

**pv magazine** **energy**  
**storage**<sup>+</sup>

February 2020

# 2020

## ENERGY STORAGE HIGHLIGHTS

### THIS YEAR'S TOP INNOVATIONS



Special edition in collaboration with



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## imprint .....

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# Diversifying for decarbonization

Photos: pv magazine/Thomas Beetz



And so it is again. With the new decade, **pv magazine** brings forth yet another energy storage highlights special edition. To address the increased societal concern of climate change, deep decarbonization of the electricity sector is required. High penetrations of variable renewable energy resources are on the rise globally, and storage is stepping up to the challenge to support integration and provide more flexibility. Advancements in a maturing storage industry provide carbon-free promise for a necessary energy transition.

Approximately two weeks of work went into sifting through this year's 22 highlights submissions, conducting research, and preparing them for the jury. Once again, this year's work was crowned by the moderation of the jury meeting, in which six leading industry experts discussed the technologies and solutions.

Differing from previous years, we have moved away from the numerical ranking of energy storage highlights. Instead, the jurors have selected the top five "Gigawatt" winners they were particularly impressed by, followed by five "Megawatt" winners, and a series of "Finalists".

At the Energy Storage Europe trade fair and conference, taking place March 10-12 in Düsseldorf, Germany, you can meet all the companies whose products and projects you will read about in this issue.

In our "Decarbonization is the new storage" interview with Andreas Moerke, the new director of Energy Storage Europe, we discuss industrial reductions of CO<sub>2</sub> emissions, where energy storage serves as a prerequisite, and the corresponding evolution of the event.

We would like to thank Messe Düsseldorf and Energy Storage Europe for their cooperation and support, as well as their insight into a growing industry that is steering us closer toward a decarbonized future.

Please join **pv magazine** at the Open Forum on the second day of the fair at 10 a.m. for presentations from the Gigawatt winners, followed by a panel discussion with the jurors. We also look forward to welcoming you at our booth, # 8BC11.

*Michael Fuhs, Editorial Director  
Erica Johnson, Managing Editor*

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The Top 5 out of 22 submissions selected across a field of categories from our leading jury of industry experts and analysts.

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Read up on the Megawatt winners and Finalists of this year's energy storage highlights.

# Decarbonization is the

The Energy Storage Europe trade show and conference started as a trade fair for devices nine years ago. Since then, it has developed into an event for energy storage systems. And now the organizers are moving toward decarbonization as a core topic. For 2020, they collected case studies for reductions of CO<sub>2</sub> emissions in four industries, explains Andreas Moerke, executive team manager at Energy Storage Europe.



Photo: Messe Düsseldorf

*Andreas Moerke, executive team manager of Energy Storage Europe*

**pv magazine:** *Energy Storage Europe has ambitions to bring storage forward in retail and industry. For this you have done some market research. Which segments are more dynamic, and which are less?*

**Andreas Moerke:** The field of retail is particularly dynamic. This market segment was one of the first to start with energy efficiency measures, because a large portion of costs in retail are associated with energy costs. We have already seen the advancement of green energy in this space with solar panels and with storage in the market. But now, what is quite new is retailers deploying charging stations to attract customers and increase business. Looking to other segments, there are some energy intensive industries like metal production which are also quite dynamic as far as the big companies are concerned. Salzgitter and Thyssenkrupp, known for their steel production, are working on technologies to use hydrogen instead of coal. This is motivated by environmental issues – and that change promotes decarbonization.

*“If one really wants to decarbonize steel production, it must be hydrogen from renewable sources like wind and solar”*

**Is energy storage also involved?**

Yes, but it is more hydrogen storage than electrical storage. For steel production you need a huge amount of hydrogen – and if one really wants to decarbonize steel production, it must be hydrogen from renewable sources like wind and solar. And you will find technologies for it in Düsseldorf. There are producers of electrolyzers at the show, and the afternoon of March 11 at the conference is dedicated to “power to hydrogen.”

**In the retail segment, have you also found examples which surprised you, and which may open up a new outlook?**

In fact I did. For example, Lidl and Kaufhof will erect something like 70 electric charging stations, with two chargers each in Berlin. The combination of photovoltaics plus storage plus mobility services is something new. Metro Group and Aldi Nord provide another example. They are applying ice storage. So we are not just talking about batteries but also about thermal storage. And these fields overlap. Aldi Süd has invested in the first electric truck that is also equipped with cooling systems. Retail logistics has huge potential to be developed, because logistics are an instrumental part of the whole retail value chain.

# new storage

## *Are there other interesting findings from additional industries?*

Even the wine industry is looking to CO<sub>2</sub> reduction and storage. For instance, Tobias Jung from the winery Jung & Knobloch in Germany will present their efforts to lower energy costs and decrease CO<sub>2</sub> emissions at the Energy Storage Europe Forum. They not only use solar panels and electrical storage, but are also using thermal storage and heat recuperation, which helps to optimize the heating and cooling system of the wine fermentation process.

## *Is the motivation more for reputation gain, or is it economic?*

At least for Jung & Knobloch, it is the economic effect by which they're motivated to invest in these technologies – because they save energy, and therefore they save money. Becoming more energy independent from the utilities is also a motivation. For the retail industry, it's also economics that are driving the application of photovoltaics and storage. When used in combination with charging infrastructure, peak shaving through storage becomes very important.

## *There are also market segments which have much more difficulty finding economically viable use cases for battery storage. Are there any advancements for such segments?*

Yes. For example, we cooperate with the leading plastics machinery and plastics material trade show, "K". For this industry, energy costs are only a very small part of overall production costs, so they haven't paid much attention to energy-related CO<sub>2</sub> reductions so far. However, with recent developments, such as carbon taxes, this industry is considering measures to reduce CO<sub>2</sub> emissions. This should open up new opportunity for storage. The plastics and rubber machinery group of the Mechanical Engineering Industry Association is reportedly creating a working group for CO<sub>2</sub> reductions. And the companies which are constructing machines to produce plastic components are being forced to invest resources into designing machinery that produce less CO<sub>2</sub> and use less energy.

## *You have now established the so-called "decarbonization hub" at the Energy Storage Europe show. What is this about?*

The decarbonization hub is a special area at Energy Storage Europe 2020 which will showcase four industries in particular, and how energy storage solutions can contribute to CO<sub>2</sub> reductions along their value chain. We are cooperating with the world's leading trade shows for these industries, which also belong to the Messe Düsseldorf portfolio: the plastics machinery show K, the retail show EuroShop, the ProWein for the wine industry, and Thermprocess for metal production. Additionally, in our new format of industry-specific lectures we provide best practices from our exhibitors for these industries. They will provide solutions to lower energy costs and to decrease CO<sub>2</sub> emissions.

## *My impression is that the key phrase "CO<sub>2</sub> reduction" might become more important than the keyword "storage." Will the trade show develop and expand to cover the more all-encompassing topic of CO<sub>2</sub> reduction rather than solely storage?*

This is a natural development. We started with a trade fair that mostly showed storage devices. Then we developed into an energy storage systems event. And now, we see that storage solutions are an essential part of the decarbonization process for industries. We have to move into this direction.

*“Storage solutions are an essential part of the decarbonization process for industries”*

# Energy storage highlights

A jury of leading analysts and industry experts selected a shortlist of the must-see concepts, developments, and products from the exhibitors at Energy Storage Europe in Düsseldorf. The **pv magazine** energy storage highlights are a compiled ranking of 22 entries, showcasing a variety of industry trends across battery development and deployment, hydro-

gen technologies, thermal solutions, and sector coupling. The jurors evaluated the submissions on the criteria of innovation, relevance, strength, prospects for success, and the extent to which they contribute to the energy transition. The following pages paint a picture of their findings with five gigawatt winners, five megawatt winners, and a grouping of finalists.

