of platinum is not a constant. For manufacturers, the use of platinum in a fuel cell is initially a cost factor. It is therefore generally accepted that a fully optimized fuel cell will contain less platinum in the future. If one considers such an optimized fuel cell, as described for example by the US Department of Energy in 2020, it contains only 0.125 g of platinum per kW. This reveals that the costs of recycling could far exceed the recoverable values in the future (Figure c). This is already the case if the platinum price remains unchanged (base scenario). If it is assumed that the price will continue to fall in the long term, then economically viable recycling based solely on the value of platinum is not possible.

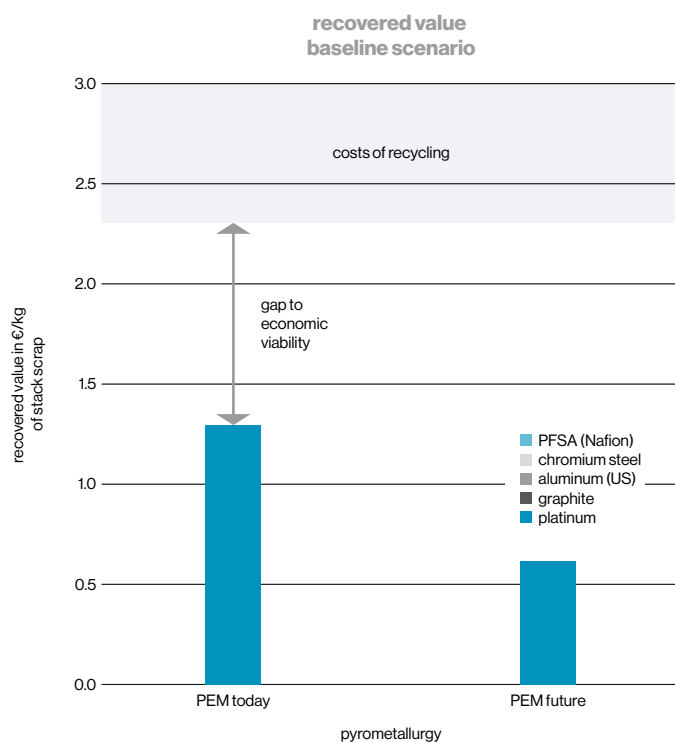
Before drawing conclusions, further factors affecting economic viability must be considered. The use of hydrometallurgical methods can enable the recovery of additional value. For example, several projects in Europe are actively working on the recovery of ionomers, and the Horizon funding program includes a dedicated topic area for this.

In addition, steel and copper components of a fuel cell vehicle can still be recycled as a whole. This reduces the costs, which in the example given are fully attributed to the recycled stack. Nevertheless, the costs of recycling a fuel cell vehicle will in all likelihood exceed the recoverable values.

Less is not always better Where there is no individual economic incentive to bear the costs of collecting and transporting fuel cell stacks, the regulatory framework can only partially compensate. Thus, the statement made by our es-

teemed former colleague, the energy specialist Werner Zittel in 2012 remains valid. In a progress report for the Austrian Climate and Energy Fund, he warned that the recycling of metals is “increasingly problematic [because] their more efficient use also reduces the metal content in the discarded products.” If the quantities become even smaller and eventually only traces of the element remain, technological limits are also reached. As a result, the likelihood of platinum dissipation increases: it disappears from the raw material cycle and ultimately ends up in landfills or simply in our environment.

What is the solution? A circular and therefore resilient European economy must question fundamental principles of action and truly design product development with the end in mind. The additional parameter “economic viability of recycling” could change overall optimization, especially since ever-lower platinum content also comes at the expense of performance and service life. Industrial-scale catalytic converters could serve as inspiration for a circular model. These are already offered today in a kind of leasing model. In such cases, manufacturers have a strong interest in recovering their platinum. ○



Potentially recoverable value based on a fuel cell with optimized platinum loading compared to the recycling costs to be expected.

© LBST

Can this approach be transferred to fuel cell stacks?
What other ideas are there?
Join the discussion: [linkedin.com/company/hzwei-magazin](https://www.linkedin.com/company/hzwei-magazin)



Dr. Leo Diehl
Project Manager,
Ludwig-Bölkow-System-
technik (LBST)
leo.diehl@lbst.de

Johannes Moll
Master's student, LBST

Hydrogen in the nano-network

By Neel Sirosh

Can reticular materials serve as hydrogen storage systems in the future? After years of research into this question, a start-up in California is now testing the use of such innovative solid-state storage systems in drones and e-bikes. If upscaling is successful, these storage systems could be used across the entire mobility sector.

Reticular materials are crystalline structures made of metal ions connected by organic molecules. They form a porous network with an extremely large surface area. Hydrogen gas can be stored within this network at high density through adsorption. When such materials come into contact with hydrogen at moderate pressure, they trap hydrogen molecules in their microscopically small pores.

This adsorption process typically takes place at around 30 bar and at temperatures close to room temperature. To release the hydrogen stored in this way, it is sufficient to reduce the pressure or slightly increase the temperature. This allows for precise control of the hydrogen supply, for example in a fuel cell, with minimal energy input.

TOP: Animated representation of a reticular material storing hydrogen (turquoise).

© H2MOF

Innovative hydrogen storage system Based on reticular materials, our start-up H2MOF has developed a novel solid-state hydrogen storage architecture. The company, based in Irvine, California, was founded in 2021 by Sir Fraser Stoddart, the Nobel Prize winner who passed away in 2024, and Omar Yaghi, professor of chemistry at the University of Berkeley and founder of reticular chemistry. In 2025, he received the Nobel Prize in Chemistry for his research. H2MOF's innovation is based on a new class of reticular materials. These over-

come the limitations of conventional hydrogen storage methods and thus enable the transition from pilot trials to real-world, scalable applications.

Drones and e-bikes for field testing In the near future, we are focusing on drones and light mobility. However, this is only the beginning. If successful, a wide range of potential applications opens up: compact low-pressure and high-performance storage systems on the ground, large-scale gas transport, and use in the mobility sector, such as in heavy-duty road transport, rail, aviation, and maritime applications.

With a gravimetric capacity of over 5.5 weight percent and a volumetric density of over 40 g/l, these materials outperform many conventional ➤



high-pressure systems. They offer up to 30 percent improved weight efficiency and nearly twice the power density. As a result, drones, e-bikes, or e-scooters can carry more hydrogen in smaller, lighter tanks, increasing their range and payload capacity without compromising performance.

In addition to storage efficiency, systems that store hydrogen in solid form offer key advantages in terms of safety, thermal integration, and operational reliability. Moreover, there are no boil-off losses, making them ideal for vehicles that remain idle for extended periods.

The reticular materials are developed on the nanoscale. The selection of chemical building blocks – typically metal ions connected by organic molecules – is made in such a way that they form a highly porous framework compound with precisely defined geometry. The basic principle is: the more cavities, the more opportunities to “park” hydrogen molecules inside.

Artificial intelligence accelerates processes However, the pores must not only be sufficiently large, but also accessible and evenly distributed – even the smallest changes on the nanoscale can drastically affect storage capacity. In addition, the material must be designed to attract hydrogen selectively without binding it too strongly, so that it can be absorbed and released reversibly.

Artificial intelligence (AI) and machine learning (ML) play a central role in this development process. Unlike in the past, not every arrangement of the individual components of the reticular material has to be synthesized and tested for its properties. Instead, AI software specifically programmed for this purpose analyzes large datasets and preselects structures with high potential. What used to take years of trial and error can now be reduced to just a few weeks.