## Meet the winners and finalists:

Find the companies and research institutes from this year's energy storage highlights at the Energy Storage Europe trade fair and conference, taking place from March 10-12, 2020, in Düsseldorf, Germany.

For more information, visit <https://www.esexpo.de/>

## Join the panel discussion with gigawatt winners and jurors

March 11, 2020 | 10:05-11:20 a.m.  
Energy Storage Europe, Düsseldorf

Join **pv magazine** at Energy Storage Europe in honoring the companies of energy storage highlights at our annual award ceremony and discussion. The leading gigawatt winners will

showcase their technology and solutions with a pitch to the jury panel, followed by a discussion from the independent analysts and experts.

We look forward to you joining us for a scintillating discussion surrounding storage technologies and how they can decarbonize industry and accelerate the energy transition.

## The Jury



### Xavier Daval

Xavier Daval is an international solar and storage expert, and the CEO of French solar technical advisory firm kiloWattsol SAS, which he founded in 2007. Daval is an electrical engineer and the former EMEA director of a NYSE-listed manufacturer in the electronics industry. He is also the vice president of French renewable energy association Syndicat des Energies Renouvelables-SER, the chair of its solar commission SER-SOLER, and the director of the Global Solar Council (GSC).



### Julian Jansen

Julian Jansen is a research manager at IHS Markit Technology, leading the group's global research on stationary energy storage to provide deep insights on the key value drivers and emerging business models accelerating storage deployment across Europe and North America. Jansen also delivers strategic advice for bespoke projects on a range of new energy technologies.



### Nina Munzke

Nina Munzke has worked at the Karlsruhe Institute of Technology, serving as the team leader of "Systems Control and Analysis" since 2012. At the KIT Electrotechnical Institute, her focus is on energy storage systems. Munzke has extensive experience in the field of dimensioning and simulation, in addition to developing intelligent system controls for stationary storage systems. She is also an expert in the evaluation of the performance of stationary storage systems.



### Florian Mayr

Florian Mayr is a partner at Apricum, where he provides expertise on energy storage, renewables, and e-mobility. Mayr supports companies around the world to advance clean technologies by providing counsel for strategy and transactions in the sector. Prior to joining Apricum, Mayr spent eight years in senior positions at McKinsey & Company and German utility RWE.



### Mark Higgins

Mark Higgins is the COO of Strategen, a professional services firm focused on market development for a decarbonized grid. Higgins also serves on the board of the Vehicle-Grid Integration Council, a nonprofit organization committed to advancing the role of smart EV charging. His past experience includes serving as the director of utility west at SunEdison, vice president of finance for Hu Honua Bioenergy, and Pacific Gas & Electric's lead for key policy areas, including interconnection and transmission planning.



### James Frith

James Frith spearheads the energy storage team at BloombergNEF. He leads the company's coverage on energy storage technologies and the lithium battery supply chain to provide insights on technology, markets, policies, and regulation. He leverages his background in battery research to provide key insights into the chemistries, applications, and markets for lithium-ion batteries.

Enapter

## Distributed hydrogen generation at a low cost



**In recent years, it has been made clear at Energy Storage Europe that a wave of hydrogen developments is on the horizon. This year, market entries in the field have finally arrived. Small devices produced in high volumes without expensive precious metals are needed. Enapter wants to produce low-cost, distributed green hydrogen to revolutionize the market. The jury placed the company among one of the top 5 gigawatt winners.**

A key question that arises for the sector is how decentralized hydrogen generation might be. Enapter, a proponent of a distributed approach, appealed to jurors with its offering of a small 2.4 kW electrolyzer. The company has a goal for the low costs it wants to achieve, and provides a concept to realize this goal, which seems to offer a unique selling proposition in the market.

The heart of the small electrolyzer, which is the size of a microwave oven, is a so-called anion exchange membrane (AEM), which distinguishes it from the PEM electrolyzers on the market that use proton exchange membranes. The advantage of Enapter technology is that no highly corrosive acids are used, explains Jan-Justus Schmidt, the company's founder and managing director of Enapter. This means that expensive precious metals are not needed for the electrodes.

With a targeted service life of 30,000 hours, the company currently has achieved a price of €6.70 per kilogram of hydrogen, corresponding to €0.20 cents per kWh of thermal energy when the hydrogen is burned. However, these figures do not take into account the cost of the 54 kilowatt-hours of electricity that are currently still required to produce one kilogram of hydrogen.

Today's costs are therefore in line with the cost of hydrogen produced with other electrolysis technologies, although the market spread is large. Additionally, Enapter's process is likely still two to three times more expensive than hydrogen produced from fossil fuels via steam reforming.

But Enapter has clear ideas about how to continue to drive down costs. Recently, it increased the production volume of its factory in Pisa, Italy, eightfold and reduced costs by 20%. By further scaling up production to large quantities, the cost target of €1.50 per kilowatt-hour should be achieved "well before 2030," accord-

ing to the company. To deliver this, a production facility with a capacity of 100,000 units per year is scheduled to go online in Pisa in four to five years.

Schmidt draws parallels to the computer world to underscore the plausibility of the concept. Distributed personal computers have replaced mainframe computers to a great extent because, due to mass production, they are cheaper to manufacture than small numbers of mainframes. Similarly, the Enapter product is expected to reduce costs compared with the cost of central electrolyzers, which are not manufactured on an industrial scale.

There are many potential applications; the devices would be well suited to convert even small surplus quantities of electricity generated by domestic PV systems into hydrogen. A single device produces about 40 grams of hydrogen per hour. This amount is sufficient for one kilowatt of electricity when converted back, or for an approximate 10-kilometer drive with a fuel-cell vehicle. Other applications that Enapter describes are a backup system for longer-lasting power failures, seasonal energy storage in remote locations, or the operation of a company's own industrial hydrogen filling station.

Ultimately, cost structures and markets will decide where distributed and centralized concepts are more competitive. Distributed concepts, apart from offering the advantages Enapter claims they do, might save grid costs. On the other hand, large volumes of hydrogen are needed in industry, which favors large-scale electrolyzers. Of course, in the end, one could also stack Enapter's devices. About 416 electrolyzers produce the equivalent of 1 MW of electrical power.

### Jury comments

**Florian Mayr** "Green hydrogen will be one of the key ingredients to achieve maximum decarbonization, but costs still need to come down substantially. Enapter's approach to reduce capex through low-cost materials and the mass-production of standardized and stackable small-scale electrolyzers seems promising."

**Mark Higgins** "Cost-effective, distributed green hydrogen is a unique concept; should the commercial model prove viable, Enapter will have developed a truly unique value proposition."

**Nina Munzke** "Good approach with a clear price target."

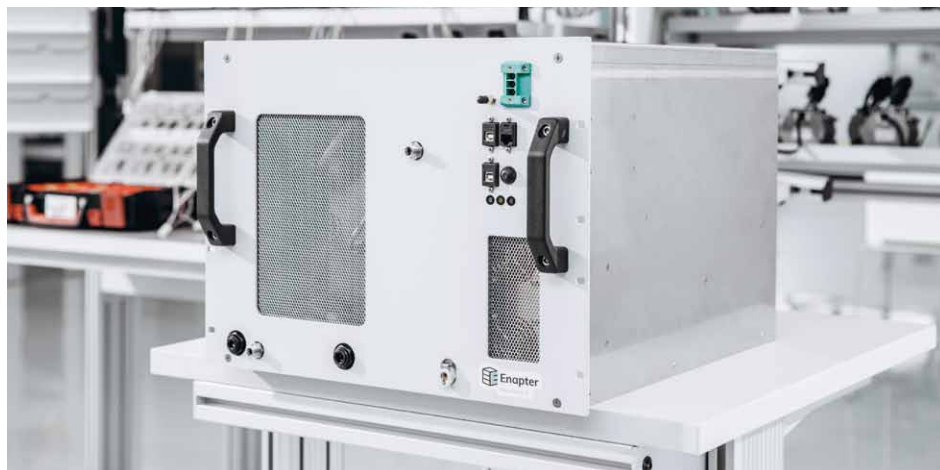


Photo: Enapter

*egrid and ads-tec*

## The battery swarm in the power distribution network



**With a project set against a breathtaking backdrop, egrid and ads-tec Energy have secured one of the five spots among the Gigawatt winners in Energy Storage Highlights. The two companies have developed a method of arranging medium-sized storage systems within a distribution network and operating them as a swarm so that they can offer a wide range of services.**

There has already been plenty of reporting on business models for batteries; their use to shift the solar generation peak, for load peak shaving – when charging electric cars, for instance – or their use in the frequency containment reserve market. But where should the batteries be located to ensure that they do not place an undue burden on the distribution network – or better still, where can they be deployed to reduce grid expansion and at the same time provide the aforementioned services in the local grid? The companies egrid and ads-tec explained how they accomplished this task with their Allgaeu DESS (distributed energy storage system), thus earning them a spot among the Gigawatt winners of the Highlights at Energy Storage Europe.

In the project, the partners installed six battery storage systems, each with a capacity of 336 kWh and a power output of 500 kW, distributed throughout the power network in the Allgaeu, a region in southern Germany with around 1,600 PV systems. The customer is the local distribution network operator, Egrid’s parent company. In contrast to other swarm models, the storage systems are not residential storage units, but medium-sized

grid-scale storage systems. And unlike the residential systems, they are run by the grid operator. In theory, location-specific deployment of residential storage could also be used to address similar local distribution challenges, as highlighted in the Allgaeu DESS project – but this would only be possible if distribution system operators were to set up a market or pay for the provision of such services, explains juror Julian Jansen of IHS Markit.

The DESS concept also has several advantages over a large central storage facility, says Thomas Schönland of egrid. If you want to connect a few megawatts of storage to the grid, you have to build a new grid connection point or expand an existing one, which, he points out, is very expensive. By distributing the battery capacity across six locations, the engineers found that they could reduce grid-connection costs for the project. To find the right locations, the company had to develop a method for evaluating 1,700 possible connection points. Another requirement was to build the storage facilities small enough, as space was sometimes very limited at suitable locations.

However, the biggest challenge, according to Schönland, was developing

the control system, to enable the storage systems to operate both locally and also to offer network services as a swarm.

Depending on the use case, the swarm or the local battery unit require different modes of operation, and hence different interfaces to communicate with various market participants. Recharging has to be optimized as well. For the long term, it is also important that the battery control system is easily adaptable to new markets and business cases.

After all, business models are likely to change. This is also a matter of regulation, which makes business models for such storage systems in Germany more difficult to implement. Nevertheless, the companies say that the Allgaeu DESS project was a good solution.

“The intention was not to rely on subsidies, a goal we were able to reach through lean project realization – that is, by finding suitable partners, choosing the best locations and creating a smart control system,” the companies wrote in their submission.

They supplied the turnkey system, with egrid supplying the control technology and ads-tec the battery systems. Their customer is responsible for the business model, so they cannot provide details on the revenue streams.

### Jury comment

**Julian Jansen** “The Allgaeu DESS project could become a proof of concept for utilizing distribution-grid-sited battery storage to provide critical services at the distribution level. While the aggregation of energy storage systems is in principle not an innovation in itself, the growing need across the world for resilience and smart local networks highlights the importance that pilot projects such as this play in enabling a path for long-term integration of storage.”



*Six stations of this size act like a large network storage system and can simultaneously carry out tasks in their immediate vicinity.*



# Metka EGN: Energy storage shift

Athens-headquartered Mytilineos is expanding its geographic span and technology focus to establish a diversified business, fit for the new energy era. Energy storage comprises part of its new focus.

Regarding renewable energy more generally, Mytilineos' solar business, Metka EGN, includes a platform for the construction, operation, financing, and resale of both photovoltaic and storage units.

The company is transitioning from a traditional EPC business model to being a complete project solutions provider, supporting the development and financing of projects, rather than just building them.

Currently, Metka EGN is developing a number of storage projects worldwide, with both on- and off-grid applications. Its grid-connected projects offer a number of ancillary services to grid operators, and are also often tied to utility-scale solar PV plants.

Metka EGN says it is a pioneer in the implementation of battery storage technology, both in integrating with solar PV systems and applying independently for grid control applications. Of particular note is the company's accomplishment of tying a battery storage system to a 57 MW solar PV facility in Puerto Rico, which the company says was the largest operating solar farm in the Caribbean when it was completed in 2016. Recently, Metka EGN also embarked on a series of hybrid energy storage projects spanning across the United Kingdom which provide innovative fast frequency response and other ancillary services to the U.K. transmission grid operator, National Grid.

## Innovative UK Fast-Frequency Response (FFR) Projects

Together with its long-term client Gresham House, since 2017, Metka EGN has completed a series of battery storage projects in the United Kingdom, offering Fast Frequency Response (FFR) and other ancillary services to the National Grid. "This development is of great importance, as the U.K. is one of the world's most competitive and innovative energy markets," says Nikos Papapetrou, CEO of Metka EGN. The storage projects facilitate the reliability and stability of the U.K.'s grid, and also generate revenues by storing energy at times of low demand and releasing it back to the grid when there is increased demand.



Photos: Metka EGN

*The Staunch 20 MW FFR project is the first of its kind in the United Kingdom, and has been operating since March 2017.*

The scope of these projects includes turnkey engineering, procurement, and construction (EPC) solutions for several new sites, in addition to the expansion of battery energy storage systems at four existing sites.

These UK projects are not connected to solar parks. Instead, the battery energy storage systems (BESS) are directly tied to the grid, with some of the projects also in a hybrid configuration with diesel or gas generators. With each site having different constraints, each new project is customized specifically to work within these parameters. "This is a new area where several relatively well-established technological components need to be integrated, but often in new configurations," says Papapetrou.

Upon completion of the entire portfolio in the first quarter of 2020, Metka EGN will have installed a total capacity of 230 MW of battery storage in the United Kingdom, with 315 MWh of energy storage. "This further strengthens our position as one of Europe's leading solution providers for utility scale battery storage systems," Papapetrou says.



*Metka EGN's Lockleaze 15 MW battery storage project was recently expanded to double the amount of batteries and energy of the plant.*

sonnen

## An electric car subscription model for PV and storage system customers



**sonnen presents a business model that makes switching to an electric car easy, promotes solar power charging, and advances the market for storage systems. The next big step could be integrating the vehicles into virtual power plants of distributed home storage systems, which the company has operated on the German frequency containment reserve market for the past year.**

**C**an an entry that is only indirectly related to energy storage be among the top 5 Storage Highlights and thus be one of the Gigawatt Winners? And what does that show us? sonnen’s electric vehicle (EV) subscription model in Germany, similar to those for PV and storage systems, was well received by the judges – even more so than the virtual power plant based on the manufacturer’s many distributed battery home storage systems, which sonnen also submitted.

Customers who sign up for an electric car subscription through the new “sonnenDrive” service save up-front costs just as they would if they rented a PV system with storage instead of buying – a plan offered under the name “sonnenNow.” sonnen Managing Director Christoph Ostermann wants to lower barriers to entry for individuals in order to advance the energy transition.

To achieve this goal, he had to aim at a monthly cost for the rental models that would be on the same level for customers as if they simply did nothing at all – that is, subscribing to the models had to be comparable with continuing to pur-

chase electricity from a power company and driving an old car that runs on gasoline. “People who don’t make the switch with our new service simply don’t want to,” he says.

With the business model, the minimum term for the electric car subscription is only six months, compared to two years or more with leasing contracts, which allows customers to just give it a try. However, the car subscription is contingent on joining the solar community and purchasing electricity from it. According to sonnen, this means switching primarily to solar energy.