The batteries commonly used in drones, e-bikes, or e-scooters to date are generally heavy, slow to charge, and have limited range. Hydrogen, if stored

The founders of H2MOF:

Sir Fraser Stoddart (center), Omar Yaghi (right), Samer Taha (left).

© H2MOF





Hydrogen tank with
reticular materials.

© H2MOF

efficiently, can provide a solution. In drones, H2MOF's hydrogen storage system enables an almost tenfold increase in range and, depending on the application, in flight time. Payload capacity also improves significantly.

Hydrogen-powered e-bikes or scooters with solid-state storage can be refueled in just a few minutes and enable a new class of ultra-light bicycles with long range. These are suitable, for example, for urban delivery services, commuters, or use in corporate fleets.

The development of our reticular materials is already at an advanced stage. We are currently designing and validating the first prototypes. After corresponding in-house tests, we are ready to test our technology in the field. To this end, we are working with industry partners in the drone and e-bike sectors. We plan to conduct the first field trials with drones later this year.

In my view, storing hydrogen in reticular materials represents a groundbreaking improvement for fuel cell technology as well, because it enables compact, safe, and efficient hydrogen storage at low pressure and ambient temperatures.

Hydrogen storage still challenging In the past, the promise of hydrogen as an emission-free energy carrier was lim-

ited by the complexity and inefficiency of its storage. High-pressure tanks, cryogenic systems, and metal hydrides each present different challenges in terms of weight, safety, cost, legal, and infrastructure requirements. These are among the reasons that have so far hindered the widespread use of hydrogen, especially in applications requiring mobility, modularity, and rapid deployment.

By overcoming these fundamental obstacles, H2MOF's technology, in my opinion, opens the door to the broad integration of hydrogen in areas that were previously considered impractical. It makes the mobile, decentralized use of hydrogen economically attractive.

While initial applications of hydrogen-powered drones and light mobility offer immediate and tangible benefits, the true significance of this breakthrough lies in its potential to reshape the way hydrogen is stored, transported, and used across the entire energy landscape. ○



Dr. Neel Sirosh
CTO at H2MOF

TESTING, MANUFACTURING, AND PRODUCTION SYSTEMS FOR FUEL CELLS AND ELECTROLYZERS

HORIBA



Meet our experts at Hydrogen Technology Expo Europe 2025
October 21 – 23, 2025 | Hall B7, Booth 7A90 | Hamburg Messe



The gap filler

By Eva Augsten

In June, the French company Vallourec received certification for its Delphy storage system. It targets the technological gap between small pressure vessels and large cavern storage facilities and is primarily intended for industrial customers.



“It is a new solution for a new market,” says Vincent Designolle, who is responsible for hydrogen at Vallourec. The underlying challenge, however, is as old as the world itself: the sun only shines during the day, and the wind blows with varying intensity. Anyone who wants to

produce and use green hydrogen must adapt to these fluctuations. However, steel and chemical plants cannot simply be ramped up or down according to the weather. “The offtaker wants stability in supply,” says Designolle. To use a fluctuating supply for constant production, storage

Inauguration of the demonstrator facility at Vallourec in Aulnoye-Aymeries.

© Vallourec

is needed—and in the case of industrial operations, these must be quite large. With up to 100 tonnes of hydrogen storage capacity, Delphy falls into this category. For comparison: the new large trailer from Linde holds 3.9 tonnes of hydrogen, the Harsefeld cavern storage facility in northern Germany is planned to hold 7,500 tonnes, and the daily demand of steel and ammonia plants is in the range of several hundred tonnes. With a 100-tonne storage system, a smaller plant or one in an early expansion stage can easily get through the night. Another customer group includes large refuelling stations or operators of backup solutions, for example for hospitals or data centres. Here, the requirement is a few tonnes per day.

Storage provides flexibility Beyond the absolute necessity, storage systems also enable flexibility to respond to different situations in the electricity market and the grid. This can make a real difference, as in many countries flexibility means a price advantage when purchasing electricity. In Germany, many companies rely on being able to buy electricity more cheaply on the power exchange during low-load periods. In France, the grid operator pays a bonus if large customers can reduce their consumption at specific times. And Saudi Arabia has drastic differences between electricity tariffs during peak and off-peak periods. In summary, this always means: those who can act flexibly reduce their electricity costs – and thus the strongest cost driver in hydrogen production via electrolysis.

So far, when industrial companies respond to this situation, battery storage systems have mainly been the technology of choice. These buffer expensive peak loads and shift consumption to times when electricity is cheaper. Vallourec's new Delphy storage system must therefore also be compared with these. The manufacturer has looked at various use cases. In short timeframes, for example with 15-minute optimisation, the battery has the advantage. But the longer the period to be bridged, the more the cost calculation shifts in favour of the Delphy storage system. When it comes to bridging the nightly generation gap in solar power within a hydrogen value chain, the manufacturer claims it is clearly ahead.

However, if the hydrogen is converted back into electricity, the calculation shifts in favour of the battery. In addition, for the sake of simplicity, the comparison refers to the CAPEX of the storage systems. System costs may differ. In many applications, the battery would be credited with enabling more continuous operation of the electrolyser, allowing it to be smaller. In favour of the Delphy storage system, it should be noted that even with battery storage, a hydrogen storage system is often planned in addition to bridge possible outages.

Being safe while saving space The storage design takes into account two typical conditions at industrial sites: limited space and strict safety regulations. With regard to the subsoil, the technology is quite flexible, as the solution is modular and adapted to the respective conditions.

“There are very few show stoppers in terms of soil. It is mostly about finding the best combination of depth and the number of tubes,” says Designolle. The modular design and adjustable length of the cylinders make the storage system highly scalable. Typically, 10 tonnes of hydrogen can be stored in 80 cylinders. There is no hard limit, but if the number of cylinders is too high, the piping eventually becomes too complex.

As far as civil engineering is concerned, Vallourec relies on diaphragm wall drilling in combination with earth excavation—a proven and space-saving method also used to build ventilation shafts for underground railways in city centres. A concrete ring supports the outer edge of the pit, while excavation can continue deeper inside. Of course, digging deeper means higher costs. However, Vallourec points out that a conventional pressure vessel also requires a foundation, and with the Delphy concept, increasing size reduces the specific costs. All in all, the CAPEX per storage capacity for Delphy is similar to that of above-ground pressure vessels, says Designolle. However, the underground storage system scores points with its lower space requirement and safety. The vertical underground design means that even in the event of a leak, the escaping hydrogen cloud would be significantly smaller. Safety distances can therefore be reduced, which also saves space at ground level.

The pilot project has been in operation since November 2023, the tests have been completed, and DNV certification was finalised in June 2025. Commercialisation can now begin. Memorandums of Understanding (MoUs) have already been signed: with H2V for projects for the production and use of green hydrogen, and with NextChem Tech for applications in the field of green hydrogen and green ammonia. Discussions are ongoing with other companies, says Designolle. Twelve to eighteen months after the first order is received, the first commercial underground tube storage facility could go into operation, estimates Designolle. The main reason for the long lead time is the delivery times for components, especially the pressure vessels, measurement technology, and automation. The actual civil engineering could be completed more quickly, it is said. In theory, if an order were placed today, an underground tube storage facility could be operational by the end of 2026. Vallourec, however, does not want to commit to this date. “We have a pipeline of opportunities,” is all that is said so far. ○



Up the chain you see the big picture

Interview: Eva Augsten

Stoba develops processes and machinery that enable suppliers to serve industrial companies. CSO Philippe Schwenger spoke with H2international about his long-term perspective on the hydrogen market.