The subscription model for PV systems with storage runs for 20 years, but the system can be purchased out at any time. After 20 years, it is turned over to the customer free of charge. It differs from the widely available rental offers for PV systems in that it is provided with a flat rate, so that it covers the full electricity needs of the house.

Whether these models are transferable to other countries cannot be answered, as they are highly dependent on feed-in tariffs and incentive programs.

In the United States, rental models for photovoltaics have been very successful in the past. That has been due to the fact that up-front investment costs for such systems were very high, and also because end users were typically unable to take full advantage of ITC/MACRS benefits under direct ownership, so third-party ownership was encouraged, says Florian Mayr of Apricum, one of the energy storage highlights jurors. Conversely, since there is still a feed-in tariff in Germany and self consumption is exempt from levies for systems below 10 kW, end customers can also operate systems themselves relatively easily.

Ostermann admits that every rental model includes interest. People who have sufficient money at their disposal, for which they get paltry interest rates at the bank, can invest. But the subscription models are particularly attractive for young families whose houses are not yet paid off, he says.

### The virtual power plant

sonnen also submitted an entry for its virtual power plant (VPP) – which it created from its network of battery home storage systems – to **pv magazine** for the energy storage highlights competition. Prequalified by the transmission system operators in Germany in autumn 2018, the virtual power plant has been participating in auctions for primary balancing power, also known as the frequency containment reserve market (FCR) market, since spring 2019. The proceeds, according to sonnen, will benefit owners of its home storage systems who have signed onto “sonnenFlat” as their electricity rate in Germany. In principle, the primary balancing power provided by battery storage systems will be needed if conventional power plants are to be decommissioned one day. At present, they still provide only a fraction of primary control power.



Photo: Sonnen

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of the future
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For the virtual power plant, sonnen has to control home storage systems based on power grid requirements. According to the company, this type of system is competitive with larger battery storage facilities, which already offer significant capacity to the primary balancing power market. The primary purpose of small home power storage systems is to increase household consumption, whereas marketing them as VPPs is more for an additional source of revenue, to lower costs. Secondly, the use of home storage systems can cut out some of the phases of planning and construction and do not require the same land necessary for large utility-scale storage plants. They also have the advantage of a lower environmental impact compared to that of a large power storage facility. Furthermore, hardly any intervention in charging and discharging the storage systems themselves seems to be necessary. Since many more storage systems are combined in the pool than the amount of power marketed, statistically there is always enough energy available in the VPP, explains the company.

In itself a great achievement, the VPP is not anything completely new, say experts. The concept has been around for several years and sonnen has been working on it for quite some time. According to the jurors, the challenge in Germany stemmed primarily from complex regulations and the resulting prequalification. In other countries, such a concept is easier to implement and has therefore been in place for some time. For example, sonnen also operates a VPP in Australia. There, unlike in Germany, it is used to compensate for price differences on the spot energy market as well.

The fact that the VPP in this highlight competition has now been overshadowed by the electric car business model also shows how interlinked these segments have become, and how transport and generation have become two sides of the same coin. Ultimately, a comprehensive offer that combines electromobility, photovoltaics, and battery storage will help to advance the storage market, as well as charge electric cars that use solar power, say the jurors. In the next step, combining sonnen's electric car service and its VPP could be on the way: in principle, the battery storage capacity of the electric cars could be used as a virtual power plant to stabilize the grid. Many experts consider this combination to have very high potential.

## Jury comments

**Florian Mayr** "sonnen's leasing and subscription models have the potential to significantly lower the entry barriers to rooftop PV, residential storage and electric mobility. By avoiding upfront costs, a broader share of the population – beyond the early adopter market – is likely to be attracted to actively participate in both the energy and transport transitions."

**James Frith** "By providing a subscription model for EVs, alongside its PV and storage subscriptions, sonnen is helping to increase access to EVs. It also enables customers to have the greenest possible experience with their EV by charging from their solar systems."

**Mark Higgins** "Business model innovation is key to accelerating the energy transition, and sonnen's model is a consumer-friendly approach that is poised to open up new markets."



**xelectrix**  
POWER

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Fraunhofer ISE

## Silicon carbide for partial load efficiency

One of the challenges with residential PV storage systems is that they need to be charged within a few hours when the sun is intense, and discharged over a longer period of time when the electricity is consumed at partial load. Therefore, battery inverters should have a high conversion efficiency over a broad power range. Fraunhofer ISE has just concluded a project in partnership with Kaco New Energy and STS, developing

a 6 kW hybrid inverter comprised of silicon carbide components. The researchers say that by implementing new wide band-gap semiconductors, the inverter maintains high efficiency even at partial loads, while also reaching a high power density. Underlining the crucial role of power electronics and their significance to the development of storage systems, Fraunhofer ISE is one of the five Gigawatt winners of this year's competition.

A special highlight of the engineered innovation is the battery charger's DC-DC converter with a three-leg interleaved synchronized topology, that switches the silicon carbide module to make use of its three distinct control input legs.

In serial production, the institute says that the device built from silicon carbide components would not cost

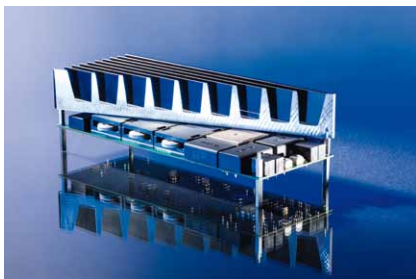
more than today's battery inverters. When compared to particularly poor-performing inverters on the market, savings could amount to €150-250 per year. However, as conventional devices have improved in the past, final potential savings may depend on the choice of comparison.

Jury comments

**Xavier Daval** "The main benefit of wide band-gap power transistors is a strong reduction of switching losses. This new generation of power semiconductors are the components expected to build more efficient DC-DC converters for storage."

**Nina Munzke** "Very high efficiencies in the partial power range, which is very important for residential storage."

Photo: Fraunhofer ISE



Areva H2Gen

## Highly dynamic electrolyzer provides control power

While unlikely to stand out visibly in the Hoechst industrial park near Frankfurt, Germany – where pipes, valves, and pressure vessels are commonplace – the new Areva H2Gen project for hydrogen production and grid stabilization surely has the attention of jurors. As part of the MethQuest research project, the company's solution shows promise for a new direction in the development of large-scale proton exchange membrane (PEM) electrolysis. Areva H2Gen and project partners are developing a PEM electrolysis system with 1 MW nominal power and an overload capacity of 100% – thus capable of temporarily operating at 200% – to deliver frequency containment reserve (FCR) with the overload power.

According to rough cost estimates by project manager Lucas Busemeyer, Areva H2Gen hopes its technology will provide hydrogen for €3.60 per kilo-

gram, including electricity costs at €0.05 per kilowatt-hour without FCR. However, this would require near full utilization of the device, at 8,000 hours per year over a 20 year duration. In order to do so, it must accompany renewables with operating grid power.

To open up new revenue streams, Areva intends to bring its device to the market for FCR, which would also provide flexibility to support the integration of renewable energy.

The challenge to accomplish this is that the electrolyzer must not only be able to run temporarily with twice the nominal output, but it must also be able to run with only 250 kW - without premature damage or aging. If accomplished, this wouldn't increase investment costs by more than 20% compared to a standard system, explains Busemeyer. He expects that the additional



Photo: Areva H2Gen

revenue would translate to a three-to-five year payoff. When cross-financing the hydrogen production with FCR, the price of hydrogen would lower even further to approximately €3.45 per kg.

Jury Comment

**Xavier Daval** "The solution can deliver FCR and grid stabilization. Once the energy is converted to hydrogen, it can be used for multiple applications such as mobility or industry."