H2international: Stoba is currently working on positioning itself in the hydrogen sector. Until now, the company has mainly been known as part of the automotive supply chain. Are you now aiming to become a supplier for fuel cell technology – of all things, in these challenging times?

Philippe Schwenger: That's not quite accurate. The automotive market is indeed one of the largest markets worldwide and our "home market." But our technology portfolio is not limited to automotive. In recent years, we have also worked on sophisticated tech consumer products and components for the semiconductor industry.

Our expertise lies in process development and the industrialization of high-precision components and assemblies, as well as in mechanical engineering. Our most important product is therefore, first, the development of innovative manufacturing processes that do not yet exist – and second, the industrialization of precision components at one of our global sites. We are a so-called Tier 2 supplier. This means that in the hydrogen sector, our customers could include fuel cell manufacturers for automotive applications, but also electrolyzer manufacturers.

So which customers are you primarily targeting?

To answer that, I need to take a step back. We have to think far ahead in this regard, which is why we conducted our own market research – specifically on hydrogen and the question of what future drive technologies will be used in passenger cars and trucks.

In the passenger car segment, it became clear that this market is likely to continue growing due to increasing global demand – but the types of drives will become more diverse. The share of diesel in the passenger car market has declined significantly, the share of gasoline is not expected to grow further, and everything related to electric drives will primarily take place in Asia. At the same time, it is becoming apparent that fuel cells will not achieve significant market growth in passenger cars. The technology is unlikely to become affordable in the long term.

“Fuel cells are unlikely to become affordable for passenger cars in the long term. The situation is somewhat different for trucks.”

The situation is somewhat different for trucks. According to experts, green hydrogen is expected to be used in industry first and only much later in the truck sector – but once that happens, it could become quite relevant. In the truck market, we are seeing that hydrogen combustion may gain more traction compared to fuel cells. I'm referring here to heavy-duty transport, not regional or urban transport, which is increasingly battery-electric. Another approach involves combined injection systems that operate with diesel and natural gas. Some of our customers are also working on combinations with hydrogen or alternative fuels. But even for hydrogen combustion engines, many questions remain open – for example, regarding the network or infrastructure.

If we also look at the end customers, i.e. the freight forwarders, and ask about their purchasing criteria, we usually get the same answer: in the end, it depends on regula-

tion, subsidies, and operating costs – the latter also including maintenance. Therefore, we may not see real development in hydrogen drives until 2030 to 2035, and then primarily in the heavy-duty segment described above. But as a Tier 2 company, we still have to develop the processes now so that we can start producing as soon as demand increases.

To finally answer the question: in the mobility sector, we are focusing on our existing customers and developing with them what the market requires. At the same time, we are approaching new customers with this mindset.

In the field of hydrogen production, we have been working for about three years in the stationary sector for various customers on components for electrolyzers. We are in various prototype phases and recently secured our first series production order. So far, the volumes are still modest. However, the forecasts are very positive.

What does such a process development look like, as you describe it?

That depends very much on the requirements of the components and systems themselves. There is no one-size-fits-all solution – otherwise, it would already be on the market. In general, the processes are developed using a simultaneous engineering approach, in which the project team works together with the customers through various prototype phases and design adjustments.

In the hydrogen market, the current focus is on meeting the high technical requirements while producing hydrogen at a lower cost per kilogram in order to generate demand.

That's why we have invested heavily in machinery and equipment with different technologies for various applications, to prepare ourselves for production in both mobile and stationary sectors. At the same time, we are present at topic-specific trade fairs to increase our visibility, stay up to date with market developments, and better understand the challenges faced by manufacturers.

When planning future machine and plant concepts, we always focus on efficiency from the very beginning. Because when scaling from small to large series, our customers generally expect significant cost effects, which depend primarily on the right combination of materials used and the highest precision. ►

FAR UP THE VALUE CHAIN

Cars Fuel Cells. Valves, pressure sensors, bipolar plates. Machines and processes for bipolar plates... To understand Stoba's role, one has to move quite far back along the value chain. If you imagine an industry like automotive production as a river, an original equipment manufacturer (OEM) like VW is located somewhere near the mouth, i.e. close to the end customer. Further up the stream – or rather, earlier in the process – are suppliers, categorized by tiers. At Tier 1, for example, Bosch supplies injection systems to the car manufacturer. For its components, the supplier uses parts and processes developed by a Tier 2 company like Stoba. Even earlier in the chain are steel manufacturers (Tier 3), and further back toward the source are the mines (Tier 4), where, for example, iron ore is extracted.



Machinery at Stoba

© Stoba

Does that mean manufacturers can largely delegate the development of production to you?

That varies. Large, well-known German companies invested in the development and production of their systems many years ago. They began ramping up with their own capacities and are now scaling step by step as needed with external partners. Other system providers start working with partners right from the beginning – this is especially common in the US.

Stoba – as a potential partner – can score not only with its technological expertise but also with its international locations. Compared to the large manufacturers, we also have a better cost structure.

Speaking of cost: China is excellent when it comes to low-cost, high-volume production. What does that look like for electrolyzers and fuel cells?

It's no longer about China copying European technology. In the field of electromobility, for example, they have impressively overtaken Europe through speed and standardization. We keep hearing that European companies have relocated their development departments to China in recent years.

“We keep hearing that European companies are relocating their development departments to China.”

In terms of electrolyzers, China is already producing higher volumes than Europe today, and hydrogen programs are strongly supported by government policy. Here too, we expect the same efficient scaling of their production in the coming years. This will create intense global competition – and as a component manufacturer in this market, we must prepare for that. I can't say anything about fuel cells in China, as that is not our focus.

What strengths does Europe still have to offer?

Europe can still rely on its engineering and inventive spirit – we remain strong and broadly positioned in this area. The industry is reorganizing itself, and I still perceive trust in major European technology companies – even in Asia – as very significant.

But: if we approach hydrogen the same way we did electromobility, it will be a very difficult endeavor. Everyone must now pull together to build hydrogen networks and de-

ploy technologies that make green hydrogen production economically viable and competitive, thereby turning it into a real alternative to conventional fossil energy. Only then can the energy transition succeed. But if the infrastructure doesn't materialize, if regulation in Europe is not harmonized, and if subsidies are not designed for the long term – then investment will be half-hearted. We need an EU-wide solution to permanently reduce energy costs for industry and thus become more competitive.

Accordingly, we hope that the topics in which Europe can play a significant global role – including hydrogen – will soon be supported and promoted again at the European level. Then, after the last hundred years with the internal combustion engine, they could become the next European success story. I hope that the European hydrogen strategy will not remain just a spark, but become a flame.

Until recently, the US seemed to be an important market for hydrogen technologies. How do you assess it now?

That's hard for us to assess. The current administration gives us little hope that the new technologies will be supported to the necessary extent. Nevertheless, we remain optimistic, expect merely a time lag, and are therefore focusing on Europe for hydrogen for now.

And how do you see things developing in Europe?

Generally speaking, the steadily growing energy demand cannot be met with the currently installed production capacities for green hydrogen. These are almost negligible when compared to global energy demand. As for further development, we at Stoba continue to closely monitor the forecasts for our relevant submarkets. Unfortunately, the volume scenarios up to 2030 have recently been significantly reduced.