Ecocoach

## Digital solution integrates energy management with building automation

The case project for which Swiss tech company Ecocoach developed and launched its new digital solution is spectacular. The new 50-unit Mättivor smart complex development near Zurich, situated on a slope with a magnificent view of the mountains, hosts a 260 kWh battery system, 20 EV charging stations, and standard smart home functionality. Ecocoach developed a unique software solution to integrate energy management with building automation in a way that facilitates easy setup and programming for installers. With this innovative approach, they convinced the jury to include them in the group of the five Megawatt winners this year.

Ecocoach's software itself was inspired during the planning and construction of the new Swiss settlement. For housing estates, the digital connection of smart

energy equipment and their scaling has historically required a high degree of programming knowledge and effort. Ecocoach simplifies the challenge with its digital solution, featuring a graphical user interface (GUI) that allows the system to be set up via drag and drop. The company says that their comprehensive solutions integrate all relevant smart energy technologies, including the automation of all relevant building components, such as lights, blinds, heating, and air conditioning.

Once set up, the graphically supported installation compiles the program for the building. The code can be copy, pasted, and adapted for other building units. Even the consumption of power, heat, water, and gas can be grasped by the integrated smart meter and used as basis for analysis and invoicing.

### Jury Comment

**Florian Mayr** "Highly relevant as it facilitates the trend towards prosumer-ship and will allow a broader spectrum of providers to offer integrated building energy systems."



Photo: Ecocoach



Nilar

## Increasing sustainability of battery storage

In recent years, lithium-ion batteries have far overtaken nickel metal hydride (NiMH) batteries. Particular for stationary storage, lithium-ion dominates the market. Nilar, however, has come up with a NiMH solution it believes will provide significant advantages for the residential and C&I markets.

One of these advantages is increased sustainability. With a battery's limited lifespan and the necessity for replacement, there are both waste and cost concerns. Nilar has developed a methodology which it says will allow its battery's lifetime to be multiplied.

Nilar's NiMH utilize a water-based electrolyte that can be regenerated. By filling the battery with oxygen, the same battery's energy can be restored once it starts to wear out. Nilar expects an initial residential battery application to last for

approximately 10 years. After application of the service, the battery could be used for another decade.

How will NiMH technology with the refilling option compare to standard lithium ion technology? "Lithium-ion batteries are common in the energy storage market because the demand for EVs has driven their development," says Nilar. "We believe that NiMH batteries are more suitable for the energy storage market, since energy density and weight are of less concern." While the up-front costs for their batteries are higher, their calculations result in a lower total cost of ownership after life extension.

### Jury Comments

**Mark Higgins** "Kudos to Nilar for developing something that holds the potential to significantly improve the longevity and sustainability of existing battery systems."

**James Frith** "Nilar's ability to regenerate their nickel metal hydride batteries is an elegant solution to help extend project life, therefore reducing the associated manufacturing emissions. Further to this, the system can be easily recycled, making end-of-life management less of a concern."



Photo: Nilar AB

Lumenion

## Combining electricity and heat with low-priced storage



**Berlin startup Lumenion is advancing “flexible sector coupling.” The company has installed a steel storage system in one of Vattenfall’s Berlin district heating networks, which can temporarily store excess solar and wind power with a high degree of efficiency. The solution is capable of converting 25% of thermal energy back into electricity.**

If you think steel is “old economy” or outdated technology, think again. Assuming Lumenion’s projects are successful, this heavy-industry material will solve a problem that lithium-ion batteries have not been able to cope with so far. Solar radiation generally fluctuates in 12-hour cycles, and wind power also comes in waves with 18 to 24-hour intervals of little or no wind, according to Lumenion. This means that a storage system is needed that can be operated economically at an average of 180 cycles per year. In addition, the peak loads at

which this energy has to be stored are about three times as high as the peak loads at which the storage systems are later discharged.

With purely electrical storage, this translates into comparatively high costs for power electronics. If lithium-ion batteries were used for this type of storage, in the very best case, the power they store would cost at least €0.08 per kilowatt-hour, according to Philip Hiersemenzel, Lumenion’s press officer. By contrast, the steel storage system can be operated at €0.02 per kilowatt hour, assuming a service life of 40 years and just 150 cycles per year.

For storage, electrical energy heats a huge steel block by up to as much as 650 degrees Celsius. This can be done with low tech, so to speak, which means that the high feed-in peaks do not drive up the cost of power electronics. The thermal energy is then used either as industrial high-temperature process heat, or as low-temperature heat, in a district heating network or for greenhouses.

If necessary, up to 25% of the energy can be converted back into electricity. To accomplish this, a steam turbine can be connected to the system which can be operated due to the high temperature. It is well known that reconversion of thermal energy into electricity is not very efficient when only the electrical energy is considered. However, the remaining low-temperature heat of 100 to 120 degrees Celsius can still be used in the heating network. As a result, the overall efficiency of the system is around 95%, according to the company. If you subtract what the heat is worth from the price of electricity, you might even be able to achieve electricity costs of €0.03 to €0.04, competitive with gas-powered plants.

At the end of the day, Lumenion is not competing against battery storage sys-

tems, but against thermal storage systems that use other materials – with the most well-known likely being hot water. However, these storage systems are operated at just 150 degrees, which is insufficient for some applications, as it doesn’t allow for efficient reconversion into electricity. With concrete or molten salt, similar storage concepts can be implemented as with the steel storage tank. Lumenion argues that the steel concept is ultimately more cost-effective, that steel is easily recyclable, and that it retains much of its value – which after 40 years of service life still offers positive benefits to the operator.

In 2019, such a steel storage system with a capacity of 2.4 megawatt-hours and a charging power of 340 kilowatts went into operation in a Berlin district heating network operated by Vattenfall, but still without a gas turbine for reconversion. A 40 MWh project is planned for 2020.

After that, the growth in size is expected to continue, as the technology becomes cheaper and is deployed on a larger scale. The vision is to expand to gigawatt-scale storage systems that are the size of home improvement stores. Then, finally, the turbines for reconversion of heat into electricity would also be installed.

### Jury comments

**Julian Jansen** “The Lumenion energy storage system can provide crucial capability for realizing the wider energy transition. It is a strong example of how technology innovation will drive sector-coupling and help decarbonizing both electricity and heat.”

**Nina Munzke** “Very interesting approach for a future large-scale heat supply.”

Photo: Lumenion



**At the opening of the new installation in Berlin last December, Lumenion showcases its 4-ton steel block, which stores at up to 650 degrees Celsius.**

m-Bee

## A cascade for more efficient battery systems



**m-Bee's system eliminates the strict separation between power electronics and batteries. While this seems revolutionary in a battery inverter, it is well-known in the field of high voltage direct-current transmission. With this approach, the company wants to achieve higher efficiencies over a wide performance range.**

**M**-Bee's story started by accident. In 2007 Nam Truong began his studies at the Technical University of Munich. Just two days after the start of the semester, he happened to sit next to fellow student Arthur Singer. Now, after having completed their doctorates, both of them are working on the new startup, which they founded with two other former students. They want to develop a completely different battery inverter technology, which to the jury is worth placing among the megawatt winners of this year's **pv magazine** storage highlights.

"We are eliminating the strict separation between batteries and power electronics," explains Truong, who also acts as the company's managing director. Instead, they ingeniously connect the batteries together to form a swarm so that alternating current at the correct voltage is produced at the end.

This "multi-level approach" can have several advantages, says Truong. Ultimately, it can offer greater flexibility – by allowing different types of batteries or second-life batteries to be interconnected, for instance – or it can achieve higher efficiency over a wide power range at similar cost, thereby reducing overall costs. This has been demonstrated by experience with high-voltage direct current transmission. "This technology is standard for inverters in that field," says Truong.

In conventional battery systems, battery blocks with 48 volts, for instance, are connected in series, so that inverters can be operated at high input voltages, sometimes exceeding 700 volts. At this voltage, the electronic components switch the current flow on and off at a high frequency. Downstream filters smooth the curve until the desired sinusoidal AC voltage at 220 volts, or 380 volts for three-phase systems, is produced.

In m-Bee's innovative "Stabl" system, the individual batteries are

instead connected directly to electronic switches. These determine which batteries are connected in parallel at one moment and which are perhaps connected in series at another moment. This allows direct generation of the sine wave for the AC voltage. As a result, the components operate at the battery voltage instead of the higher system voltage, and also at a lower frequency. You need more components, says Truong, but they are cheaper. And the field-effect transistors m-Bee uses would also have lower losses at lower voltages than the IGBTs used in conventional inverters.

The software controlling the switches also ensures battery balancing. This term refers to compensation for different battery characteristics if components age differently or are of different types. The use of this concept can even compensate for the failure of individual PV panels. During maintenance, a further advantage is that only the low battery voltage is applied, rather than the high system voltage as in conventional battery systems connected in series.

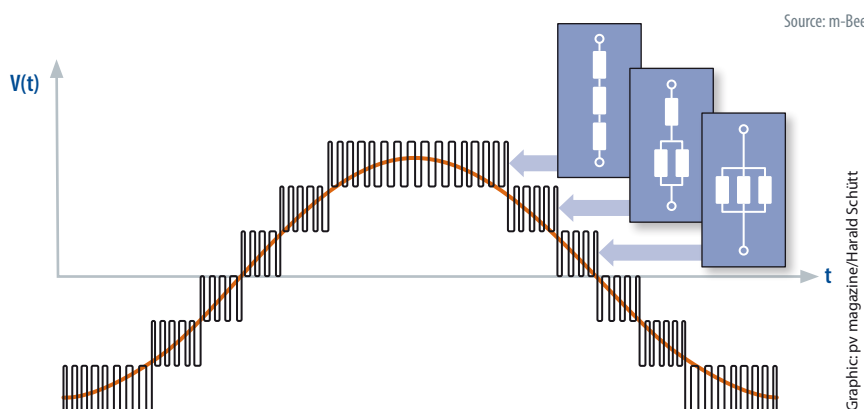
Singer has already proven the concept in his doctoral thesis at the Bundeswehr

University Munich. There, the technology was developed in partnership with storage EPC Smartpower. In the startup's laboratory there is also a system that Truong says is ready for operation. The company founders are currently measuring and optimizing the circuit and efficiency based on this system. The preliminary measurement results are promising, Truong says. Conventional systems would often have poor efficiencies at low loads, but their prototype is different, he claims.

Recently, the company took its next big step. "We just equipped a pilot system at Smartpower comprising of 115 kilowatt-hours of second-life batteries with a 50 kVA inverter," says Truong. The next task will be to obtain the necessary certifications. By the end of the year, the company plans the market launch of components with which storage systems can be built according to the new concept. The founders have their sights set on systems larger than 60 kilowatts.

### Jury comment

**Nina Munzke** "Interesting approach to achieve high efficiencies."



**Battery modules are alternately connected in series and parallel to generate the sinusoidal AC voltage. In the future, the fine-tuning might be done by pulse width modulation (indicated by the square wave curve).**

JenaBatteries

**Metal-free for greater price stability and independence**



**Redox flow batteries are a well-known alternative to their lithium-ion counterparts. Currently, most of the ones that are being built contain vanadium. JenaBatteries is replacing the metal to achieve greater price stability and independence.**

In this year’s energy storage highlights, there were surprisingly few submissions for redox-flow batteries, which become more competitive with lithium-ion batteries at longer storage durations. In *pv magazine* energy storage edition 2018, consulting company Apricum demonstrated the best way to calculate the threshold of the corresponding “storage hour cutoff.” For solar power generated during the day and consumed at night, redox flow batteries are a viable alternative.

Most of today’s redox flow systems use vanadium-based electrolytes. Yet experts are constantly discussing the availability of the element, and whether the price will increase as more redox flow batteries are installed.

This question of uncertainty is shared by Olaf Conrad, the managing director of JenaBatteries, and this is why he is working on alternatives. For the company’s submission in its work on “a metal-free redox flow battery,” it achieved a spot in the Highlights among the Megawatt winners. JenaBatteries uses electrolytes

containing ammonia, acetone, and pyridine, which are all currently produced from abundant petrochemicals.

The company sees the profitability threshold for its technology occurring at electrolyte production volumes of 1,000 metric tons or more per year, which would correspond to approximately 100 MWh of additional storage capacity per year. The producer expects to reach this volume in 2024, bringing the cost of the battery to less than EUR 500 per kWh, at a C-rate of 0.25. A capacity of 400 kWh would then translate into 100 kW of charging and discharging capacity.

A typical question surrounding battery technologies is the fundamental issue of durability. “We do not yet have exact data on service life,” says Conrad, but published research suggests that the electrolyte lasts 10,000 cycles. The company’s own studies indicate that 80% of capacity would still be available after the targeted service life of 20 years and 10,000 cycles. In principle, the electrolyte could also be recycled, but Conrad expects that in 10 years’ time, the production costs of

the electrolyte would be so low that this would not be worthwhile.

The company has just announced the completion of its first fully installed system in the field. With an output of 30 kW at a capacity of 100 kWh, it is part of the EU Horizon2020 EnergyKeeper project. The first published findings related to the new system are expected to be released in the course of this year.

Aside from JenaBatteries, other companies are also working on redox flow batteries, developing metal-free alternatives to vanadium electrolytes. Olaf Conrad sees his company at an advantage over its competitors – particularly in regards to stability, and in terms of the capital required to rapidly expand production volume. However, the vanadium price development is not so clear cut. In 2018, it went up, but the peak in price was only for a relatively short duration. The industry will also be keeping a close eye on metal-containing electrolytes that use widely available metals, such as iron in place of vanadium, that are produced on a large scale.



*A look at the interior of the JenaBatteries device.*



Photos: JenaBatteries

*(Left to right): uncharged catholyte, charged catholyte, uncharged anolyte, charged anolyte. The organic electrolytes change color depending on their charge state.*



**Emectric battery systems**

## Taking flight: flexibility on the cell level



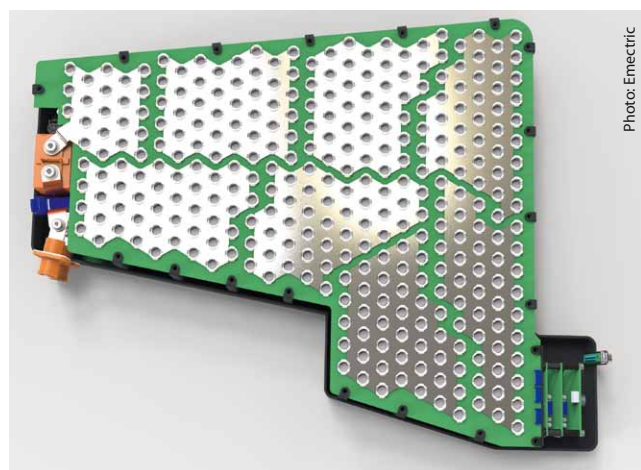
The battery shown in the photo may draw associations with an airplane wing. This is precisely the route that startup storage company Emectric is flying with its custom-tailored battery systems. During the development of a self-starting aircraft glider, the company says there was no battery system avail-

able to address the needs of the challenging assembly space and prototype costs, which brought forth its modular solution. The company has developed a lightweight non-flammable matrix to address the needs of the aviation market with minimal system mass and optimal space utilization.

“Especially in the aviation market, the presently low level of electrification is owed the need for individual geometries, high safety standards, and high energy densities where standard modules or standardized battery systems are not efficient,” says Emectric.

With unique design capabilities, the company says its flexible modular concept provides freedom for rapid prototyping and small-scale production without investing in molds, although housing is needed. By providing flexibility on the cell level, the company says that difficult assembly spaces can be filled and financial costs are reduced.