“The European market is a huge opportunity if politics, research, and industry are serious about it.”

Nevertheless, this market is a huge opportunity for everyone – if European policymakers, researchers, and industry are serious about it. Then we still have a vast market ahead of us. If not, all parties will lose interest in the energy transition. At the Hydrogen Technology World Expo in Hamburg, we will receive live feedback from the market. ○

Needle valve with new connection

The micro valve type 7024 from Schubert & Salzer Control Systems is now also available with a socket-weld connection. This is intended to facilitate leak-free installation in high-pressure applications.

The needle valve itself has been available since 2024. It is designed for applications where very small flow rates (Kv values from 0.0027 to 1.7) and high pressures (nominal pressure PN320) need to be controlled or shut off.

The valve features a housing made of solid stainless steel and hardened valve spindles. The seat assembly, i.e. the sealing part between spindle and housing, is made of hardened stainless steel or hard metal, provides metallic sealing, and is replaceable. The high-pressure packing is designed to ensure tightness even after frequent switching - including for tiny molecules such as hydrogen.

Optional, but essential for unlocking the valve's full potential, is the integrable positioner type 8049. Various versions are available, including protected designs (Ex, FM) as well as interfaces via IO-Link or to the Industrial Internet of Things (IIoT).

Via IO-Link, the positioner transmits the information required for predictive maintenance through a single cable. If the positioner needs to be replaced, this can be done easily thanks to the top-mounted installation, according to the manufacturer.

The new positioner then configures itself via IO-Link using the data from its predecessor.

A dedicated module is available for IIoT connectivity. [○](#)

More information: controlsistemas.schubert-salzer.com



© Christian Bucher

DC-DC converters for high power

According to the company, the DC-DC converters BDC668 and BDC688 from Brusa are close to series production but are already available for purchase. In principle, the bidirectional devices can increase or decrease direct current voltage, enabling a wide range of applications. However, the designated application is clear: boosting the voltage from a fuel cell system to the 800 volts required by the drive system.

In the case of the non-galvanically isolated, compact BDC668, voltages from 0 to 520 volts are possible on the low-voltage side, and 450 to 850 volts on the output side. The continuous power output of the BDC668 is 250 kW (340 hp), targeting heavy-duty vehicles such as trucks. Brusa states an efficiency of 99 percent, which is attributed to the "Zero Voltage Switching Technology". The BDC668 is intended to enable more power in the drivetrain and faster charging in electric vehicles. For the galvanically isolated BDC688, Brusa specifies several power ratings: 320 kW (435 hp) for drive power, 50 kW for compressors or other auxiliary loads, and 5 kW for pumps and other small loads. The BDC688 features a direct busbar connection to the fuel cell. It is intended for commercial electric vehicles and fuel cell buses. Specifications for both DC-DC converters are still preliminary.

Recently launched into series production are the on-board charger OBC7 (for charging high-voltage batteries) and the DC-DC converter BSC7, which is primarily designed to adapt high voltages for small applications (14 or 28 volts, 3 to 4 kW).

The safety standards are each tailored to use in electric and fuel cell vehicles. [○](#)

More information: www.brusahypower.com



**BDC 668 from
Brusa Hypower**

© Brusa Hypower

Big power, heavy loads

By Eva Augsten

Political shifts on the one hand and rapid advances in battery technology on the other are making life difficult for fuel cell technology. Manufacturers are pinning their hopes on heavy-duty transport and, in some cases, on stationary applications.



Off-grid is a success: Fuel cells have proven themselves in off-grid applications, such as this landslide monitoring station. © SFC Energy



In December 2023, the world still seemed in order. Symbio, the fuel cell joint venture of Forvia, Michelin and Stellantis, inaugurated its gigafactory SomphonHy in Saint-Fons near Lyon. Up to 50,000 fuel cell systems are to be manufactured there as part of the IPCEI billion-euro project HyMotive.

In July 2025, Stellantis changed its mind, deciding that its light commercial vehicles should run on batteries instead. The newly appointed Symbio CEO Jean-Baptiste Lucas now has to salvage what can still be saved: the remaining 640 jobs, contractual commitments, investments. As for the product, Symbio no longer wants to focus on 40 kW systems, but instead aims directly for 75 kW. The modules are intended for buses and for stationary applications such as data centers. From 2028, the next generation is to follow, with 150 and 300 kW output for heavy-duty vehicles.

The shift toward heavier loads and stationary systems is not limited to Symbio. Batteries have won the race in passenger cars and are advancing into higher power classes. Combined with tight public budgets and topped off by the return of climate change deniers in politics and business, this results in a precarious situation for fuel cell companies. It is a heavy blow for all those who have invested money and effort to scale the technology.

Compact, powerful, efficient The industry is placing its hopes on niches not yet occupied by battery technology: heavy loads, high power, long distances, autonomous systems with high reliability. This is also where genuine innovations can still be found. Progress is being made in power density, vehicle integration, cost, and durability.

Take Symbio, for example. The new Stackpack 75 was already on display in February at the H2&FC Expo in Tokyo. With a volume of 268 L and a weight of 200 kg, it is relatively light and compact (0.38 kW/kg, 0.28 kW/L). For higher outputs, multiple stacks are to be combined modularly. According to the company, the stack is ready for series production in France.

Similar trends can be seen at industry leader Ballard from the USA. Its FCmove-XD system consists of one to three stacks, each with 120 kW, sharing a common DC output. According to Ballard, the new fuel cell is the smallest and lightest in its power class (0.36 kW/L, 0.48 kW/kg). The 240 kW version with its two modules is said to fit well into the engine compartment of a Class 8 truck – the heavyweight class of trucks in the USA, roughly equivalent to a 40-ton truck in Europe. The number of parts has been reduced by one third, production time by half. Peak efficiency exceeds 60 percent, and thanks to the new “hot standby” mode, faster acceleration is possible. The integrated power controller is designed to ➤



manage all system operations. In general, the system architecture around the fuel cell and battery is considered critical to the success of fuel cell vehicles, as it accounts for 70 to 80 percent of the drivetrain cost and 30 to 40 percent of the total vehicle cost.

There is also news in the heavy-duty sector from EKPO Fuel Cell Technologies, the joint venture of Elring Klinger and OPmobility, in the form of the NM20 stack platform based on metallic bipolar plates. It is not yet available for purchase; A-samples have been delivered and are currently being tested. The system is expected to deliver up to 400 kW of power and currents up to 900 A, enabling integration into 800-volt vehicle platforms as used in high-performance electric vehicles. Backup systems for data centers could also be potential applications. For the development and commercialization of the NM20, up to EUR 177 million in subsidies are available until 2027 from the German Federal Ministry for Digital and Transport and the Federal State of Baden-Württemberg. The EU gave the green light by including the project in the IPCEI program Hy2Tech. The operating temperature is 95 °C (maximum 105 °C), and EKPO states an efficiency of 57 percent at nominal power. The interface to the vehicle is the “media module,” which also largely integrates the measurement and control technology. Power density is said to have increased by more than 50 percent.

Automotive industry keeps its options open

Among the car manufacturers, Hyundai continues to promote hydrogen loudly. The South Koreans presented the latest version of the XCient Fuel Cell in Anaheim, which, according to the company, was the first fuel cell truck in “mass production” back in 2020. The 180 kW fuel cell system has two stacks and, together with a 72 kWh battery pack, powers the 350 kW electric motor. Hyundai announced few technical innovations but used PR opportunities: with the fuel cell bus “Universe” as a VIP shuttle for the mega-project Neom in the Saudi desert, at the

international ministerial conference Clean Energy Ministerial, and at the World Congress of Economists in Korea, where Hyundai presented the first complete redesign of its fuel cell passenger car Nexo in seven years.

The Daimler-Volvo joint venture Cellentric, on the other hand, is preparing for all scenarios. At the editorial deadline for this issue, in early September, Daimler had just celebrated the successful field test of the first five customers with the prototype of the Mercedes-Benz GenH2 Truck. By the end of 2026, 100 fuel cell trucks of the next development stage are to be delivered to customers. Like EKPO, Cellentric relies on a single stack. The system is expected to deliver up to 350 kW (over 500 hp) of continuous net power.

But will mass production really happen? In December 2024, Cellentric secured an option on a plot of land in Weilheim-Esslingen to ramp up production there – if the EU actually tightens its climate regulations, which could happen in 2030, “according to current estimates,” as it was stated. Until then, the company intends to proceed “in a measured way”. Managing Director Lars Johansson moved to the Volvo Group in April.

Germany’s largest fuel cell manufacturer to date, Bosch, has discontinued production of its stationary SOFC fuel cells, although research is to continue for the time being.

The company plans to expand its PEM stack technology – but primarily for electrolyzers. At the Hannover Messe in April, Bosch presented a 2.5 MW electrolyzer in container format, built by Fest, featuring its Hybrion stack. The output per stack is 1.25 MW, with a production capacity of up to 23 kg H2 per hour. Even before the sales launch, Bosch had received orders for over 100 MW worth of stacks, and the first customer systems are expected to go into operation later this year. The stacks are manufactured in Bamberg. Bosch can leverage its experience from fuel cell stack production. For example, the company has developed a clamping tool to simplify and speed up manufacturing.

LEFT: Symbio's stack production will focus on 75 kW system in the future.

© Symbio

RIGHT: EKPO's NM20 fuel cell module is designed to deliver up to 400 kW. A-samples are currently being tested.

© EKPO

The PEM fuel cell can still be found in the Fuel Cell Power Module for mobile applications and in the BMG Power Generator. For mobile use, there are two modules with fixed outputs of 300 and 190 kW, as well as the scalable "Twin-box." The BMG Power Generator is a container solution for power generation. At the Hydrogen Technology World Expo in Hamburg, Bosch Manufacturing is not focusing on its stacks, but rather on its water treatment systems. When searching for PEM fuel cells from Bosch, one mainly finds assembly solutions, coatings, and testing technology.

Quiet exits, unclear prospects Some companies are quietly withdrawing. Toyota now only communicates about hydrogen in connection with combustion engine technology in motorsports. The last time the fuel cell passenger car Mirai made headlines was when Toyota provided 500 vehicles for the 2024 Paralympics in Paris. According to industry analysts, global sales of the Mirai in that year amounted to just over 1,700 units.

Fuel Cell System Manufacturing (FCSM), a joint venture of Honda and General Motors, opened a production facility in Michigan in 2024 and has remained silent since. Honda itself had planned to open a fuel cell factory in Japan but shelved the plans in June, despite already approved subsidies. Hyzon Motors from Illinois has made a clear exit. The company began producing fuel cells for trucks in fall 2024, but in spring 2025, shareholders approved the company's liquidation. Proton Motor continues to operate on a small scale. The remaining employees are fulfilling existing orders, and occasionally new ones come in – the hope for an investor has not yet been abandoned.

Automotive is not everything Nuvera, a subsidiary of forklift manufacturer Hyster-Yale from Massachusetts, is shifting its focus to stationary applications. The parent company has now definitively opted for batteries in forklifts. For reach stackers and terminal tractors used in container terminals, however, this is not an option. These high-performance vehicles with their long arms and grippers operate around the clock. Fuel cells are currently used only in two pilot projects, in Hamburg and Valencia, but work on the 125 kW system is continuing for now.

Nuvera has identified a new niche for its day-to-day business: decentralized, mobile applications. The PEM fuel cell systems in small trailers under the name Hydrocharge have been available since the end of 2024. A container-based charging platform for off-grid applications is also to be optionally powered by hydrogen, under the name Hydrocharge.

Off-grid and maritime SFC Energy from Brunnthal near Munich, which has been manufactur-



ing fuel cell systems for 20 years, reports plenty of orders. In September 2024, the company opened its production facility in Cluj, Romania. Full capacity of 3,000 fuel cell systems per year was to be reached by the end of the year, and 30,000 per year by the end of 2028. Using purchased stacks, the company builds systems for independent power supply, depending on the model powered by hydrogen or methanol, including devices under the Efoy brand. Many orders come from long-standing customers. Some equip military units, others operate surveillance cameras on construction sites or at borders. Numerous orders come from the USA, where SFC also has a production facility. The systems are quiet, lightweight, and low-maintenance – and when crises arise elsewhere, at least the security business remains secure.

The Swedish start-up and Volvo spin-off Powercell doubled its revenues in the second quarter of 2025, reaching nearly SEK 130 million (just under EUR 12 million). Powercell is also a system integrator and focuses primarily on maritime and stationary applications, using both hydrogen and methanol.

Most recently, revenue came mainly from license fees from a deal with Bosch to bring fuel cells to the Chinese market. Bosch is also Powercell's stack supplier. Hitachi purchased the technology for its Hyflex platform, a hydrogen-powered shore power supply for ships. And an unnamed OEM from Italy wants to have a fuel cell system developed for maritime applications.

In short: the fuel cell industry must diversify – and is in the process of doing so. ○

Companies

Bipolar Plates



SITEC Industrietechnologie GmbH, prototypes, series production, production

systems for your bipolar plates, stack assemblies and balance of plant, info@sitec-technology.de, www.sitec-technology.com

Whitecell Eisenhuth GmbH & Co. KG,

Friedrich-Ebert-Str. 203, 37520 Osterode am Harz, Germany, Phone +49-5522-9067-14, Fax -44, www.eisenhuth.de

Coating

Holzapfel Metallveredelung GmbH,

Unterm Ruhestein 1, 35764 Sinn, Germany, Phone +49-2772-5008-0, Fax -55, www.holzapfel-group.com

Communication & Marketing



contact@hydrogen-moves.de
Phone +49-7195-90430400
www.hydrogen-universe.com

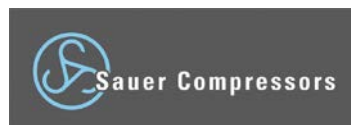
Push the Market! Hydrogen Universe: Knowledge | Network | Collaboration



mummert – creating relations,
Uta Mummert, German-French Communication Services – Media, Events, Marketing, 85 Chemin du

Vignal, 07230 Lablachère, France, Phone +33-652980552, info@mummert.fr, www.mummert.fr

Compressors



J.P. Sauer & Sohn Maschinenbau GmbH, Brauner Berg 15, 24159 Kiel, Germany, Phone +49-(0)431-3940-0,

sales@sauercompressors.de, www.sauercompressors.com



sera Hydrogen GmbH, sera-Str. 1, 34369 Immenhausen, Germany, Phone +49-5673-999-04, Fax -05, info-compress@sera-web.com, www.sera-web.com