The electrification of self-starting gliders is moving forward with certifications this year, says Emectric. Batteries for wings are scheduled to be certified in March, and batteries for the aircraft body are planned for April 2020. The company is also currently working on the development of a hybrid-glider motor.



**Kaco New Energy**

## Hybrid inverter: opening the source



Bringing something completely new into the market of hybrid inverters for small-scale solar storage systems isn't easy. Nevertheless, some special features of the new Blueplanet Hybrid 10.0 TL3 device from Kaco could attract attention.

For one thing, the new inverter not only allows you to connect solar power to 10 kW of storage, but it also handles charging and discharging at the same level. This could become particularly beneficial if you would like to charge an electric car with it. The company expects to score well in the storage inspection of HTW-Berlin, when that time comes, in its assessment of system performance – where efficiency is one key parameter. Carrying heavy weight in the performance assessment is the ability to deliver high efficiency at low loads, despite high discharge capacity

– and Kaco does just that. According to the characteristic curve of the company's product data sheet, the hybrid inverter operates at about 97% at 5 kW, but even at 600 W it should still perform at about 95% efficiency.



Another interesting feature of the product is the emergency power capability of the three-phase unit. A single-phase compensation is also being worked on, so that in the future, the device will be able to prevent energy from being fed into one phase and drawn out from the other phase, which should please network operators.

Lastly, the product has an interface to the open source energy management system OpenEMS, which was ranked among one of top five **pv magazine** energy storage highlights in 2019, and is set to support network operators, storage manufacturers, and integrators to build and expand virtual power plants.

E3/DC

## Farming on zero feed-in



**Decarbonization in the commercial sector is one of the core topics covered at this year’s Energy Storage Europe. The battery storage manufacturer E3/DC and its partner demonstrate how this goal can be achieved on a farm with a weak grid connection.**

Often, there is enough land available for solar power generation in remote areas. If there is a farm in place, there is also a considerable need for electricity. Generally this combination makes for an ideal solar+storage project. However, large PV installations in such locations are typically challenged by weak electric grids, making connection difficult.

This was also the case at Gut Gerkenhof, a breeding and agricultural farm in northern Germany where 10 employees look after 180 cattle, 50 horses, and an extensive 600-hectare farm. A 30 kW solar PV system previously installed in 2014 had little impact on the farm’s annual 250,000 kWh power consumption. Desiring more renewables, the farmers were constrained by a grid connection designed for 80 kW maximum power. Only through the development of a so-called zero feed-in plant, which curtails the generation in case

it exceeds the consumption on-site, would this be possible.

But even when a large battery storage system stores a large portion of the solar power when not directly consumed, energy management is challenging and must ensure that no short-term feed-in peaks flow into the grid. Such rapid peaks occur frequently, for example, when the air conditioning switches off or a fuse blows. A control system must also be fail-safe.

In April 2019, the last amendment to the Low Voltage Directive in Germany laid out clear criteria for such zero feed-in installations, but in the end, the grid operator determines whether an installation meets the necessary criteria to protect the grid.

Stepping in to resolve the challenge for Gut Gerkenhof, battery system manufacturer E3/DC worked with partner Laudeley Betriebstechnik. Installing an additional 140 kW of PV capacity on the

estate, the farm now has a new total generation output of 170 kW, with a 154 kWh battery storage system. And the farmers plan to install a 30 kW small wind turbine soon, bringing the farm to generate approximately 95% of its electricity on-site. Grid connection will now only serve to close the gaps in self-sufficiency during winter months.

The batteries are connected with 10 AC inverters. The maximum output power is 36 kW, with a continuous output of 27 kW. This allows the farm to be supplied with power – regardless of whether the sun is shining or the wind is blowing.

At the point of grid connection, a system monitors the current flow in real-time, every second, controlling the system to prevent grid feed-in. The documented data is provided to grid operators to demonstrate zero feed-in responsibility.

In theory, there were alternatives to the zero feed-in concept. Grid connection could have been expanded for EUR 67,000. Or, for EUR 250,000, the farm could have bought a transformer to tie in directly to medium voltage. But this seems a nonsensical investment when a grid connection is hardly needed anyway.

“Photovoltaics were added here to save costs, not to sell electricity,” says E3/DC managing director Andreas Piepenbrink. “A novelty for commercial plants of this size is the high-speed, modular, and safe control system with a corresponding measuring concept.” This has succeeded in convincing EWE, the local DSO. Incidentally, the farm uses wood from its own forest for heating, so self-sufficiency also includes this sector.

### Jury comment

**Julian Jansen** “This is an interesting project, as it highlights how storage can reduce the need for costly grid-upgrades, enabling end customers to install on-site renewables.”



Rubitherm Technologies

## Phase change material, directly applied in cooling systems

Most cooling systems are currently built with compressor-based technologies using refrigerants. To comply with EU regulations, there is a need for more energy-efficient HVAC systems to replace current systems, while also limiting the environmental impact of the expected increase in total number of systems. Using phase change material (PCM) as a storage material, in principle, is not new. But Rubitherm Technologies' new PhaseCube, however, encapsulates these materials in metal casings, which are implemented in an air duct. A fan ensures proper air circulation between the outdoors, PCM storage, and indoors.

The PhaseCube storage solution consists of single modules with a capacity of 1.2 kWh each, in a temperature range of 15K around the melting point. The melting point of the PCM is chosen to fit the expected night and day temperatures in the place of installation. The PCM melts at 20-25 degrees and absorbs heat from the room. If the temperature falls below 20 degrees due to ventilation at night, the material freezes again and can start a new cycle. By doing this, the rather simple solution stores the coldness of the night to cool the air during the day, making the devices more efficient.

Modules can be installed as single units or combined into larger systems. Depending on the system size, Rubitherm Technologies pre-installation net costs range between €300-400/kWh.

PhaseCube is cycle stable for more than 30 years (10,000 cycles) and there is no maintenance required on the PCM storage itself. Energy savings compared to conventional systems are 20% to 60%.



Photo: Rubitherm Technologies



ZAE-Bayern

## Enhancing efficiency and adaptability of PV with phase change material

SolarSplit is the second submission in this year's energy storage highlights to make direct use of phase change material (PCM) in cooling systems. But the motivation of researchers at ZAE-Bayern underlines a slightly different challenge: increased deployment

of renewable energy creates grid volatility. Thermal energy storage, in particular latent heat storage, integrated into an electrical driven cooling system can enhance efficiency and adaptability to volatile sources. The German government-funded pilot project is a grid-connect solar PV supported variable refrigerant flow heating and cooling system. The air/air based cooling and heating system with 22.4 kW nominal cooling capacity is equipped with a PCM storage system.

The storage material is in direct contact with the refrigerant through a heat exchanger, and an enhancement of the thermal conductivity from the storage material mitigates efficiency losses. To monitor the state of charge, a device was developed using the density difference between molten and solid storage material. The storage is sized with 14 kWh of latent heat capacity for daily cycling. Sev-

eral control strategies for storage operation and their influence at load shifting and cycle efficiency were evaluated over two years and a detailed comparison between operating the system with and without the storage was performed. Cycle efficiency increased due to less start-stop operation of the compressor. Depending on the actual ambient conditions, the improvement of cooling efficiency varied.

During storage discharge, temporarily stored energy was available reliably, without loss as useful cooling. At medium cooling load, performance increased by 9-17% compared to operation without storage. For high ambient temperatures with high cooling loads, the storage had its greatest effect with 20-28% performance gains. ZAE-Bayern says that the addition of storage increased the self-consumption of PV generation by 5-8%.



Photo: ZAE-Bayern



Xelextrix

## Boosting peak power

Coming online in mid-2020, the Power Box energy storage system from Xelextrix Power brings configuration units sized up to a 1000 kW inverter and 1000 kWh of storage. Power Box is applicable for both on and off-grid applications.