Consulting



Bernard Gruppe ZT GmbH, Bahnhofstr. 19, 6060 Hall in Tirol, Austria,

Phone +43-5223-5840-118, Fax -201, www.bernard-gruppe.com

Distribution



Kälte- und Systemtechnik GmbH, Refrigeration systems for cooling hydrogen according SAE, Heavy duty refueling, Strassfeld 5, 3441 Freundorf, Austria, Phone +43-2274-44109, office@kustec.at, www.kustec.at

Electrolyzers



Asahi Kasei Europe GmbH,

Fringsstr. 17, 40221 Düsseldorf, Germany, Phone +49-211-3399-2000, info@asahi-kasei.eu, www.asahi-kasei.eu



Cummins Inc., Am Wiesenbusch 2 – Halle 5, 45966 Gladbeck, Germany, Phone +49-2043-944-133, Fax -146, powersales@hydrogenics.com, www.cummins.com



Elogen GmbH, Eupener Strasse 165, 50933 Köln, Germany, Phone +49-221- 2919073-0, Fax -9, www.elogenh2.com



Enapter

Enapter srl, AEM electrolyzers for all applications, Pisa, Berlin, Chiang Mai,

Via di lavoro 56G, 56040 Crespina Lorenzana (PI), Italy, Phone +39-50644281, +49-30-921008130, www.enapter.com



FEST GmbH, Experience for future, Harzburger Str. 14, Goslar (head office), 38642 Goslar, Germany,

kontakt@fest-group.de, www.fest-group.de



iGas energy GmbH, Cockerillstr. 100, 52222 Stolberg, Germany, Phone +49-(0)2402-9791600, info@igas-energy.de, www.igas-energy.de



JA-Gastechnology GmbH, Albrecht-Thaer-Ring 9, 30938 Burgwedel, Germany, Phone +49-5139-9855-0, Fax -33, www.ja-gastechnology.com

thyssenkrupp Uhde Chlorine Engineers GmbH,

Vosskuhle 38, 44141 Dortmund, Germany, Phone +49-231-547-0, Fax -2334, info-uce@thyssenkrupp.com, www.thyssenkrupp-uhde-chlorine-engineers.com

Electronics



MACEAS GmbH,
Königstr. 2, 26676 Barßel-Harkebrügge,
Germany, Phone +49-4497-9269-90,
Fax -18, www.maceas.com



Munk GmbH,
Gewerbepark 8+10,
59069 Hamm,
Germany, sales@rectifier.com, www.rectifier.com,
Customized power supply solutions for industrial applications



plating electronic GmbH, DC Power Supplies,
Rheinstr. 4, 79350 Sexau, Germany,
Phone +49-7641-93500-0,
info@plating.de, www.plating.de



Prüfrefx Innovative Power Products GmbH, Egersdorfer
Str. 36, 90556 Cadolzburg,
Germany, Phone +49-(0)9103-
7953-0, Fax -55, www.pruefrefx.com



VAF GmbH, Automation expert
for cell stacking, Bergstr. 13,
73441 Bopfingen, Germany,
Phone +49-7362-96030,
info@vaf-bopfingen.de, www.vaf-bopfingen.de

Engineering



ARGOVIA Hydrogen AG, Germa-
nenstr. 10, 4313 Möhlin, Swit-
zerland, www.argovia-h2.com,
Automated filling stations for H₂ transport – also for your project



H2 Core Systems GmbH, Construction,
Service, Electrolyser, Fuel Cell, Com-
pressor, Storage, Berliner Str. 82-88,
25746 Heide, Germany, Phone +49-
15777438466, sales@h2coresystems.com, www.h2coresystems.com

Fittings, Regulators, Valves



Bürkert Werke GmbH & Co. KG,
Solenoid Valves, Mass Flow Controller,
Fluid Power System Solutions,
Christian-Bürkert-Str. 13-17, 74653 Ingelfingen, Germany,
Phone +49-7940-10-0, Fax -91204, www.buerkert.com



Festo SE & Co. KG,
Automation Electrolyser,
HRS, Compressor, Stack & Fuel Cell Production, Rüterstr. 82,
73734 Esslingen, Germany, Phone +49-711-3471185, markus.ott@festo.com, www.festo.com



Nova Werke AG,
H₂ High Pressure
Solenoid Valves, Vogelsangstr. 24, 8307 Effretikon,
Switzerland, Phone +41-52-3541616, www.novaswiss.com



Buschjost GmbH –
IMI Precision Enginee-
ring, Detmolder Str. 256,
32545 Bad Oeynhausen, Germany, Phone +49-5731-791-0,
Fax -179, www.norgren.com, hydrogen@imi-precision.com

Fuel Cells



SFC Energy AG, EFOY Fuel Cells,
Eugen-Sänger-Ring 7, 85649 Brunnthal,
Germany, Phone +49-89-673592-555,
info@sfc.com, www.sfc.com, www.efoy-pro.com

Fuel Recirculation and Air supply



Celeroton TurboCell AG, Industrie-
str. 22, 8604 Volketswil, Switzer-
land, Phone +41-44-25052-20,
info@celeron-turbocell.com, www.celeroton-turbocell.com

Gas Diffusion Layers (GDL)



SGL Carbon GmbH,
Werner-von-
Siemens-Str. 18,
86405 Meitingen, Germany, Phone +48-(0)8271-83-3360,
Fax -103360, fuelcellcomponents@sglgroup.com, www.sglgroup.com

Integration



**Deutsches Zentrum
für Luft- und Raumfahrt**
German Aerospace Center
Institute of Engineering Thermodynamics

**Deutsche Zentrum für Luft-
und Raumfahrt (DLR) /
German Aerospace Center,**
Institute of Engineering

Thermodynamics, Energy System Integration,
Pfaffenwaldring 38-40, 70569 Stuttgart, Germany,
Phone +49-(0)711-6862-672, Fax -747, www.dlr.de/tt

Companies

Manufacturing



ODONICS Your-Tool GmbH, Strassfeld 10, 3441 Freundorf, Austria, Phone +43-2274-30601, www.your-tool.net



Matthews International GmbH, Gutenbergstr. 1-3, 48691 Vreden, Germany, Phone +49-2564-120, vreden@saueressig.com, www.saueressig.com/en/engineering/hydrogen-solutions/

Measurement and Control Technology



BD|SENSORS GmbH, el. Druckmesstechnik,

BD-SENSORS-Str. 1, 95199 Thierstein, Germany, Phone +49-(0)9235-98110 www.bdsensors.de, Manufacturer of electronic pressure and level measurement technology



Henze-Hauck Prozessmesstechnik / Analytik GmbH,

Wasserstoffanalysatoren, ATEX zertifiziert, Sicherheitstechnik, Dünnhauptstr. 14, 06847 Dessau, Germany, Phone +49-340 5169363, info@henze-hauck.de, www.processanalytik.de



HYDAC Electronic GmbH, H₂ pressure transmitters with approvals for hazardous environments as well as EC 79/2009, Hauptstr. 27, 66128 Saarbrücken, Germany, Phone +49-6897-50901, electronic@hydac.com, www.hydac.com



JUMO GmbH & Co. KG, Measurement, control and automation technology for hydrogen applications,

Moritz-Juchheim-Str. 1, 36039 Fulda, Germany, Phone +49-661-6003-0, Fax -500, mail@jumo.net, www.jumo.de, en.jumo.de/web/applications/hydrogen



S++ Simulation Services, Ralf Kraume, Waldstr. 5, 82418 Murnau-Westried, Germany, Phone +49-8841-672147-0, ralf.kraume@splusplus.com, www.splusplus.com

Measurement Data Management and Monitoring



DiLiCo engineering GmbH, Lorenzweg 43, 39124 Magdeburg, Germany, Phone +49-(0)391-505859-86, info@dilico.de, www.dilico.de



Smart Testsolutions GmbH, Röttestr. 17, 70197 Stuttgart, Germany, Phone +49-711-25521-46, www.smart-testsolutions.de

Membranes and Separators



FUMATECH BWT GmbH, Carl-Benz-Str. 4, 74321 Bietigheim-Bissingen, Germany, Phone +49-(0)7142-3737-900, Fax -999, www.fumatech.com

Organizations

hySOLUTIONS GmbH, Steinstrasse 25, 20095 Hamburg, Germany, Phone +49-(0)40-3288353-2, Fax -8, www.hysolutions-hamburg.de

Organizers (Events)



ees Europe – International Exhibition for Batteries and Energy Storage Systems / Solar Promotion GmbH, electrical energy storage, P.O. Box 100 170, 75101 Pforzheim, Germany, Phone +49-7231-58598-0, Fax -28, www.ees-europe.com



European Fuel Cell Forum, Obgardihalde 2, 6043 Luzern-Adligenswil, Switzerland, Phone +41-(0)4-45865644, Fax 35080622, forum@efcf.com, www.efcf.com



Messe Stuttgart, hy fcell – International Expo and Conference in Stuttgart and worldwide, www.hy-fcell.com/worldwide



Tobias Renz FAIR, Berlin, Tobias Renz, tobias@h2fc-fair.com, Phone +49-30-60984556, www.h2fc-fair.com

Plant Engineering

Kloeckner DESMA Elastomertechnik GmbH,
Injection molding machine manufacturer for the production of elastomer articles, An der Baera, 78567 Fridingen, Germany, Phone +49-7463-8340, www.desma.biz

Reformers

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

Research & Development

 **DBI GUT**
Gas- und Umwelttechnik
DBI Gas- und Umwelttechnik GmbH,
Karl-Heine-Str. 109/111,
04229 Leipzig, Germany,
Phone +49-341-2457-113, www.dbi-gruppe.de

Fraunhofer Institute for Microengineering and Microsystems IMM,
Reformer and Heat Exchanger, Carl-Zeiss-Str. 18-20,
55129 Mainz, Germany, Phone +49-(0)6131-9900,
info@imm.fraunhofer.de, www.imm.fraunhofer.de

 **Fraunhofer** **Fraunhofer ISE,**
Heidenhofstrasse 2,
ISE 79110 Freiburg, Germany,
Phone +49-(0)761- 4588-5208, Fax -9202, www.h2-ise.de

Fraunhofer-Institut für Windenergiesysteme IWES,
Postkamp 12, 30159 Hannover, Germany,
Phone +49-471-14290-456, www.iwes.fraunhofer.de

 **HyCentA Research GmbH,**
Inffeldgasse 15, 8010 Graz, Austria,
Phone +43 (0)316-873-9501,
office@hycenta.at, www.hycenta.at

 **IAV GmbH Ingenieurgesellschaft**
Auto und Verkehr, Carnotstr. 1,
10587 Berlin, Germany,
Phone +49-30-39978-0, Fax -9926, www.iav.com

Storage

AMBARtec AG, Supplier of compact, efficient and sustainable H₂-storage systems, Erna-Berger-Str. 17, 01097 Dresden, Germany, Phone +49-351-30993666, www.ambartec.de

KESSELS
H₂ STORAGE AND TRANSPORT
SOLUTIONS

Kessels Prüfwerk GmbH & Co. KG,
Lehmkuhlenweg 13, 41065
Mönchengladbach, Germany,
Phone +49-(0)2161-65907-0, Fax -68, www.kessels-pruefwerke.de

Suppliers

Anleg GmbH, Advanced Technology, Am Schornacker 59,
46485 Wesel, Germany, Phone +49-(0)281-206526-0,
Fax -29, www.anleg-gmbh.de

 **Borit NV,** Bipolar Plates and Interconnects, Lammerdries 18e,
2440 Geel, Belgium,
Phone +32-(0)14-25090-0,
contact@borit.be, www.borit.be

 **HAVER & BOECKER**

HAVER & BOECKER OHG, Wire mesh in hydrogen technology,
Ennigerloher Straße 64, 59302 Oelde, +49 (0) 2522 30-0,
haverboecker.com/en

 **HIAT**
HYDROGEN AND INFORMATICS
INSTITUTE OF APPLIED TECHNOLOGIES
HIAT gGmbH,
Schwerin, Germany,
CCMs / MEAs / GDEs
for PEFC, DMFC & PEM-Electrolysis, www.hiat.de

 **Kerafol Keramische Folien GmbH & Co. KG,** Ceramic Electrolytes,
Solid Oxide Cells, Glass Tapes,
Koppe-Platz 1, 92676 Eschenbach, Germany, Phone +49-(0)9645-884-30, Fax -90,
www.kerafol.com/sofc

SIEMENS **Siemens,** contributes to successful process implementations in H₂ production, conversion, storage, transport and usage as reliable partner with a comprehensive automation and digitalization portfolio. www.siemens.com/h2

 **Sorst Streckmetall GmbH –**
Use in OEMs and electrolyzers made of titanium, stainless steel, nickel, also prefabrication, planning, implementation. Phone +49-511-67675650,
info@sorst.de, www.sorst.de

 **Spir Star AG,**
Auf der Rut 7, 64668 Rimbach-Mitlechtern, Germany,
Phone +49-6253-9889-0, info@spirstar.de, www.spirstar.de

Companies

Testing

baltic FuelCells GmbH
baltic FuelCells GmbH,
www.balticfuelcells.com,
PEM- and electrolysis-
single cell testing equipment for R&D and QA

JAG
competence in
gastechnology
JA-Gastechnology GmbH,
Albrecht-Thaer-Ring 9,
30938 Burgwedel, Germany,
Phone +49-5139-9855-0, Fax -33, www.ja-gastechnology.com

MAXIMATOR®
maximum pressure
Maximator GmbH,
High Pressure
Hydrogen Technology,
Testing Equipment, Customer Testing Services, Lange
Strasse 6, 99734 Nordhausen, Germany, Phone +49-3631-
9533-5040, info@maximator.de, www.maximator.de

Resato Hydrogen Technology
Resato Hydrogen
Technology B.V.,
Duitslandlaan 1, 9403 DL, Assen, The Netherlands,
Phone +31 501-6877, www.resato-hydrogen.com