With functional flexibility, Power Box products can work in parallel or in stacked use cases for peak shaving, load shifting, backup power, and stabilizing energy simultaneously. The company says that its storage solution can currently pay for itself with services such as grid optimization and peak shaving. And while still in R&D, the company says that in the future it will be possible to cluster several plants to form a virtual power plant.

For off-grid applications, the Power Box works to make diesel generators run at an optimal range to decrease fuel

consumption – providing advantages for the operator and climate. The Power Box runs in parallel to the diesel generator, and by adding power from the generator to that of the on-board inverter, the size of the generator can be reduced. The inverter is based on hybrid bidirectional technology with in-house programming, but cannot charge and discharge at the same time. The company says that changes in parameters can be reacted to in milliseconds.

The company also touts its benefits to support e-mobility, by tackling supply. “Many EV locations will want to install charging stations but will not have the power connections to do so, and using a diesel generator to charge EV’s makes no sense,” says Xelextrix. With Power Box’s ability to run parallel to the grid, the company says additional required power

can be supplied with its peak power boost feature. For example, the Power Box can be charged at night or at times when no EVs need to be charged.



Photo: Xelextrix



Trumpf Hüttinger

## Coupling solar + redox-flow storage via DC

One downside of hybrid inverters compared to AC-coupled systems is the loss of flexibility, as solar PV and battery inputs are usually fixed in terms of the PV-to-battery power ratio or the supported input voltage windows. Trumpf’s new TruConvert Modular System, combined with Ampt string optimizers, brings both DC- and AC-coupled

approaches to energy storage, particularly to connect redox-flow batteries.

By coupling solar PV, storage, and EV charging via a DC link, the combined power electronics solution avoids multiple conversions of energy. Using a higher, fixed DC-link voltage of 850 V, TruConvert provides a flexible and scalable battery-to-PV power ratio, wide PV input

voltage range, and a charging/discharging CEC efficiency between battery and grid of 93%. The company says its new offering will improve efficiencies for low-voltage battery storage systems, typically in the range of 30 to 75 V. A 25 kW system consists of 3 DC-DC-converters and one DC-AC-converter.

The product supports up to 16 DC/DC + 4 DC/AC in one system over one DC Link, which is used in 100 kW redox flow containers. The company plans to connect several 100 kW containers to one DC Link in the future. Made available December 2019, the company does not yet have DC-coupled system projects installed in the field where it is combined with solar PV, but it has received several inquiries. However, at Fraunhofer ICT in Karlsruhe, Germany, there is an installation running (see photo) which is coupled to a 2 MW wind turbine.



Photo: Trumpf Hüttinger

Kreisel Electric

## Fully charged EV's, without grid strain

Made available to the European market at the top of 2020, Kreisel Electric's new EV fast-charging station, Chimero HPC & EES, provides 150 kW DC or 22 kW AC power with an integrated 75 kWh of usable battery storage and net-conductive connection of 55 kW AC. The company says that with its integrated storage system, which can be powered through the grid or from renewables, EVs are able to fully charge without straining the grid.

With partial self-sufficiency of the Chimero HPC & EES solution, two battery EVs can be loaded in succession. After that, further charging is possible due to the grid connection power.

"An electric car with 95 kWh battery and 150 kW DC charging capability can be charged within 24 min from 10-80% SOC with just a 50 kW grid connection

without high networks loads," says Kreisel, adding that a typical 50 kW charge would take about 75 to 80 minutes.

Chimero has the ability to optimize self-consumption through an energy management system (EMS). When adapted with intelligent interfaces, it is possible for the charging stations to also participate in the market and provide grid services.

The company's first series of installations were installed at automobile dealers and garages in Austria, but have since been optimized for market launch. Kreisel says that its charging point costs will average approximately EUR 800-1,000 per kW of charging power over the expected lifetime of the system, which is roughly 12 years.



Photo: Kreisel Electric

Intilion

## Plug & play storage solution

Intilion's newly released Scaleblock fully integrated battery storage system is designed for behind-the-meter and off-grid applications. The holistic design approach includes battery, inverter, and an energy management system with cloud

connectivity. Its internal EMS system protects and controls all electrical system components, and allows for control of the scaleblock in the respective application.

A big brother to Intilion's Scalecube system design for C&I applications, the

new Scaleblock solution offers a modular design with 19" withdrawable racks to be modified for a wide range of requirements, scalable up to 1 MWh/MW. The plug & play concept offers 68.5 kWh of nominal energy content, one or two 30 kVA three-phase 4Q inverters, an energy management system, and an air-conditioned outdoor cabinet suitable for difficult environments.

The product's outdoor enclosure provides protection against the ingress of water and dust.

"The scalebloc is also equipped with a climatization concept which guarantees that the cell temperature are very close together even at full power," says Matthis Büter, Intilion's head of energy storage product development, adding that this is especially important to support the lifespan of the entire system.



Photo: Intilion GmbH

**Mobitron**

## Handling batteries, with data and care



Large, expensive battery energy systems frequently travel overseas to their final destination. But the potential for damages to fragile batteries during transportation can pose serious threats. Improper packing, shipping, or handling of batteries can result in damages that create enormous challenges with costly project delays. Mobitron's Cargo-log Impact and Shock Recorder system monitors the impacts, temperature, and other environmental conditions of batteries during transport.

The solution detects shocks, vibrations, and impacts in real-time to enable engineers and project managers to know what has happened to batteries during transportation before field deployment.

The recorder is installed directly to cargo to supervise, detect, and minimize the mishandling of batteries dur-

ing transport. Using calibrated sensors, the product provides online tracking.

“If the battery experienced a hard drop at the port while off-loading with the gantry crane, the Cargo-log could precisely determine this by providing the exact

time it happened and the GPS coordinates,” says Mobitron.

Depending on the energy storage system, there are different set limitation conditions set by the manufacturer, based on tests. In the contract with the cargo company, these conditions and limits are fixed for the whole voyage. The Cargo-log system will provide warnings if the limits are exceeded, supports companies to establish who is responsible for remedying battery damages, and provides the data necessary to substantiate guarantees or insurance claims. The unit is easy to install on a new shipment and can be reused without a new product purchase. It is also able to support the identification of ideal transport routes, storage options, and delivery conditions.



Photo: Mobitron

**Hoeller Electrolyzer**

## Higher-efficiency PEM stacks for hydrogen generation on the horizon



To increase efficiency, performance, and the maximum output of hydrogen generation – this is the intention of Hoeller Electrolyzer. If successful, the company's Prometheus product line will certainly add attractive value to the industry. The company says that it is working on “the next generation” of hydrogen electrolysis stacks based on PEM technology.

To explain it in more detail, the company says it holds several patents along the “PEM optimization path” – for increasing the processing temperature, for better heat exchange, for reducing high water quality requirements, and for reducing the need of precious metals.

Indeed, there is space to improve today's products on these fronts. The need for precious metals required to coat electrodes, such as currently very expensive palladium or platinum, is one of the pri-

mary reasons for high system costs. And even though PEM electrolysis is generally considered to produce the largest amount of hydrogen with the lowest total energy input compared to other electrolysis concepts, currently, manufacturers often state efficiencies of only around 75% for their devices. Researchers such as Andreas Brinner from the Center for Solar Energy and Hydrogen Research in Baden-Württemberg, Germany, suggest that the efficiency can be pushed up to 94%.

Hoeller Electrolyzer has not yet stated what the efficiency of its Prometheus series will be, but the smallest stacks in the series will have 76 kW of power, with the capability to produce 34 kilograms of hydrogen per day. The largest stack, with 1.4 MW of nominal power, will produce 635 kilograms of hydrogen. According to Hoeller, the price per kilogram of hydro-

gen could be less than €4. The company says the first developments will be completed mid-year.



Photo: Hoeller Electrolyzer

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