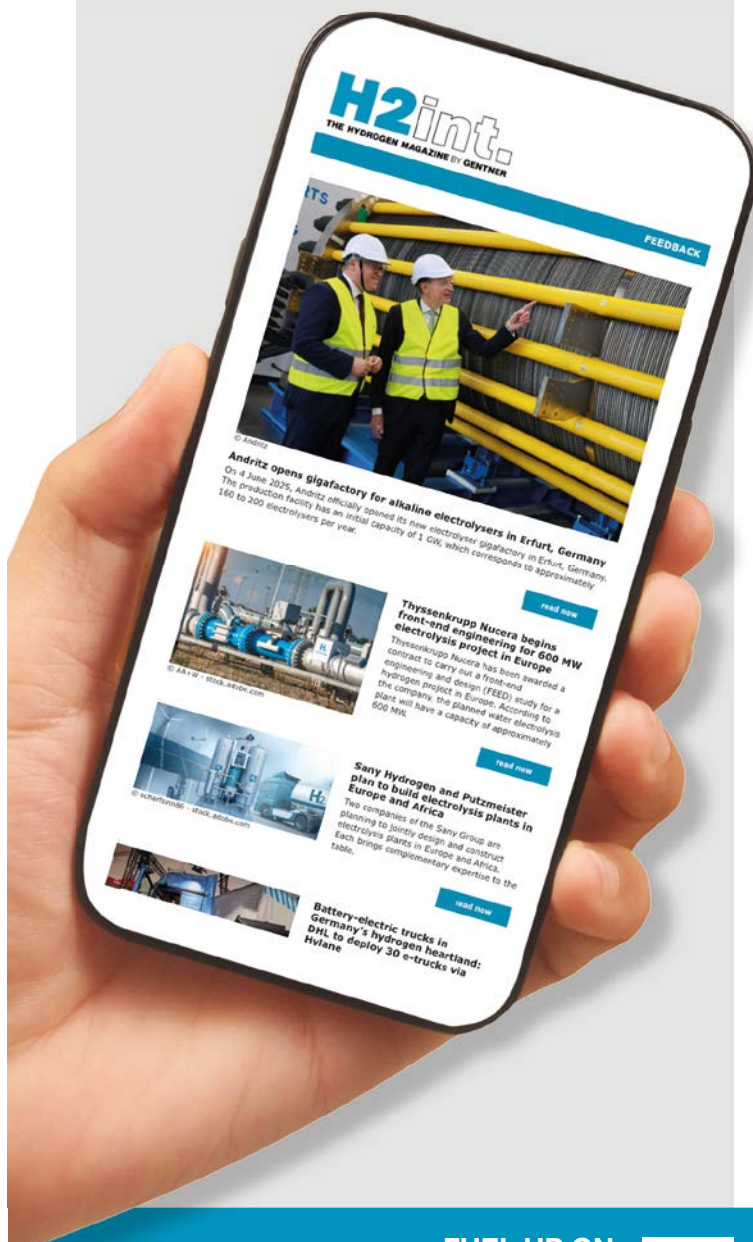
Sonplas
Sonplas GmbH, H₂ test stand,
Testing of hydrogen-carrying
components with real fuel,
Sachsenring 57, 94315 Straubing, Germany,
Phone +49-9421-9275-0, info@sonplas.de, www.sonplas.com

Test Stands

AiP automotive
AIP Automotive GmbH & Co. KG,
Hojen 30, 87490 Haldenwang,
Germany, Phone +49-8374-24090,
info@aip-automotive.de, www.aip-automotive.de

TRENDS, TECHNOLOGIES, AND INDUSTRY NEWS –

curated by our editorial team and
delivered straight to your inbox.



FUEL UP ON
HYDROGEN KNOWLEDGE
www.h2-international.com/newsletter



H2int 5/2025 to be published on 11. December 2025.

CONSTRUCTION MACHINERY

Heavy-duty vehicles are predestined for the use of hydrogen.

SECTOR COUPLING

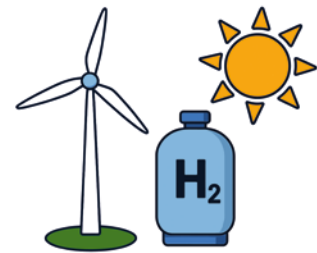
In the energy transition, electrons and molecules must work together.

SENSOR TECHNOLOGY

Precise sensors are the core components of hydrogen technology.



© FEES



© Sara - stock.adobe.com



© Wilsaif - stock.adobe.com

IMPRINT

H2int.

THE HYDROGEN MAGAZINE

PUBLISHER AND COMPANY

Gentner Energy Media GmbH
Forststraße 131, 70193 Stuttgart
Postfach 10 17 42,
70015 Stuttgart, Germany

PUBLISHER

Robert Reisch

EDITORIAL TEAM

Editor-in-Chief:
Dipl. Ing. Eva Augsten
Phone: +49 155 62 95 92 70
Email: augsten@hzwei.info

ADVERTISING MANAGEMENT

Tom Duley
Phone: +49 711 63 672-825
Mobile: +49 176 566 227 97
Email: duley@hzwei.info

ORDER MANAGEMENT

Melanie Schweigler
Phone: +49 711 63 672-862
Email: schweigler@hzwei.info

DESIGN AND LAYOUT

neon-bold.de, Berlin

PRINTING

Silber Druck oHG, Lohfelden

WEBSITE

www.hzwei.info

PUBLICATION DETAILS

Publication Frequency: 6 issues per year
25th Year, 2025
ISSN: 1862-393X

SUBSCRIPTION PRICES

€87.90 per year (including VAT),
plus shipping (Germany: €12.00)

SINGLE ISSUE

€21.90 plus shipping (incl. VAT)

New orders are subject to the subscription prices valid at the time of order. The applicable advertising rate list No. 26 from 01.04.2025 applies.

SUBSCRIPTION TERMS

Orders can be placed at any time through the reader service or bookstores domestically and internationally. Subscriptions renew annually unless canceled in writing three months before the subscription year ends.

Subscription fees are invoiced in advance or debited via direct debit. If the magazine cannot be delivered due to reasons beyond the publisher's control, there is no claim for replacement or refund of prepaid fees.

The legal venue for merchants is Stuttgart; for others, it applies if claims are made through a dunning process. Please notify the reader service of any address or recipient changes at least six weeks in advance.

COPYRIGHTS

The structured layout of the magazine and all individual articles and images contained within it are protected by copyright. By accepting an article for publication, the publisher acquires comprehensive usage rights from the author in an unrestricted and exclusive manner, particularly for further reproduction and commercial distribution through mechanical, digital, or other means.

Unless revoked (socialmedia@gentner.de), this also applies to the use of images, graphics, and audiovisual works on all social media channels, including Facebook, Instagram, and YouTube. No part of this magazine may be reproduced or converted into machine-readable language without the publisher's written consent, except within the narrow limits of copyright exceptions.

The automated analysis of the work to extract information, especially patterns, trends, or correlations according to German law § 44b Urheberrechtsgesetz (Text and Data Mining), is prohibited.

The use of product names, trade names, and trademarks in this magazine does not imply that such names may be freely used by anyone; they are often legally protected registered trademarks, even if not explicitly marked as such.

CONTACT OUR READER SERVICE

Postfach 91 61, 97091 Würzburg, Germany
Email: service@gentner.de Phone: +49 711 63 67 24 08
Fax: +49 711 63 67 24 14

DAS NEUE ENERGIEPORTAL MIT FACHWISSEN ZUR ENERGIEWENDE

Gebündeltes Expertenwissen zu allen relevanten Themen der Energiewende



Uneingeschränkter Zugriff auf exklusive Inhalte

- **30 E-Paper** Ausgaben pro Jahr von ERNEUERBARE ENERGIEN, Gebäude Energieberater und photovoltaik.
- **Fokus Themenhefte**
- **Marktübersichten** über wichtige Produkte
- Zugriff auf ein umfangreiches **Online-Archiv**
- Exklusive **Webinare**

KONTAKTIEREN SIE UNS!

Einzellizenz



Bestellung: (Mo–Fr 8–16 Uhr)
Tel: 0711-63672-400
service@gentner.de

Firmenlizenz



Eric Le Gall
Tel: 02202-2514244
Mobil: 0172- 2575333
LeGall@gentner.de

Unsere **Firmenlizenz** ist **flexibel** und passt sich der Größe sowie die spezifischen Anforderungen Ihres Unternehmens an.